2024 EXAMINATION

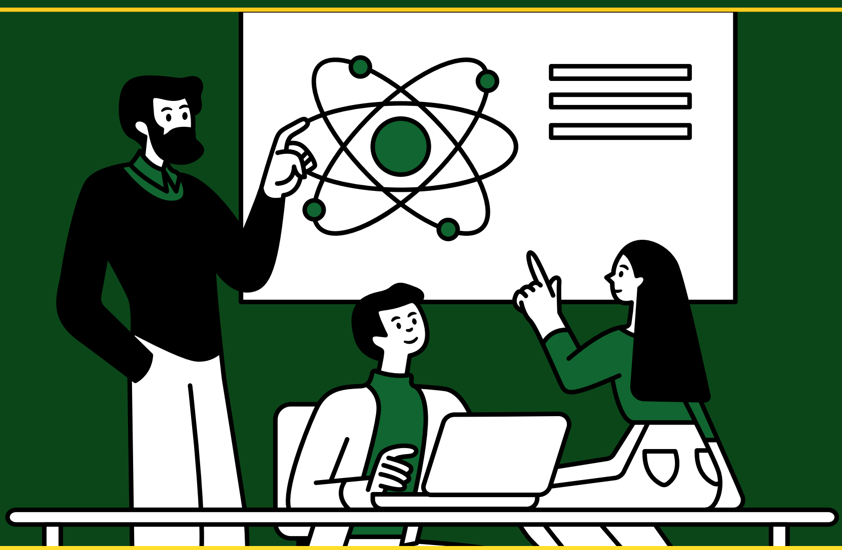
Almond Books

ICSE CLASS 10

STUDY GUIDE

(Strictly based on the latest syllabus prescribed by the council)

NOTES + QUESTION BANK + SAMPLE PAPERS



PHYSICS

Detailed Notes

REVISE SMARTLY

Examiner Feedback

AVOID SILLY ERRORS

Question Bank

WITH SOLUTIONS

ALMOND BOOKS ICSE CLASS 10 PHYSICS STUDY GUIDE

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Preface

The **Almond Books Physics Study Guide** is specifically tailored to aid students preparing for the 2024 ICSE Class 10 Science exam.

This comprehensive resource delves into the foundational aspects of physics, exploring the forces shaping our world and unraveling the mysteries of electricity, light, and sound. It enhances students' understanding of these topics through clear explanations and engaging content.

This study guide distinguishes itself from traditional physics guides by emphasising both high-quality notes and thought-provoking questions. Starting with concise overviews of each topic, students will quickly grasp essential concepts and develop a deeper understanding of the material.

Aligned with the latest ICSE Physics syllabus and exam pattern, this book assures that students are able to learn and practise thoroughly.

This book is meticulously organised in chapter-wise format, and includes the following:

- Marvels of Physics (Engaging stories that illuminate key concepts)
- Core Concepts / Revision Notes
- Multiple-choice questions (MCQs) accompanied by answer keys
- A fresh selection of practice questions with solutions
- Questions from renowned ICSE School Prelim Exams, complete with solutions
- Important questions from past board exams, featuring answers and Examiner feedback
- Sample Papers
- Answer key for the most recent official ICSE Physics Specimen Paper.

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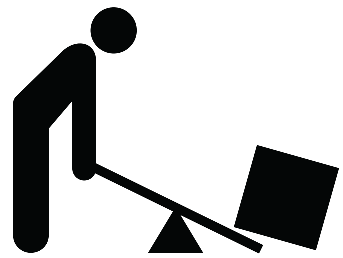

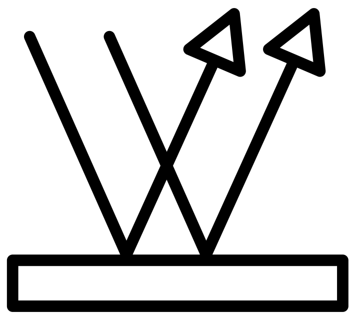

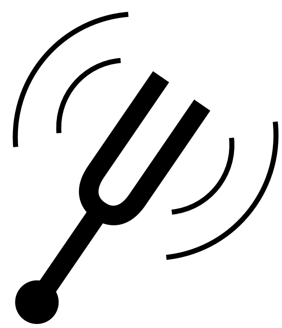

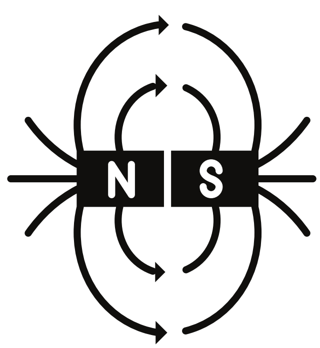

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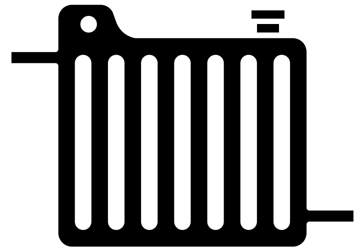

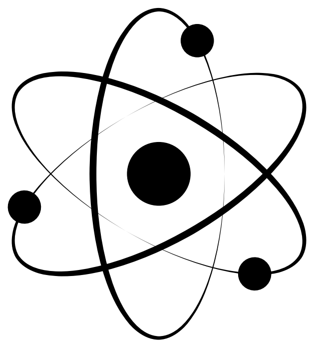

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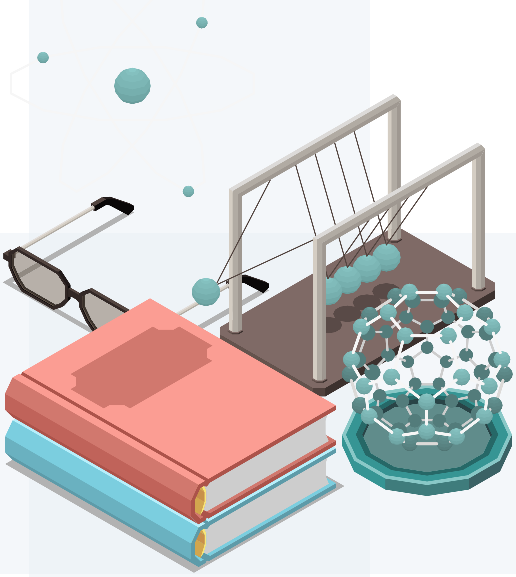

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CLASS X

*There will be one paper of **two hours** duration carrying 80 marks and Internal Assessment of practical work carrying 20 marks.*

*The paper will be divided into **two** sections, Section I (40 marks) and Section II (40 marks).*

***Section I (compulsory)** will contain short answer questions on the entire syllabus.*

***Section II** will contain six questions. Candidates will be required to answer any **four** of these **six** questions.*

***Note:** Unless otherwise specified, only SI Units are to be used while teaching and learning, as well as for answering questions.*

1. Force, Work, Power and Energy

(i) Turning forces concept; moment of a force; forces in equilibrium; centre of gravity; [discussions using simple examples and simple numerical problems].

Elementary introduction of translational and rotational motions; moment (turning effect) of a force, also called torque and its cgs and SI units; common examples - door, steering wheel, bicycle pedal, etc.; clockwise and anti-clockwise moments; conditions for a body to be in equilibrium (translational and rotational); principle of moment and its verification using a metre rule suspended by two spring balances with slotted weights hanging from it; simple numerical problems; Centre of gravity (qualitative only) with examples of some regular bodies and irregular lamina.

(ii) Uniform circular motion.

As an example of constant speed, though acceleration (force) is present. Differences between centrifugal and centripetal force.

(iii) Work, energy, power and their relation with force.

Definition of work. $W = FS\cos\theta$; special cases of $\theta = 0^0$, 90^0. W= mgh. Definition of energy, energy as work done. Various units of work and energy and their relation with SI units. [erg, calorie, kW h and eV]. Definition of Power, P=W/t; SI and cgs units; other units, kilowatt (kW), megawatt (MW) and gigawatt (GW); and horsepower (1hp=746W) [Simple numerical problems on work, power and energy].

(iv) Different types of energy (*e.g.,* chemical energy, Mechanical energy, heat energy, electrical energy, nuclear energy, sound energy, light energy).

Mechanical energy: potential energy U = mgh (derivation included) gravitational PE, examples; kinetic energy $K= \frac{1}{2} mv^2$ (derivation included); forms of kinetic energy: translational, rotational and vibrational - only simple examples. [Numerical problems on K and U only in case of translational motion]; qualitative discussions of electrical, chemical, heat, nuclear, light and sound energy, conversion from one form to another; common examples.

(v) Machines as force multipliers; load, effort, mechanical advantage, velocity ratio and efficiency; simple treatment of levers, pulley systems showing the utility of each type of machine.

Functions and uses of simple machines: Terms- effort E, load L, mechanical advantage MA = L/E, velocity ratio $VR = V_E/V_L = d_E / d_L$, input (W_i), output (W_o), efficiency (η), relation between η and MA, VR (derivation included); for all practical machines $\eta < 1$; MA < VR.

Lever: principle. First, second and third class of levers; examples: MA and VR in each case. Examples of each of these classes of levers as also found in the human body.

Pulley system: single fixed, single movable, block and tackle; MA, VR and η in each case.

(vi) Principle of Conservation of energy.

Statement of the principle of conservation of energy; theoretical verification that U + K = constant for a freely falling body. Application of this law to simple pendulum (qualitative only); [simple numerical problems].

2. Light

(i) Refraction of light through a glass block and a triangular prism - qualitative treatment of simple applications such as real and apparent depth of objects in water and apparent bending of sticks in water. Applications of refraction of light.

Partial reflection and refraction due to change in medium. Laws of refraction; the effect on speed (V), wavelength (λ) and frequency (f) due to refraction of light; conditions for a light ray to pass undeviated. Values of speed of light (c) in vacuum, air, water and glass; refractive index $\mu = c/V$, $V = f\lambda$. Values of μ for common substances such as water, glass and diamond; experimental verification; refraction through glass block; lateral displacement; multiple images in thick glass plate/mirror; refraction through a glass prism, simple applications: real and apparent depth of objects in water; apparent bending of a stick under water. (Simple numerical problems and approximate ray diagrams required).

(ii) Total internal reflection: Critical angle; examples in triangular glass prisms; comparison with reflection from a plane mirror (qualitative only). Applications of total internal reflection.

Transmission of light from a denser medium (glass/water) to a rarer medium (air) at different angles of incidence; critical angle (C) $\mu = 1/\sin C$. Essential conditions for total internal reflection. Total internal reflection in a triangular glass prism; ray diagram, different cases - angles of prism (60^o,60^o,60^o), (60^o,30^o,90^o), (45^o,45^o,90^o); use of right angle prism to obtain $\delta = 90^o$ and 180^o (ray diagram); comparison of total internal reflection from a prism and reflection from a plane mirror.

(iii) Lenses (converging and diverging) including characteristics of the images formed (using ray diagrams only); magnifying glass; location of images using ray diagrams and thereby determining magnification.

Types of lenses (converging and diverging), convex and concave, action of a lens as a set of prisms; technical terms; centre of curvature, radii of curvature, principal axis, foci, focal plane and focal length; detailed study of refraction of light in spherical lenses through ray diagrams; formation of images - principal rays or construction rays; location of images from ray diagram for various positions of a small linear object on the principal axis; characteristics of images. Sign convention and direct numerical problems using the lens formula are included (derivation of formula not required).

Scale drawing or graphical representation of ray diagrams not required.

Power of a lens (concave and convex) – [simple direct numerical problems]: magnifying glass or simple microscope: location of image and magnification from ray diagram only [formula and numerical problems ***not*** *included]. Applications of lenses.*

(iv) Using a triangular prism to produce a visible spectrum from white light; Electromagnetic spectrum. Scattering of light.

Deviation produced by a triangular prism; dependence on colour (wavelength) of light; dispersion and spectrum; electromagnetic spectrum: broad classification (names only arranged in order of increasing wavelength); properties common to all electromagnetic radiations; properties and uses of infrared and ultraviolet radiation. Simple application of scattering of light e.g. blue colour of the sky.

3. Sound

(i) Reflection of Sound Waves; echoes: their use; simple numerical problems on echoes.

Production of echoes, condition for formation of echoes; simple numerical problems; use of echoes by bats, dolphins, fishermen, medical field. SONAR.

(ii) Natural vibrations, Damped vibrations, Forced vibrations and Resonance - a special case of forced vibrations.

Meaning and simple applications of natural, damped, forced vibrations and resonance.

(iii) Loudness, pitch and quality of sound:

Characteristics of sound: loudness and intensity; subjective and objective nature of these properties; sound level in decibel(dB) (as unit only); noise pollution; interdependence of: pitch and frequency; quality and waveforms (with examples).

4. Electricity and Magnetism

(i) Ohm's Law; concepts of emf, potential difference, resistance; resistances in series and parallel, internal resistance.

Concepts of pd (V), current (I), resistance (R) and charge (Q). Ohm's law: statement, V=IR; SI units; experimental verification; graph of V vs I and resistance from slope; ohmic and non-ohmic resistors, factors affecting resistance (including specific resistance) and internal resistance; super conductors, electromotive force (emf); combination of resistances in series and parallel and derivation of expressions for equivalent resistance. Simple numerical problems using the above relations. [Simple network of resistors].

(ii) Electrical power and energy.

Electrical energy; examples of heater, motor, lamp, loudspeaker, etc. Electrical power; measurement of electrical energy, $W = QV = VIt$ from the definition of pd. Combining with ohm's law $W = VIt = I^2 Rt = (V^2/R)t$ and electrical power $P = (W/t) = VI = I^2R = V^2/R$. Units: SI and commercial; Power rating of common appliances, household consumption of electric energy; calculation of total energy consumed by electrical appliances; $W = Pt$ (kilowatt × hour = kW h), [simple numerical problems].

(iii) Household circuits – main circuit; switches; fuses; earthing; safety precautions; three-pin plugs; colour coding of wires.

House wiring (ring system), power distribution; main circuit (3 wires-live, neutral, earth) with fuse / MCB, main switch and its advantages - circuit diagram; two-way switch, staircase wiring, need for earthing, fuse, 3-pin plug and socket; Conventional location of live, neutral and earth points in 3 pin plugs and sockets. Safety precautions, colour coding of wires.

(iv) Magnetic effect of a current (principles only, laws not required); electromagnetic induction (elementary); transformer.

Oersted's experiment on the magnetic effect of electric current; magnetic field (B) and field lines due to current in a straight wire (qualitative only), right hand thumb rule – magnetic field due to a current in a loop; Electromagnets: their uses; comparisons with a permanent magnet; Fleming's Left Hand Rule, the DC electric motor- simple sketch of main parts (coil, magnet, split ring commutators and brushes); brief description and type of energy transfer(working not required): Simple introduction to electromagnetic induction; frequency of AC in house hold supplies , Fleming's Right Hand Rule, AC Generator - Simple sketch of main parts, brief description and type of energy transfer(working not required). Advantage of AC over DC. Transformer- its types, characteristics of primary and secondary coils in each type (simple labelled diagram and its uses).

5. Heat

(i) Calorimetry: meaning, specific heat capacity; principle of method of mixtures; Numerical Problems on specific heat capacity using heat loss and gain and the method of mixtures.

Heat and its units (calorie, joule), temperature and its units (^oC, K); thermal (heat) capacity $C' = Q/\triangle T$... (SI unit of C'): Specific heat Capacity $C = Q/m\triangle T$ (SI unit of C) Mutual relation between Heat Capacity and Specific Heat capacity, values of C for some common substances (ice, water and copper). Principle of method of mixtures including mathematical statement. Natural phenomenon involving specific heat. Consequences of high specific heat of water. [Simple numerical problems].

(ii) Latent heat; loss and gain of heat involving change of state for fusion only.

Change of phase (state); heating curve for water; latent heat; specific latent heat of fusion (SI unit). Simple numerical problems. Common physical phenomena involving latent heat of fusion.

6. **Modern Physics**

(i) Radioactivity and changes in the nucleus; background radiation and safety precautions.

Brief introduction (qualitative only) of the nucleus, nuclear structure, atomic number (Z), mass number (A). Radioactivity as spontaneous disintegration. α, β and γ - their nature and properties; changes within the nucleus. One example each of α and β decay with equations showing changes in Z and A. Uses of radioactivity - radio isotopes. Harmful effects. Safety precautions. Background radiation.

Radiation: X-rays; radioactive fallout from nuclear plants and other sources.

Nuclear Energy: working on safe disposal of waste. Safety measures to be strictly reinforced.

(ii) Nuclear fission and fusion; basic introduction and equations.

A NOTE ON SI UNITS

SI units (*Systeme International d'Unites*) were adopted internationally in 1968.

Fundamental units

The system has seven fundamental (or basic) units, one for each of the fundamental quantities.

Fundamental quantity	Unit	
	Name	Symbol
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Derived units

These are obtained from the fundamental units by multiplication or division; no numerical factors are involved. Some derived units with complex names are:

Derived quantity	Unit	
	Name	Symbol
Volume	cubic metre	m^3
Density	kilogram per cubic metre	$kg\ m^{-3}$
Velocity	metre per second	$m\ s^{-1}$
Acceleration	metre per second square	$m\ s^{-2}$
Momentum	kilogram metre per second	$kg\ m\ s^{-1}$

Some derived units are given special names due to their complexity when expressed in terms of the fundamental units, as below:

Derived quantity	Unit	
	Name	Symbol
Force	newton	N
Pressure	pascal	Pa
Energy, Work	joule	J
Power	watt	W
Frequency	hertz	Hz
Electric charge	coulomb	C
Electric resistance	ohm	Ω
Electromotive force	volt	V

When the unit is named after a person, the *symbol* has a capital letter.

Standard prefixes

Decimal multiples and submultiples are attached to units when appropriate, as below:

Multiple	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

INTERNAL ASSESSMENT OF PRACTICAL WORK

Candidates will be asked to carry out experiments for which instructions will be given. The experiments may be based on topics that are not included in the syllabus but theoretical knowledge will not be required. A candidate will be expected to be able to follow simple instructions, to take suitable readings and to present these readings in a systematic form. He/she may be required to exhibit his/her data graphically. Candidates will be expected to appreciate and use the concepts of least count, significant figures and elementary error handling.

Note: Teachers may design their own set of experiments, preferably related to the theory syllabus. A comprehensive list is suggested below:

1. Lever - There are many possibilities with a meter rule as a lever with a load (known or unknown) suspended from a point near one end (say left), the lever itself pivoted on a knife edge, use slotted weights suspended from the other (right) side for effort.

   Determine the mass of a metre rule using a spring balance or by balancing it on a knife edge at some point away from the middle and a 50g weight on the other side. Next pivot (F) the metre rule at the 40cm, 50cm and 60cm mark, each time suspending a load L or the left end and effort E near the right end. Adjust E and or its position so that the rule is balanced. Tabulate the position of L, F and E and the magnitudes of L and E and the distances of load arm and effort arm. Calculate MA=L/E and VR = effort arm/load arm. It will be found that MA <VR in one case, MA=VR in another and MA>VR in the third case. Try to explain why this is so. Also try to calculate the real load and real effort in these cases.
2. Determine the VR and MA of a given pulley system.
3. Trace the course of different rays of light refracting through a rectangular glass slab at different angles of incidence, measure the angles of incidence, refraction and emergence. Also measure the lateral displacement.
4. Determine the focal length of a convex lens by (a) the distant object method and (b) using a needle and a plane mirror.
5. Determine the focal length of a convex lens by using two pins and formula $f = uv/(u+v)$.
6. For a triangular prism, trace the course of rays passing through it, measure angles i_1, i_2, A and δ.Repeat for four different angles of incidence (say $i_1=40^0$, 50^0, 60^0 and 70^0). Verify $i_1+ i_2=A+\delta$ and $A = r_1 + r_2$.
7. For a ray of light incident normally ($i_1=0$) on one face of a prism, trace course of the ray. Measure the angle δ. Explain briefly. Do this for prisms with $A=60^0$, 45^0 and 90^0.
8. Calculate the specific heat capacity of the material of the given calorimeter, from the temperature readings and masses of cold water, warm water and its mixture taken in the calorimeter.
9. Determination of specific heat capacity of a metal by method of mixtures.
10. Determination of specific latent heat of ice.
11. Using as simple electric circuit, verify Ohm's law. Draw a graph, and obtain the slope.
12. Set up model of household wiring including ring main circuit. Study the function of switches and fuses.

Teachers may feel free to alter or add to the above list. The students may perform about ten experiments. Some experiments may be demonstrated.

EVALUATION

The practical work/project work are to be evaluated by the subject teacher and by an External Examiner. (The External Examiner may be a teacher nominated by the Head of the school, who could be from the faculty, **but not teaching the subject in the relevant section/class**. For example, a teacher of Physics of Class VIII may be deputed to be an External Examiner for Class X, Physics projects.)

The Internal Examiner and the External Examiner will assess the practical work/project work independently.

Award of Marks	**(20 Marks)**
Subject Teacher (Internal Examiner)	10 marks
External Examiner	10 marks

The total marks obtained out of 20 are to be sent to the Council by the Head of the school.

The Head of the school will be responsible for the online entry of marks on the Council's CAREERS portal by the due date.

FORCE, WORK, POWER & ENERGY

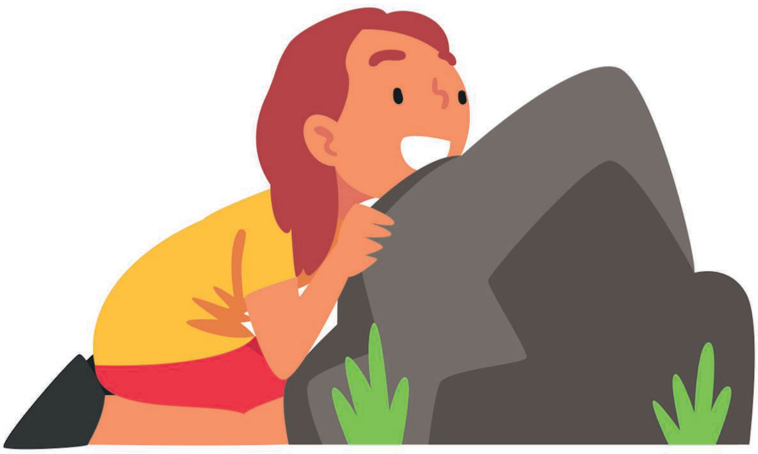
Once upon a time, in the enchanted land of Physicsville, there lived four inseparable friends: Force, Work, Power, and Energy. Together, they were known as the Power Pals. They loved helping the townspeople with their everyday tasks, each in their unique ways. One sunny day, the Power Pals decided to go on an adventure, and little did they know, this adventure would be the perfect way to explain their individual roles and the relationship between them.

As the Power Pals strolled along, they came across Mighty Mo, a 10-year-old girl who was trying to push a large, stubborn boulder off the path in front of her house. Mighty Mo was struggling to move the boulder, so the Power Pals decided to lend her a helping hand.

First up was **Force**, a strong and energetic character. "Mighty Mo, to move the boulder, you need to apply force. That's me! I'm the push or pull that acts on an object, like this boulder," Force said. With Force's help, Mighty Mo pushed the boulder with all her strength, and the boulder started to roll.

Next came **Work**, a smart and practical member of the Power Pals. "Great job, Mighty Mo! But you need to know that it's not just the push or pull that's important, it's also the work you do. That's where I come in! Work is done when a force causes an object to move in the direction of the force. Since you pushed the boulder and it moved, you've done work on it!" Work explained.

Just then, **Power**, the most efficient of the Power Pals, stepped forward. "That's right, Work! But let's not forget about me. I'm Power, and I'm all about how fast work is done. The quicker you do the work, the more power you have. You, Mighty Mo, have shown great power by moving the boulder so quickly!"



Lastly, **Energy**, the most versatile Power Pal, chimed in. "Friends, we can't forget that everything we do involves me, Energy! You see, Mighty Mo, you had stored energy in your muscles, which you converted into kinetic energy to push the boulder. And the boulder, once you moved it, gained kinetic energy as it rolled away."

Mighty Mo looked at the Power Pals with appreciation and said, "Thanks to you all, I now understand how force, work, power, and energy are related! Force helps move things, work is done when a force moves something, power is about how quickly the work is done, and energy is what makes it all possible!"

The Power Pals smiled, proud of their teamwork and how they'd helped Mighty Mo. And with that, they continued on their adventure, ready to lend a helping hand and teach more valuable lessons about the magical world of physics.

MARVELS OF PHYSICS

MACHINES

As Mighty Mo and the Power Pals continued their adventure, they came across another boulder blocking a path. This time, Mighty Mo thought about how she could move the boulder more easily. The Power Pals knew just the solution: **MACHINES**!

Force, the strong and energetic character, began the explanation. "Mighty Mo, machines can help us apply force more efficiently. They are tools or devices that make work easier by changing the size or direction of the force needed. One of the simplest machines is a lever."

Work, the smart and practical member of the Power Pals, continued, "A **lever** is a straight, rigid rod or plank that rests on a support called a fulcrum. When you apply force to one end of the lever, the other end moves in the opposite direction. This can help you lift or move heavy objects, like this boulder!"

Power, the most efficient of the Power Pals, added, "By using a lever, you can move the boulder with less force and still have great power. The lever allows you to do the work more easily and quickly."

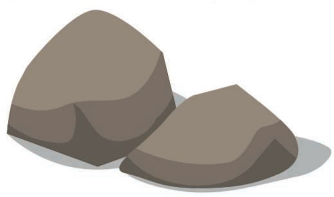
Energy, the most versatile Power Pal, chimed in, "And let's not forget that when you use a machine like a lever, you're transferring energy more effectively. You use your muscles to apply force on one end of the lever, and that force is transmitted through the lever to the boulder, lifting or moving it with ease."

Mighty Mo was excited to try this new idea. The Power Pals helped her find a sturdy plank and a rock to use as a fulcrum. They positioned the plank under one edge of the boulder and placed the rock as the fulcrum near the boulder. With a deep breath, Mighty Mo pushed down on the free end of the plank.

To her amazement, the boulder lifted off the ground with much less effort than before! She understood how the lever made her work easier by increasing her mechanical advantage, which meant she could apply a smaller force over a greater distance to achieve the same result.

Mighty Mo looked at the Power Pals with gratitude and said, "Thanks to you all, I now understand how machines, like levers, can help make work easier! They allow us to apply force more efficiently and make the most of our energy."

The Power Pals smiled, proud of their teamwork and how they'd helped Mighty Mo. And with that, they continued on their adventure, eager to explore more of the magical world of physics and teach Mighty Mo even more valuable lessons.



MARVELS OF PHYSICS

LIGHT

Once upon a time, in a small town called Lumen, lived a 10-year-old boy named Leo. Leo was a curious child who loved learning about the world around him. One sunny morning, while playing in his backyard, he noticed something unusual in the sky. It looked like a huge, colourful arc that seemed to stretch from one end of the sky to the other.

Leo was excited and decided to investigate this phenomenon. He put on his explorer's hat and went to see his wise friend, Mr. Knowitall, who lived nearby. Mr. Knowitall was a retired scientist and enjoyed sharing his knowledge with young Leo.

"Mr. Knowitall!" Leo exclaimed, "What is that giant rainbow in the sky?"

"Aha, Leo!" Mr. Knowitall smiled. "That, my young friend, is called a **spectrum**. It happens when sunlight passes through water droplets in the atmosphere, and the light gets separated into its different colours. Let me teach you about light and how it works." Leo's eyes sparkled with excitement as he eagerly listened.

"First, let's talk about **lenses**," said Mr. Knowitall. He handed Leo a magnifying glass. "Lenses are pieces of glass, like this one, that can bend light to make things appear larger or smaller."

Leo looked through the magnifying glass, and the objects appeared bigger. He was amazed.

"Now, let's move on to **reflection**," Mr. Knowitall continued. He showed Leo a shiny mirror. "When light hits a smooth surface, like this mirror, it bounces off and reflects the image of whatever is in front of it." Leo played with the mirror, watching as his reflection appeared and disappeared.

Next, Mr. Knowitall took out a glass of water and a pencil. He placed the pencil inside the water, and Leo noticed that it appeared to be bent.

"This is called **refraction**," Mr. Knowitall explained. "When light passes through different materials, it changes direction and can make objects look distorted or bent."

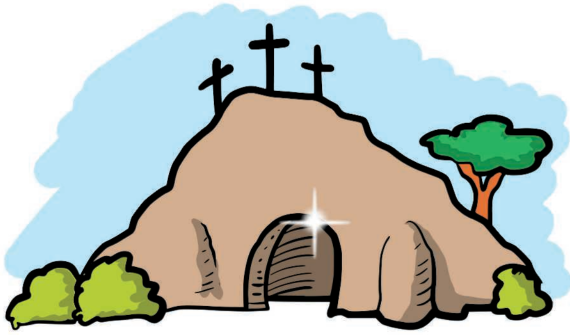
Leo couldn't believe his eyes! He wondered what other fascinating things light could do.

Now, Mr. Knowitall led Leo outside and showed him a **prism**. "This is a great way to demonstrate the spectrum you saw in the sky earlier," he said.

As the sunlight passed through the prism, a beautiful rainbow of colours appeared on the ground. "Light is made up of many colours, and when it passes through a prism, it gets separated into a spectrum," Mr. Knowitall explained. Finally, Mr. Knowitall showed Leo how light could scatter. He shone a flashlight through a jar filled with water and a little milk.

"See how the light seems to spread in all directions? This is called **scattering**. It's what makes the sky look blue during the day and red during sunsets." Leo was amazed by all the wonderful things light could do. As the day turned into night, he looked up at the stars and marvelled at the beauty and mystery of light.

From that day on, Leo developed a deep appreciation for the science of light, and he continued to explore and learn about the world around him. And every time he saw a rainbow or a beautiful sunset, he remembered his friend Mr. Knowitall and the incredible journey they had taken together.



SOUND

Once upon a time in the enchanting land of Harmonia, there lived a young girl named Melody. She had a unique gift - the ability to communicate with everything that made a sound. One day, she stumbled upon a hidden cave with a mysterious door. As she touched the door, it sang, "To enter, you must learn about Sound and how it works"

Melody was determined to solve the puzzle. She embarked on a quest, guided by her gift, to learn everything she could.

Her first stop was the Whispering Woods, where she met **Sound**, a playful breeze. Sound explained that he was created by vibrations, the back-and-forth movement of particles in the air. "When I travel through the air and reach your ears," Sound said, "I make your eardrums vibrate, allowing you to hear me!"

Next, Melody ventured into the land of **Pitch**, ruled by the Pitch Queen, a giant tuning fork. The queen showed Melody that pitch refers to the sense of highness or lowness of a sound. To demonstrate this, she struck her tines, creating a high-pitched sound. She explained that the pitch of a sound was determined by its frequency - the number of vibrations per second. Faster vibrations created higher pitches, while slower vibrations made lower pitches.

Melody then climbed the Echoing Mountains, where she encountered **Echo**, a mischievous parrot. Echo taught her that when sound waves hit a surface, they can bounce back, creating an echo. They had fun shouting into the valley and hearing their words repeated. 

In the Vibrant Valley, Melody discovered a field filled with musical instruments. The instruments introduced her to **Loudness**, explaining that the amplitude of sound waves determined how loud or soft a sound was. The larger the waves, the louder the sound. They played a symphony together, exploring different volumes.

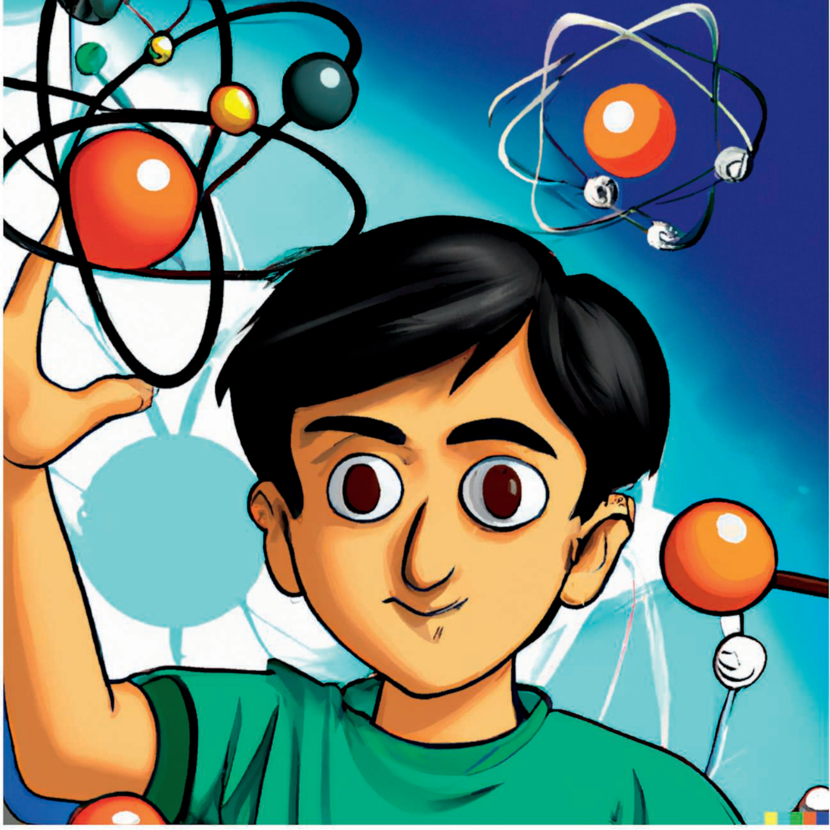
Melody's next destination was the bustling city of Noisopolis. There, she met **Noise**, a chaotic mix of sounds. He explained that unlike Music, which had harmony and structure, he was a disorganised jumble of many different sounds.

Finally, Melody arrived at the Palace of **Music**, where she met Queen Harmony and her royal orchestra. Queen Harmony taught Melody that music was a beautiful arrangement of sounds, pitch, and loudness, crafted to evoke emotions and tell stories. She gave Melody a magical flute, which played enchanting melodies.

Armed with her newfound knowledge, Melody returned to the hidden cave. She played her flute, skilfully blending Sound, Pitch, Echoes, Vibrations, Loudness, Noise, and Music. The door sprang open, revealing a breath-taking world of colours and sounds. Melody had unlocked the secret of the magical land and discovered the beauty and wonder of sound.

MARVELS OF PHYSICS

ELECTRICITY & MAGNETISM



Once upon a time, in the magical land of Electropolis, there lived a bright young boy named Edison. Edison was an adventurous and curious kid, always eager to learn and explore the world around him. In Electropolis, everything worked on electricity and magnetism, two mysterious forces that fascinated Edison.

One day, Edison was exploring the forest when he stumbled upon a mysterious door. He pushed the door open and found himself in a magical workshop. Inside, he met Ohm, the wise old wizard who controlled the secrets of electricity and magnetism. Ohm saw the curiosity in Edison's eyes and decided to teach him about these mystical forces.

Ohm began with the basics. "Everything around us is made of tiny particles called **atoms**," he explained. "Some atoms have a property called **electric charge**. There are two types of charges: positive and negative. When charged particles are attracted to each other or repelled, that's the **force of electricity**."

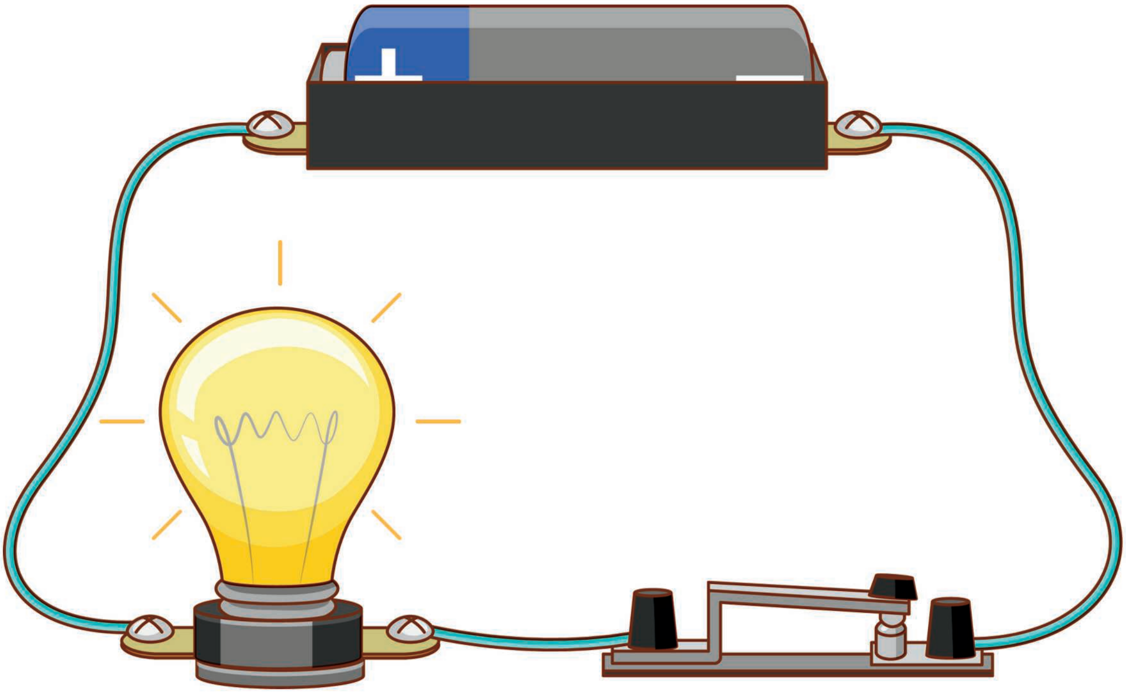
Edison's eyes sparkled with excitement. Ohm then demonstrated how **electric current** flowed through a wire, like water in a river. "This movement of charged particles is called electric current," Ohm said.

To help Edison understand **voltage**, Ohm created a small hill with a ball on top. "Voltage is like the force that pushes the ball down the hill. In a circuit, voltage is what pushes the electric charge through the wires," he explained.

Next, Ohm introduced the concept of **resistance**. He picked up a thick and a thin wire and asked Edison to blow air through them. Edison found it harder to blow through the thin wire. "This is resistance," Ohm said. "Resistance slows down the flow of electric current, just like the thin wire made it harder for you to blow air."

Ohm then showed Edison different materials: **conductors**, **insulators**, and **semiconductors**. "Conductors, like metals, allow electric current to flow easily. Insulators, such as rubber, resist the flow of electric current. Semiconductors, like silicon, can be both conductors and insulators depending on their conditions."

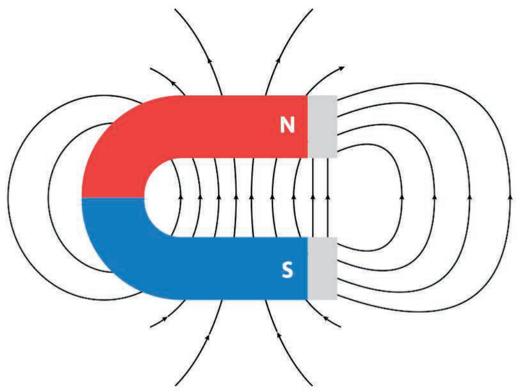
Afterward, they explored the idea of **electrical power** and **energy**. Ohm explained how electrical energy could be converted into other forms of energy, such as light, heat, or motion. He taught Edison that electrical power is the rate at which electrical energy is used or produced.



Ohm then took Edison to a model house to learn about household circuits. Edison saw how circuits connected appliances to a power source, and how safety devices like fuses and circuit breakers protected the house from electrical hazards.

Next, Ohm revealed the magic of **magnetism**. He showed Edison how an electric current could produce a magnetic field around a wire. "This is the magnetic effect of a current," Ohm said. "When we coil the wire around an iron core, we create an electromagnet."

Ohm then introduced **electromagnetic induction** by moving a magnet near a coil of wire.



"When you change the magnetic field near a coil, it induces an electric current in the wire," Ohm explained.

To demonstrate the practical applications of these principles, Ohm showed Edison a **transformer**, an AC generator, and a DC motor. "Transformers can change the voltage of alternating current (AC), stepping it up or down as needed.

AC generators produce electricity by rotating a coil in a magnetic field, while DC motors convert electrical energy into mechanical energy, making things move."

> A step-up transformer makes electricity stronger. Imagine you have a toy car that goes slow, but you want it to go faster. You can use a transformer to make the battery stronger so the car can go faster.
>
> On the other hand, a step-down transformer makes electricity weaker. Imagine you have a big flashlight that's too bright for your eyes. You can use a transformer to make the battery weaker, so the light is not as bright and doesn't hurt your eyes.

Edison was amazed by the wonders of electricity and magnetism. He thanked Ohm and returned to Electropolis with newfound knowledge, ready to use these magical forces to improve the lives of everyone in the land.

MARVELS OF PHYSICS

HEAT

Once upon a time, in a faraway land called ThermoTown, there lived a young, inquisitive boy named Max. Max was a bright and curious 10-year-old, and he was always eager to learn about the world around him.

One hot summer day, Max set out on an adventure to understand heat and its mysterious ways. He knew that heat played a significant role in his daily life, but he was determined to unravel its secrets. As Max walked along the path, he stumbled upon a wise, old owl named Sir Calorimetry. Sir Calorimetry was a renowned scientist in ThermoTown, and Max knew he could help him understand the concept of heat.

Max asked Sir Calorimetry, "Can you teach me about heat, and how it works?"

Sir Calorimetry, pleased by Max's curiosity, said, "Of course, young Max. Let's start with Calorimetry. **Calorimetry** is the measurement of heat when a substance changes temperature or phase. For example, when you heat water and it turns to steam, we can measure the heat transferred during that process." Max nodded, eager to learn more.

Sir Calorimetry continued, "Now, let's discuss **Specific Heat Capacity**. Every substance has a unique ability to absorb heat. Specific Heat Capacity is the amount of heat needed to raise the temperature of a unit mass of a substance by one degree Celsius." Max thought about it and asked, "Is that why metal gets hot faster than wood?"

"Exactly," replied Sir Calorimetry. "Metal has a lower specific heat capacity than wood, meaning it heats up faster."

Next, Sir Calorimetry introduced Max to the concept of **Thermal Capacity**. "Thermal Capacity is the amount of heat needed to raise the temperature of an entire object by 1°C. It depends on both the object's mass and its specific heat capacity."

As they walked further, they reached a river where the water flowed smoothly over the rocks. Sir Calorimetry pointed at the ice and said, "See the ice melting? That's because it has reached its **Melting Point**, which is the temperature at which a solid changes into a liquid." Max watched the ice melt and then asked, "What about when water freezes?"

Sir Calorimetry explained, "That's the **Solidification Point**, the temperature at which a liquid changes into a solid. For water, the melting and solidification points are the same, at 0°C." Max was fascinated, and they continued their journey. They soon came across a boiling pot of water.

Sir Calorimetry said, "Boiling is when a liquid changes into a gas. The temperature at which this happens is called the **Boiling Point**. For water, it's 100°C" Max then asked, "But what about when water disappears without boiling?"

Sir Calorimetry explained, "That's called **Evaporation**. It's a slower process where a liquid changes into a gas without reaching its boiling point. It happens when molecules at the surface gain enough energy to break free from the liquid."

Max was amazed by all that he had learned about heat. He thanked Sir Calorimetry for his guidance and wisdom, and he returned to his home in ThermoTown, eager to share his newfound knowledge with his family and friends.

MODERN PHYSICS

Once upon a time in the enchanting land of Atomia, a curious 10-year-old named Timmy ventured out on an extraordinary journey. The world of Atomia was incredibly tiny, and everything in it was made up of tiny building blocks called **atoms**.

Timmy's journey began at the centre of Atomia, in a magical place called the Nucleus Kingdom. Here, he met two fascinating creatures, the mighty Protons, and the neutral Neutrons. Together, these creatures were known as Nucleons, who held the secret to the kingdom's identity and stability.

Timmy learned that each Nucleus Kingdom had a unique number of Protons, which determined its identity. This number was called the **Atomic Number**. The kingdom's **Mass Number**, on the other hand, was the total number of Protons and Neutrons residing in it.

As Timmy explored further, he met the swift and energetic Electrons, who danced around the Nucleus Kingdom in circular paths known as Atomic Models. These Electrons had a negative charge, which perfectly balanced the Protons' positive charge.

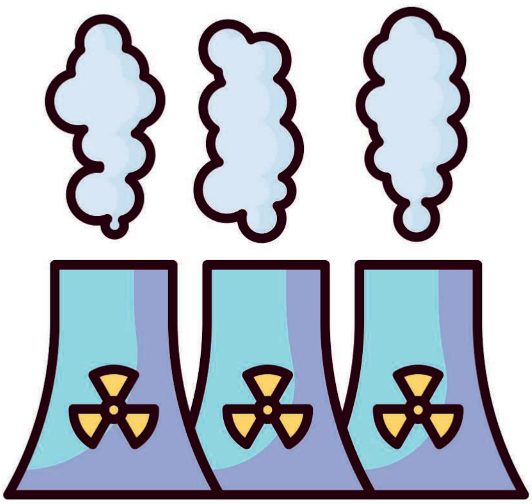
Timmy then discovered that some kingdoms had unique families called Isotopes. These kingdoms had the same Atomic Number, meaning they were the same element but had different Mass Numbers because of their different Neutron counts.

Timmy also encountered two other intriguing families: Isobars and Isotones. Isobars were kingdoms with the same Mass Number but different Atomic Numbers, while Isotones shared the same number of Neutrons but had different Atomic Numbers.

One day, Timmy heard whispers of a mysterious force known as **Radioactivity.** It was a powerful energy released by certain kingdoms that were unstable. Timmy learned about three types of radioactive emissions: Alpha particles, Beta particles, and Gamma radiations.

Alpha particles were like Protons and Neutrons moving together, while **Beta particles** were like high-speed Electrons. **Gamma radiations**, however, were invisible waves of energy that could pass through many materials.

As Timmy delved deeper into Atomia, he discovered the incredible power of **Nuclear Fission** and **Nuclear Fusion**. Nuclear Fission was a process where a kingdom's Nucleus split into two smaller kingdoms, releasing vast amounts of energy. This process powered the Sun of Atomia, a massive energy source for the entire realm.



Nuclear Fusion, on the other hand, occurred when two smaller kingdoms combined to form a larger, more stable kingdom, also releasing an enormous amount of energy.

Timmy learned that scientists in the human world were trying to harness this power to create clean, sustainable energy.

As his journey came to an end, Timmy realised that the world of Atomia was full of wonder, complexity, and energy.

Unit 1 FORCE, WORK, POWER, & ENERGY

REVISION NOTES

Force is an external agent that can modify a body's resting or moving position. It has a direction and a magnitude.

Force can produce the following effects on a body:

- Alter the speed of a moving object.
- Alter the direction of motion of an object that is already in motion.
- Increase the amount of motion a body is capable of producing as well as the ability to halt motion in a body that is already in motion.
- Alter the size and the shape of a body.

1. **Translational and Rotational Motions**: When acted upon by a force, rigid bodies can undergo two types of motion:
   a) Translational or Linear Motion: Translational motion refers to the movement of an object from one point to another in a straight line. This type of motion is also known as linear motion.
   b) Rotational Motion: Rotational motion is the movement of an object around a fixed axis. When an object is rotating, it is turning around a point, like a wheel turning around its centre. The object moves in a circular path, and the distance travelled by the object is called the circumference of the circle.

2. **Moment of Force or Torque**: The moment of force, or torque, is a measure of how much a force can cause an object to rotate around a certain point or axis. For example, if you are using a wrench to turn a bolt, the moment of force is the rotational force that you are applying to the bolt. The direction of the moment of force is either clockwise or anticlockwise, depending on the direction in which you are turning the wrench.

3. **Factors affecting the Turning Effect of a Body**:
   a) The magnitude of the force applied, and
   b) Distance of the line of action of force from the axis of rotation.

4. **Measurement of Moment of Force (Or Torque)**: The product of the force and the perpendicular distance of the line of action of force from the axis of rotation.

5. **Clockwise and Anticlockwise Moment of Force**: The moment of force is referred to as clockwise if the turning effect on a body is clockwise. It is taken **negative**. The moment of force is referred to as an anticlockwise moment when it turns a body in the opposite direction. It is taken as **positive**.

6. **Couple**: A couple is a pair of forces that act on an object at two different points, causing the object to rotate around an axis that is perpendicular to the line connecting the two points of force application.
   S.I unit of moment of a couple is **newton metre.**

C.G.S. unit of moment of force is **dyne cm**.

Moment of Couple: The moment of a couple is a measure of the rotational force exerted by two forces that are equal in magnitude and opposite in direction, and are applied to a body at a specified distance from a given axis. It is a way to describe how much a force is trying to make an object rotate around a particular point.

For example, imagine two people pushing a heavy box. One person is pushing to the left with a force of 100 kg, and the other person is pushing to the right with a force of 100 kg. The moment of the couple would be equal to the product of one of the forces (100 kg) and the distance between the two forces (the distance between the two people pushing the box).

Moment of couple = Force × Perpendicular distance between the two forces (or arm of couple)

7. **Equilibrium of Bodies**: When a body does not change its state of rest or of uniform motion on the application of a number of forces on it, then the body is said to be in equilibrium.

   - **Static Equilibrium**: When a body remains in the state of rest under the influence of an applied force, it is said to be in static equilibrium.
   - **Dynamic Equilibrium**: A body is considered to be in dynamic equilibrium when it maintains in the same state of motion (translational or rotational) while being affected by several forces.

   Conditions for Equilibrium:

   a) The resultant of all the forces acting on the body should be equal to zero.

   b) The algebraic sum of moments of all the force acting on the body about the point of rotation should be zero.

8. **Principle of Moments**: According to the principle of Moments, in equilibrium,

   Sum of the Anticlockwise Moments = Sum of the Clockwise Moments

9. **Centre of Gravity**: The centre of gravity (also known as the centre of mass) is a point in an object or system of objects where the total weight is evenly distributed. This point is important because it determines the object's stability and balance.

   An example of the centre of gravity in everyday life is a person standing on one foot on a balance beam, with the centre of gravity being the point at which their body is evenly balanced and they are able to maintain their balance.

10. **Uniform Circular Motion**: A particle's (or a body's) motion is described as being uniformly circular when it follows a circular path at a constant speed.

11. **Difference between the Uniform Circular Motion and Uniform Linear Motion:**

	UNIFORM CIRCULAR MOTION	UNIFORM LINEAR MOTION
DESCRIPTION	Motion in a circular path at a constant speed	Motion in a straight line at a constant speed
PATH	Circular	Straight line
SPEED	Constant	Constant
ACCELERATION	Centripetal acceleration towards the center of the circle	Constant acceleration in a given direction
FORCE	Centripetal force towards the center of the circle	Constant force in a given direction
EXAMPLES	Motion of the Earth around the Sun, motion of a car on a circular racetrack	Motion of a ball rolling down a ramp, motion of an object in free fall under the influence of gravity

12. **Centripetal Force**: It is a force that acts on a body moving in a circular path and is directed towards the centre around which the body is moving.

13. **Centrifugal Force**: Centrifugal force is a fictitious force that is used to describe the tendency of an object moving in a circular path to move outward away from the center of the circle. It is not a real force, but a mathematical construct used to describe the behaviour of objects moving in a circular path.

14. **Work:** Work is the product of a force applied to an object over a distance. It is a measure of the amount of effort required to perform a task.

15. **Power:** Power is the rate at which work is done, or the rate at which energy is used.

16. **Energy**: Energy is the capacity to do work, or the ability to cause change.

For example, if you lift a heavy box from the ground to a shelf, you are doing **work**. The force you apply to the box is the weight of the box, and the distance you lift it is the height of the shelf. The amount of work you do is equal to the force applied times the distance over which it is applied.

Power is the rate at which work is done. If you lift the box in a shorter amount of time, you are using more power. If you lift the same box, but take longer to do it, you are using less power.

Energy is the capacity to do work. When you lift the box, you use energy. This energy can come from food that you have eaten, or it can come from the fuel that powers a machine. Energy is often measured in units of work, such as joules or calories.

So, in summary: work is the effort required to do a task, power is the rate at which work is done, and energy is the capacity to do work

17. **Mechanical Energy:** Mechanical energy is created by a body as a result of work performed on it. It is of two types -

a) Potential Energy

b) Kinetic Energy

Potential Energy: Potential Energy is the energy that a body possesses as a result of its altered location (or configuration). It is mainly of two kinds:

- **Gravitational Potential Energy:** The Gravitational Potential Energy is the energy that a body possesses as a result of the earth's force of attraction.
- **Elastic Potential Energy:** Elastic Potential Energy is the energy that a body possesses when it is deformed as a result of a change in its configuration.

Kinetic Energy: Kinetic energy is the power that a body possesses as a result of its motion. The letter K is typically used to represent it.

18. **Expression for the kinetic energy ($K = \frac{1}{2}mv^2$):** The amount of labour that a moving body may accomplish before coming to rest is equivalent to the kinetic energy that it possesses.

19. **Work Energy Theorem**: According to the work – energy theorem, the increase in kinetic energy of a moving body is equal to the work done by a force.

20. **Forms of Kinetic Energy:** A body can have three types of motion namely the translational, rotational, and vibrational, so the kinetic energy is also of three forms:
a) Translational kinetic energy
b) Rotational kinetic energy, and
c) Vibrational kinetic energy

- **Translational Kinetic Energy:** The energy possessed by a body *moving in a straight line* is called translational kinetic energy.

- **Rotational Kinetic Energy:** The energy possessed by a body due to its *rotation about an axis* is called rotational kinetic energy.

- **Vibrational Kinetic Energy:** The energy possessed by a body due to its *vibrations, or motion*, is called vibrational kinetic energy or simply the vibrational energy.

21. **Conversion of Potential Energy into the Kinetic Energy:** Potential energy is the energy that an object possesses due to its position or configuration. Kinetic energy is the energy an object possesses due to its motion. When an object falls from a height, it converts its potential energy into kinetic energy.

22. **Different Forms of Energy:** Nature has provided us energy in the various forms
a) **Solar Energy:** The energy radiated by sun is called solar energy.
b) **Heat Energy:** The energy released on burning coal, oil, wood, or gas is heat energy.
c) **Light Energy:** This is the form of energy that allows us to see other objects.
d) **Chemical (or Fuel) Energy:** The energy possessed by the fossil fuels such as coal, petroleum and natural gas is called the chemical energy or fuel energy. These fuels contain chemical energy stored in them.
e) **Hydro Energy:** The energy possessed by the fast-moving water is called hydro energy. This energy is used to generate electricity in hydroelectric power stations.
f) **Electrical Energy:** Two dry bodies get charged when they are rubbed together because free electrons are transferred from one body to the other. As a result, they have electrical energy.
g) **Nuclear Energy:** The energy released due to loss in mass during the process of nuclear fission and fusion, is called nuclear (or atomic) energy.

h) **Wind Energy:** The energy possessed by the fast-moving air (i.e. storm) is called wind energy. This energy is used in driving a windmill for producing electricity.

i) **Sound Energy:** The energy is possessed by the vibrating bodies. Our ears can detect it.

j) **Mechanical Energy:** The energy that a body possesses because of its condition of motion or rest is referred to as mechanical energy. A body in motion, a body at a height, a stretched bow, etc. all possess mechanical energy.

k) **Magnetic Energy:** The energy possessed by a magnet due to which it can attract iron fillings, is called magnetic energy. An electromagnet has magnetic energy.

l) **Geothermal Energy:** The energy released in nuclear disintegrations in the interior of earth gets stored deep inside the earth and is called geothermal energy.

m) **Tidal Energy:** The energy produced by tides. Tidal energy refers to the periodic rise and fall of ocean water caused by tides.

23. **Calorie:** Heat energy is usually measured in calorie.
1 calorie is the energy (heat) regained in raising the temperature of 1g of water from 14.5°C to 15.5°C (or through 1°C)

$$1 \text{ calorie} = 4.18 \text{ J}$$
$$1 \text{ kilocalorie} = 4180 \text{ J}$$

24. **Principle of Conservation of Energy:** According to the principle of conservation of energy, energy can neither be created nor can it be destroyed. It only changes from one form to another. It is one of the fundamental principles of nature.

25. **Conversion of one form of energy into the other form:** We need energy in a variety of forms throughout our daily lives. Since one type of energy may be changed into another, we can use the form of energy we already have to get the energy we need.
Examples of conversion of one form of energy into the other form:

1.	*Electrical generator (or a dynamo)*	Converts the mechanical energy into the electrical energy
2.	*Electric motor*	Convert the electrical energy into the mechanical energy
3.	*Electric toaster, geyser, oven, heater, etc.*	Electrical energy changes into the heat energy
4.	*The unwinding of a watch spring*	Potential energy of wound-up spring converts into kinetic energy
5.	*A loaded truck when started and set in motion*	Chemical energy of petrol or diesel converts into mechanical energy
6.	*A car going uphill*	Kinetic energy to potential energy
7.	*Photosynthesis in green leaves*	Light energy changes into chemical energy
8.	*Charging of a battery*	Electrical energy changes into chemical energy
9.	*Respiration*	Chemical energy changes into heat energy
10.	*Burning of a matchstick*	Chemical energy changes into heat energy
11.	*Explosion of crackers*	Chemical energy changes into heat, light and sound energy
12.	*Loudspeaker*	Electrical energy into sound energy

13.	*A steam engine*	Heat energy into mechanical energy
14.	*Microphone*	Sound energy into electrical energy
15.	*Washing machine*	Electrical energy to mechanical energy
16.	*A glowing electric bulb*	Electrical energy into light and heat energy
17.	*Burning coal*	Chemical energy to heat energy
18.	*A solar cell*	Light energy into electrical energy
19.	*Bio-gas burner*	Chemical energy into heat energy
20.	*An electric cell in a circuit*	Chemical energy into electrical energy
21.	*A petrol engine of running car*	Chemical energy to mechanical energy
22.	*A photovoltaic cell*	Light energy into electrical energy
23.	*An electromagnet*	Electrical energy into magnetic energy

26. Conditions for the work done by a force to be zero:

a) When there is no displacement ($S = 0$) and

b) When the displacement is normal to the direction of force ($0 = 90°$).

MACHINES

IMPORTANT POINTS, FORMULAE, DEFINITIONS, TERMS

1. A **machine** is a device that uses energy to perform a specific task or set of tasks.

   Machines can be simple, like a lever or a pulley, or they can be complex, like a car or a computer. Machines can be operated manually, or they can be automated and controlled by a computer or other type of control system. The purpose of a machine is to make work easier and more efficient by reducing the amount of physical effort or mental effort required to perform a task.

2. **Input**: The term "input" refers to the work done on the machine or the energy that is supplied to the machine.

3. **Output**: The work or energy a machine produces is referred to as output.

4. **Actual Output**: The actual output of a machine is the result or product that is produced by the machine when it is operating. For example, if the machine is a printing press, the actual output might be printed documents.

5. **Useful Output**: The useful output of a machine is the portion of the actual output that is useful or valuable to the user or consumer of the output. The useful output is the result or benefit that the user or consumer is interested in or intends to use. It is different from the actual output because the actual output may include waste or byproducts that are not useful or valuable to the user or consumer.

6. **Ideal Machine**: A machine whose parts are weightless and frictionless, is called ideal machine.

7. **Ideal mechanical advantage**: Ideal mechanical advantage is the ratio of total load moved to effort applied, including friction, and moving machine elements.

8. **Actual mechanical advantage**: The term "mechanical advantage" refers to the relationship between the usable load or resistance overcome by the machine and the effort exerted to it, while "actual mechanical advantage" is a more specific term.

9. **Velocity Ratio**: It is the ratio of the velocity at which effort is applied to the velocity at which load moves.
   OR
   It is the ratio of displacement of effort to the displacement of load.

10. **Efficiency of a machine**: It is the ratio of a machine's useful output to actual output.
    OR
    It is the machine's velocity ratio in relation to its mechanical advantage.

$$\textbf{Efficient } \eta = \frac{\text{Work output}}{\text{Work input}},\ \eta\ \% = \frac{\text{Work output}}{\text{Work Input}} \times 100$$

11. **Functions of a Machine:**
    - It is used to multiply force, i.e., used as a force multiplier
    - It allows a force that was exerted at one location to be utilized at another desired point
    - It changes the direction of force applied
    - It increases the speed

12. For a perfect (an Ideal) machine, Output = Input
    But in any practical machine, **work output < work input**

13. **Load (L)**: The resistive force that a machine is required to overcome is referred to as the load (L). The point at which energy is obtained by successfully overcoming the load is referred to as **load point**.

14. **Effort (E)**: The term "effort" refers to the force that is applied to a machine to overcome the resistive force (L).
    The term "effort point" refers to the location within the machine at which the resistive force begins to supply the machine with energy.

15. **Mechanical advantage (M.A.)**: It is the ratio of the load to the effort (the forced applied machine).

$$\textbf{Mechanical Advantage (M.A)} = \frac{Load}{Effort}$$

    Since it is the ratio of two similar quantities, the mechanical advantage has no unit.

16. Efficiency (η) of an ideal machine is 100%. In practice however no machine is 100% efficient due to some reasons, such as:
    a. Smoothness in moving parts
    b. Elasticity of the string (if any)
    c. Rigidity of a part.
    d. Weight of moving parts

17. Relation between M.A, VR, and n:

M.A. = V.R. × η OR $\eta = \frac{MA}{VR}$ OR $\eta\ \% = \frac{MA}{VR} \times 100$

18. In a perfect machine, the efficiency would be 1, which would be the same thing. According to the formula presented above, the mechanical advantage is equivalent to the velocity ratio, which is written as V.R. In real use, the velocity ratio of any machine will always be lower than the mechanical advantage of that machine, thus the efficiency will always be lower than 1.

19. **Lever**: A rigid bar, either straight or bent, that is capable of rotating at a fixed point or axis of rotation, called its *fulcrum*, is the definition of a lever. The most basic and fundamental form of machinery that we employ in our daily lives is the lever**.**

20. **Principle of lever**: For an ideal lever: **Load** × **Load arm = Effort** × **Effort arm**

This is called principle of lever.

Mechanical advantage of lever = $\frac{Effort\ arm}{Load\ arm}$

This relation is known as law of levers.

21. **Mechanical advantage of lever**: It is equal to the **ratio** of the length of its effort arm to the length of its load arm.

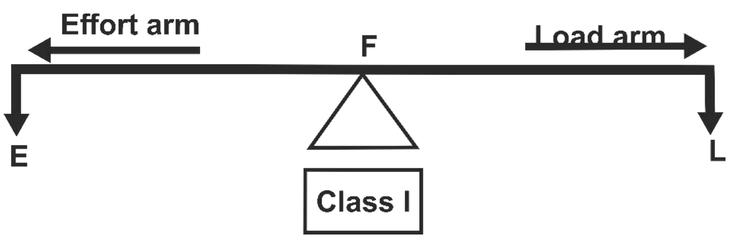
a) If effort arm = Load arm M.A = 1
b) If Effort arm > Load arm M.A > 1
and
c) If Effort arm < Load arm M.A < 1

So, the mechanical advantage of a lever can be increased either by increasing its effort arm or by decreasing its load arm.

22. **Kinds of Levers**: Depending upon the relative positions of the effort, load and fulcrum, there are following three types of levers:

Class I levers, Class II levers and Class III levers

Class I levers:

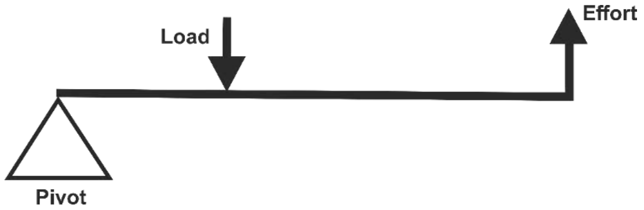


As can be seen in the illustration, the fulcrum F of this kind of lever is situated in the middle of the effort E and the load L.

Note: *It is important to keep in mind that the fulcrum F does not necessarily have to be in the middle of the load L and the effort E, but that both the load and the effort are moving in the same direction.*

Example: A seesaw, a pair of scissors, crowbar, handle of water pump, claw hammer, pair of pliers, beam of a physical balance, spade, catapult, nodding.

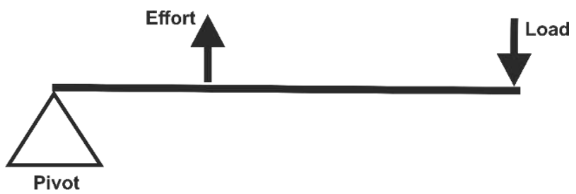
Class II levers:



When it comes to levers of this kind, the load (L) is positioned in between the effort (E) and the fulcrum (F). When it comes to levers of this sort, the mechanical advantage is invariably going to be greater than 1.

Example: An oar of a boat, a lemon squeezer, a nutcracker, a wheelbarrow, a fort below, etc.

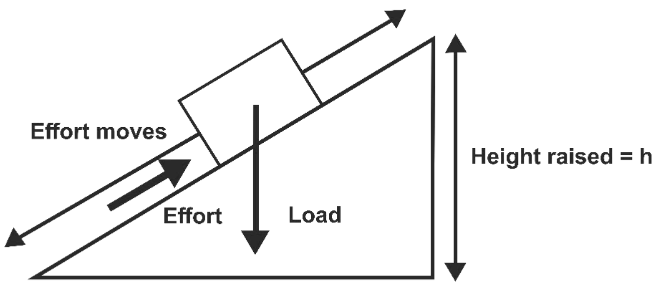
Class III levers:



When it comes to levers of this kind, the effort (E) is located somewhere between the load (L) and the fulcrum.
The mechanical advantage in case of class III levers is always less than 1 (M.A< 1).
Example: Human forearms, fire tongs, foot treadle, fishing rods, etc.

23. **Inclined plane:** An inclined plane is a flat surface that slopes at an angle. It is a simple machine that is used to make it easier to lift an object to a higher height or to lower an object to a lower height.

Imagine a ramp that you might use to push a heavy box up to a high shelf. The ramp is an example of an inclined plane. The slope of the ramp makes it easier to push the box up to the shelf, because you don't have to lift it as high.



24. Mechanical advantage (M.A) of an inclined plane = $\frac{1}{\sin\theta} = \frac{l}{h}$
Where l = length of the inclined plane
And h = height of the inclined plane

25. **Pulley:** A pulley is a simple machine that consists of a wheel with a grooved rim that is used to change the direction of a force. It is often used to lift heavy objects, such as when you use a pulley to lift a bucket of water out of a well. Pulleys are often used in combination with other simple machines, such as levers and inclined planes, to make it easier to lift heavy objects. They can also be used in complex systems, such as the pulleys and cables used to lift a bridge.

There are two main types of pulleys: fixed pulleys and movable pulleys.

- A **fixed pulley** is attached to a stationary object, such as a beam or a wall, and is used to change the direction of a force.
- A **movable pulley** is attached to a moving object, such as a bucket of water, and is used to lift or lower the object.

26. **Direction of tension in the string:** When a load is supported by a string held in support, the tension in the string acts equal in both directions downward and upward.

27. **Gears:** Gears are mechanical components that transmit power and motion between machines and devices. They consist of a series of teeth on the edges of two or more rotating cylinders or disks, which mesh to transmit torque and rotation from one gear to another.

Gears are used in many different types of mechanical systems, such as automobiles and clocks, to increase or decrease the speed and torque of a rotating shaft, or to change the direction of rotation.

There are several different types of gears, each with its own unique characteristics and designed for specific applications.

28. **Gear ratio**: The ratio of the number of teeth on the driving wheel to that on the driven wheel is called gear ratio.
If N_A and N_B are the number of teeth in the driving gear and the driven gear respectively, then:

$$\textbf{Gear ratio} = \frac{N_A}{N_B}$$

29. **Velocity ratio of a pair of gears**: It is the ratio of the number of rotations per unit time of the driving gear to the number of rotations per unit time of driven gear.

30. $VR = \frac{No.of\ rotation\ per\ unit\ time\ of\ driving\ gears}{No.of\ rotations\ per\ unit\ time\ of\ driven\ gear}$
or $VR = \frac{Speed\ of\ rotation\ of\ driver(n_A)}{speed\ of\ rotation\ of\ driven\ gear\ (n_B)}$

31. Gain in torque (turning effect) = $\frac{N_B}{N_A}$
Where N_A = number of teeth in driving gear
N_B = number of teeth in driven gear

IMPORTANT FORMULAE

1. Input = Effort × displacement of effort = E × D
2. Actual Output = Total load × displacement = L × d
3. Useful Output = Useful load × displacement of useful load = l × d
4. Principle of Ideal Machine = Total output = Total input
   = L × d = E × D
5. Ideal Mechanical Advantage = $\frac{Total\ load\ lifted}{Effort} = \frac{l}{E}$
6. Mechanical Advantage = $\frac{Useful\ load\ lifted}{Effort} = \frac{l}{E}$
7. Velocity Ratio = $\frac{Displacemet\ of\ Effort}{Displacement\ of\ Load} = \frac{D}{d} = \frac{d_E}{d_e}$

8. Efficiency = η = $\frac{Mechanical\ advantage}{Velocity\ ratio} = \frac{M.A}{V.R} = \frac{l \times d}{E \times D}$

9. Ideal Mechanical Advantage = Velocity ratio = $\frac{L}{E} = \frac{D}{d}$

10. Weight of movable part of machine: x = E (V.R – A.M.A)

Or x = E (I.M.A – A.M.A) (∴ V.R = I.M.A)

(x is the resistance due to movable pats of machine and friction etc.)

11. Velocity ratio of lever = $\frac{Effort\ Arm}{Load\ Arm} = \frac{D}{d}$

12. Mechanical advantage of lever = $\frac{Load}{Effort} = \frac{L}{E}$

M.A = $\frac{Effort\ Arm}{Load\ Arm}$

13. Mechanical advantage of pulley system = number of pulleys – $\frac{x}{E} = n - \frac{x}{E}$

14. Velocity ratio of pulley system = No. of pulleys = n

15. For Gears:

$$\frac{No.\ of\ rotation\ of\ driven\ wheel}{No.\ of\ rotations\ of\ driving\ wheel} = \frac{No.\ of\ teeths\ of\ driving\ wheel}{No.\ of\ teeths\ of\ driven\ wheel} = \frac{Radius\ of\ driving\ wheel}{Radius\ of\ driven\ wheel}$$

16. $\frac{E\ or\ incline}{Mechanical\ advantage} = \frac{L}{E} = \frac{Length\ of\ inclined\ plane}{height\ of\ inclined\ plane} = \frac{l}{h} = \frac{l}{sin\theta}$

V.R = $\frac{d_E}{d_l}$

PART 1

Multiple Choice Questions (MCQs)

1. Which energy does a stone resting on the roof of a building have?

a) Potential Energy
b) Gravitational Energy
c) Kinetic energy
d) None of these

2. Which energy does a falling raindrop have?

a) only kinetic energy
b) only potential energy
c) both kinetic and potential energy
d) None of these

3. One horsepower is equivalent to:

a) 764 W
b) 746 W
c) 700 W
d) 1000 W

4. Kilowatt-hour is the standard unit for?

a) Electric Power
b) Electric Energy
c) Electric Force
d) None of these

5. Which among the following pair, when combined together formulates "Power"?

a) Force and Velocity
b) Force and Displacement
c) Force and Acceleration
d) Force and Time

6. What is the S.I. unit of moment of force?

a) Joule
b) Nm
c) mgh
d) kwh

7. An aeroplane is moving at a speed of 300 kilometres per hour while flying at a height of 10,000 metres. At this altitude, what is form of energy that the aeroplane possesses?

a) Both Kinetic and Potential Energy
b) Zero Kinetic and Potential Energy
c) Only Kinetic Energy
d) Only Potential Energy

8. In situations wherein the displacement is in the same direction as the force. When this occurs, work is said to be?

a) Zero
b) Positive
c) Negative
d) Finite

9. Which one of the following converts electrical energy into sound energy?

a) Mic
b) Loudspeaker
c) Solar panel
d) An electric iron

10. What happens to the electric energy when a flashlight is switched on?

a) First changes to light energy and then to heat energy
b) First changes to heat energy and then to light energy
c) Instantly transforms into the light energy
d) None

11. Which of the following quantity remains constant in a uniform circular motion?

a) Velocity
b) Speed
c) Acceleration
d) Both velocity and speed

12. The centrifugal force is:

a) Real force
b) The force of reaction of centripetal force
c) A fictitious force
d) Directed towards the centre of circular path

PART 2

Important Questions

1. State the kinds of motion a rigid body has when acted upon by force. **[2]**
2. What is translational motion? Give one example. **[2]**
3. What is rotational motion? Give one example. **[2]**
4. State the condition when on applying a force, the body has: **[2]**
a) The translational motion b) The rotational motion
5. State two factors affecting the turning effect of a force. **[2]**
6. Define moment of force and state its S.I unit. **[2]**
7. State whether the moment of force is a scalar or vector quantity. **[1]**
8. Differentiate between translational motion and rotational motion. **[2]**
9. Define the term ‘turning force’. **[2]**
10. What do you understand by clockwise and anticlockwise moment of force? **[2]**
11. When does a body rotate? State one way to change the direction of rotation. **[2]**
12. Write the expression for the moment of force about a given axis. **[2]**
13. State one way to obtain a greater moment of a force about a given axis of rotation. **[2]**
14. State one way to reduce the moment of a given force about a given axis of rotation. **[2]**
15. Why is it earlier to open a door by applying the force at the free end of it? **[2]**
16. The stone of a hand flour grinder is provided with a handle near its rim. Give reason. **[2]**
17. It is easier to turn the steering wheel of a large diameter than that of a small diameter. Give Reason. **[2]**
18. A spanner has a long handle. Why? **[2]**
19. A body is acted upon by two forces each of magnitude F, but in opposite directions. State the effect of the forces if: **[2]**

a) Both forces act at the same point of the body.
b) The two forces act at two different points of the body at a separator r.

20. It is easier to pull down the branch of a tree from its free end than from anywhere else. **[2]**

21. Draw a neat, labelled diagram to show the direction of two forces acting on a body to produce rotation in it. Also mark the point 'O' about which the rotation takes place. **[2]**

22. What do you understand by the term couple? State its effect. Give two examples of couple action in our daily life. **[3]**

23. Prove that Moment of couple = Force × couple arm. **[3]**

24. What do you mean by equilibrium of a body? **[2]**

25. State the condition when a body is in a) static, b) dynamic, equilibrium. Give me example each of static and dynamic equilibrium. **[3]**

26. State two conditions for a body, acted upon by several forces, to be in equilibrium. **[2]**

27. Give any two examples of rotational motion. **[2]**

28. Give one example when a body possesses both the translational and rotational motion. **[2]**

29. Give any five examples of couple in everyday life. **[2]**

30. What do you understand by 'arm of couple'? **[2]**

31. Draw a labelled diagram to show the direction of two forces acting on a body to produce rotation in it with O or the fixed point of rotation. **[3]**

32. Describe a simple experiment to verify the principle of moments, if you are supplied with a metre rule, a fulcrum and two springs with slotted weights. **[3]**

33. Define the term centre of gravity of a body. **[2]**

34. What do you understand by the term 'centre of gravity' of a body? **[2]**

35. Is it necessary that the centre of gravity always be within the material of the body? Justify your answer giving example. **[3]**

36. State the factor on which the position of the centre of gravity of a body depends. Explain giving an example. **[2]**

37. What is the position of centre of gravity of a: **[2]**
a) Rectangular lamina b) Cylinder

38. At which point is the centre of gravity situated in: **[2]**
a) A triangular lamina b) A circular lamina

39. Where is the centre of gravity of a uniform ring situated? **[2]**

40. State whether the following statement are true or false. **[2]**
a) The position of centre of gravity of a body remains unchanged even when the body is deformed.
b) The centre of gravity of a freely suspended body always lies vertically below the point of suspension.

41. Explain the meaning of uniform circular motion. Give one example of each motion. **[3]**

42. Give an example of motion in which speed remains uniform, but the velocity changes. **[2]**

43. Is it possible to have an accelerated motion with a constant speed? Name such type of motion. **[2]**

44. Differentiate between a uniform linear motion and a uniform circular motion. **[2]**

45. Name the force required for circular motion. State its direction. **[2]**

46. What is centripetal force? **[2]**

47. What is centrifugal force? **[2]**

48. Is centrifugal force a real force? **[2]**

49. Explain the motion of a planet around the sun in a circular path. **[2]**

50. State whether the following statements are true or false by writing T/F against them. **[2]**
a) The earth moves around the sun with a uniform velocity.
b) The motion of moon around the earth in circular path is an accelerated motion.
c) A uniform linear motion is un accelerated, while a uniform circular motion is an accelerated motion.
d) In a uniform circular motion, the speed continuously changes because the direction of motion changes.

51. State difference between centripetal and centrifugal force. **[2]**

52. Give centre of gravity for some regular objects. **[3]**

53. Show the position of centre of gravity by the point G for a circular ring, triangular lamina, a rectangle, parallelogram, square lamina, a rod and a cylinder. **[2]**

54. a) What do you understand by the terms **[2]**

i) Positive Moments ii) Negative Moments

b) State the absolute units of moments in **[2]**

i) C.G.S. System and ii) S.I. system

c) Draw a neat, labelled diagram from a particle moving in a circular path with a constant speed. In your diagram show the direction of velocity at any instant. **[3]**

55. Is it possible to have a body whose centre of gravity is outside the body? If so, explain. **[2]**

56. How will you determine centre of gravity of an irregular piece of a cardboard (Irregular lamina)? **[3]**

57. A stone of mass 'm' is rotated in a circular path with a uniform speed by tying a strong string with the help of your hand. Answer the following questions. **[3]**

a) Is the stone moving with a uniform or variable speed?

b) Is the stone moving with a uniform acceleration? In which direction does the acceleration act?

c) What kind of force acts on the hand and state its direction?

58. Define work. When is work said to be done by a force? **[2]**

59. How is the work done by a force measured when? **[2]**

a) Force is in direction of displacement

b) Force is at an angle to the direction of displacement

60. A body is acted upon by a force. State two conditions when the work done is zero. **[2]**

61. A force F acts on a body and displaces it by a distance S in a direction at angle O with the direction of force. **[2]**

a) Write an expression for the work done by the force.

b) What should be the angle between the force and displacement to get

i) Zero ii) Maximum work

62. State the condition when the work done by a force is a) positive b) negative. Explain with the help of examples. **[2]**

63. A satellite revolved around the earth in a circular orbit. What is the work done by the satellite? Give reason. **[2]**

64. State whether the work is done or not by writing yes or no, in the following cases? **[2]**

a) A man pushes a wall

b) A coolie stands with a box on his head for 15 min

c) A boy climbs up 20 stairs

65. a) State the CGS and SI units of work. **[2]**

b) How is joule related to erg? **[2]**

66. Define power. State two mathematical expressions for power. **[2]**

67. a) State the absolute unit of power in S.I. system. **[2]**

b) What is horsepower? What is its magnitude in S.I. unit? **[2]**

68. a) What is energy? State and define S.I. unit of energy. **[2]**

b) Define potential energy. Give two examples of potential energy. **[2]**

69. How many types of potential energy is there? Define them. **[2]**

70. Derive an expression for gravitational potential energy for a body placed at a height above the ground. **[2]**

71. Name the unit of physical quantity obtained by the formula $\frac{2K}{v^2}$, where K: Kinetic energy, V: linear velocity. **[2]**

72. Define kinetic energy. Give examples of kinetic energy. **[2]**

73. The sun is the ultimate source of all forms of energies on earth. Why? **[2]**

74. What kind of energy is possessed by a body in the following cases? **[3]**

a) A cocked-up spring and air gun

b) A shooting arrows

c) A stone lying on the top of a house

d) Water stored in the dam

e) An electron spinning around the nucleus f) A fish moving in water

75. State the Law of conservation of energy. **[3]**

76. What do you understand by the conservation of mechanical energy? State the condition under which the mechanical energy is conserved. **[2]**

77. Name two examples in which the mechanical energy of a system remains constant. Two examples in which the mechanical energy of a system remains constant are? **[2]**

78. A body falls freely under gravity from rest. Name the kind of energy it will possess. **[2]**

a) At the point from where it falls
b) While falling
c) On reaching the ground

79. A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero? **[2]**

80. Name the type of energy possessed by the bob of a simple pendulum when it is used at a) the extreme position, b) the mean position, and c) between the mean and extreme positions. **[2]**

81. What do you mean by degradation of energy? Explain it by taking one example of your daily life. **[2]**

82. When a body moves in a circular path, how much work is done by the body? Give reason. **[2]**

83. State whether the potential energy in each of the following cases increases or decreases. **[2]**

a) A spring is compressed
b) A spring is stretched
c) A body is taken away against the force of gravity
d) Air bubble rises in water

84. A truck driver starts off with his loaded truck. State the major changes that take place in setting the truck into motion. **[2]**

85. A shot fired from a cannon explode in air. What will be the change in kinetic energy? Justify your answer. **[2]**

86. What kind of energy transformation takes place a) At a hydroelectric power station b) In a geothermal power plant c) At a thermal power station and d) When a car at rest starts and stops on the application of brakes? **[2]**

87. Write an expression for the potential energy of a body of mass 'm' placed at a height 'h' above the earth surface. State the assumption made, if any. **[2]**

88. A body of mass 'm' is moving with a velocity 'v'. Write the expression for its kinetic energy. **[2]**

89. A body of mass 'm' is moving with a uniform velocity 'u'. A force is applied on the body due to which its velocity changes from u to v. How much work is being done by the force? **[3]**

90. Find relationship between kinetic energy and momentum. **[3]**

91. Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation. **[3]**

92. Show that for the free fall of a body, the sum of the mechanical energy at any point in its path is constant. **[3]**

93. Differentiate between work and power. **[2]**

94. Differentiate between energy and power. **[2]**

95. Differentiate between the potential energy and kinetic energy. **[2]**

96. Differentiate between tidal energy and ocean thermal energy. **[2]**

97. Give one difference between tidal energy and geothermal energy. **[2]**

98. Give any two differences between nuclear energy and chemical energy. **[2]**

99. What is a machine? **[2]**

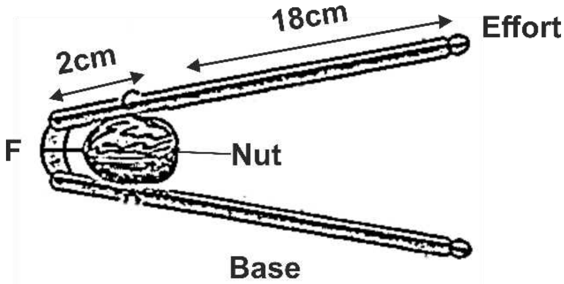
100. State functions of machine. **[2]**

101. Give difference between Ideal machine and Practical machine. **[2]**

102. a) Name six simple machines **[3]**

b) Give one practical example of each machine named in (a)

103. In the diagram shown below calculate the resistance (R) offered by the nut when an effort of 50N is applied. **[4]**



104. Define the following terms with reference to a machine: (any one for 2 marks) **[2]**

a) Total load
b) Useful load
c) Effort
d) Ideal machine
e) Ideal mechanical Advantage
f) Actual mechanical Advantage
g) Velocity ratio
h) Efficiency of a machine

105. Why a machine cannot be 100% efficient? **[2]**

106. Derive a relationship between Efficiency (n), Mechanical Advantage (M.A), Velocity ratio (V.R) **[3]**

107. What is a lever? **[2]**

108. How many classes of lever and there name the class of lever and give are example of each class. **[2]**

109. How will you determine the order/class of lever? **[3]**

110. A resistance of 1000N is overcome by a machine of V.R 4 and efficiency 60%. Find (a) Mechanical advantage, (b) Effort required to overcome resistance. **[3]**

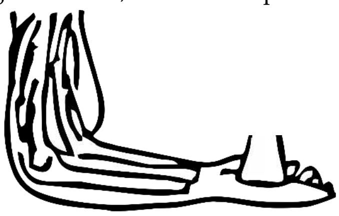
111. To which order do the following levers belong and why? **[2]**

a) A Railway Signal
b) A Nutcracker
c) A Man Cutting Bread with The Knife
d) A Boy Writing a Piece of Paper
e) Handle Of a Water
f) See-Saw
g) Forceps
h) A Man Rowing a Boat
i) A Lock and Key
j) Soda Water Opener
k) A Door
l) Motorcar Foot
m) Fishing Rod
n) Lemon Squeezer

112. Why does a lever of third order have mechanical advantage less than 1? **[2]**

113. Why are cutting edges of pliers smaller than the cutting edges of scissors? **[2]**

114. Copy the diagram of the forearm given below, indicate the positions of load, Effort and Fulcrum. **[3]**



Human arm carrying weight (Class III lever)

115. What do you understand by the term 'inclined plane'? **[3]**

116. Explain how does an inclined plane acts as a machine. **[2]**

117. Inclined plane acts as a machine in daily life. Give four examples. **[2]**

118. What is gradient of inclination? Support your answer with an example. **[3]**

119. What do you understand by the following terms? **[3]**

a) Gear b) Driven wheel c) Driving wheel

120. When the rotations of a driven wheel are more than a driving wheel, does it increase speed or load capacity? **[2]**

121. What is a pulley? **[2]**

122. What is fixed pulley? **[2]**

123. Mechanical advantage of single fixed pulley is always less than 1. Why is the pulley commonly used? **[2]**

124. What is a movable Pulley? **[2]**

125. A pulley system comprises of two pulleys, one fixed and the other movable. **[4]**

a) Draw a labelled diagram of the arrangement and clearly show the directions of all the forces acting on it.

b) What change can be made in the movable pulley of this system to increase the mechanical advantage of the system?

126. Which class of levers has a mechanical advantage always greater than 1? What change can be brought about in this lever to increase its mechanical advantage? **[2]**

127. Give the expression for mechanical advantage of an inclined plane in terms of the length of an of an inclined plane**.** **[4]**

PART 3

ICSE School Prelim Questions

1. State the amount of work done by an object when it moves in a circular path: Explain your answers. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**
   a) for half a rotation b) for one complete rotation
2. If the power of a motor is 60kW, at what speed can it raise a load of 20000 N? *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**
3. A hydroelectric power station takes its water from a lake whose water level is 100 m above the turbine. If the overall efficiency is 80%, calculate the mass of water which must flow through the turbine each second to produce a power output of 1 MW. ($g = 10\ m/s^2$) *(Maneckji Cooper Education Trust School, Mumbai)* **[3]**
4. Give one example each of class I lever where mechanical advantage is: *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**
   a) more than one b) less than one
5. A labourer uses a sloping wooden plank of length 2.0 m to push up a load of 600 N into the truck at a height of 0.8 m. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**
   a) What is the mechanical advantage of sloping plank?
   b) How much effort is needed to push the load up in the truck?
6. A block and tackle pulley system has a velocity ratio of 3. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**
   a) Draw a labelled diagram of this system showing the load and the effort.
   b) Why should the lower block of this pulley system be of negligible weigh?
7. A stone is whirled by a boy in a circular path with a constant speed. *(Dhirubhai Ambani International School, Mumbai)* **[2]**
   a) Is the stone moving with a uniform or variable acceleration?
   b) Name the force acting on the stone and hand of the boy.
8. Answer the following questions. *(Dhirubhai Ambani International School, Mumbai)* **[4]**
   a) Name the type of the single pulley that has an ideal mechanical advantage equal to 2.
   b) Draw a labelled diagram of the pulley mentioned by you.
9. Which molecules, ice at 0°C or water at 0°C have great potential energy? Explain. *(Dhirubhai Ambani International School, Mumbai)* **[2]**
10. For the same kinetic energy of a body, what should be the change in its velocity if its mass becomes four times? *(Dhirubhai Ambani International School, Mumbai)* **[3]**

11. Determine the nature of work (positive, negative or zero) done on the body in the following cases. *(Dhirubhai Ambani International School, Mumbai)* **[3]**
a) Work done by its weight when a body is displaced along a horizontal surface.
b) A ball falling freely under the action of gravity
c) When two similar charges are brought closer to each other, they repel each other.

12. A block and tackle system has two pulleys in each block, with the tackle tied to the hook of the lower block and the effort being applied upwards. Draw a neat diagram to show this arrangement and calculate its mechanical advantage. *(Dhirubhai Ambani International School, Mumbai)* **[3]**

13. An electric motor of power 150 W is switched on for 2 minutes and 40 seconds. If 65% of the energy of the motor is useful. Calculate - *(Dhirubhai Ambani International School, Mumbai)* **[4]**
a) Useful work done by the motor.
b) Load lifted by it through a vertical height of 4 m.

14. Answer the following questions. *(Dhirubhai Ambani International School, Mumbai)* **[3]**
a) On what basis would you classify an energy source as renewable?
b) Also, state one advantage and one limitation of tidal energy.

15. Aman can apply a force of 100 N and move with a uniform speed of 40 ms^{-1}. Calculate, the power developed by the man. *(Lilavati Podar High School, Mumbai)* **[2]**

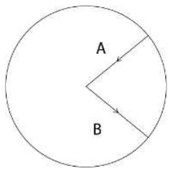
16. State the conversion of energy that occurs for the following cases: - *(Lilavati Podar High School, Mumbai)* **[2]**
a) A battery being charged
b) A microphone

17. Define moment of couple. Write its S.I unit. *(Children's Academy, Mumbai)* **[2]**

18. State any two differences between work and power. *(Children's Academy, Mumbai)* **[2]**

19. A pair of scissors is used to cut a piece of a cloth by keeping it at a distance 8.0 cm from its rivet and applying an effort of 10 kgf by fingers at a distance 2.0 cm from the rivet. Find: (i) the mechanical advantage of scissors (ii) the load offered by the cloth. *(Children's Academy, Mumbai)* **[2]**

20. a) State the difference between the uniform circular motion and uniform linear motion
b) The given diagram represents the forces acting on a body in a circular motion. A and B represents two forces which among them is fictitious force? *(Children's Academy, Mumbai)* **[3]**



21. A simple pendulum while oscillating rises to a maximum vertical height 5 cm from its rest position when it reaches to its extreme position on one side. If mass of the bob of the simple pendulum of 500g ($g = 10\ ms^{-2}$), find: *(Children's Academy, Mumbai)* **[2]**
a) Total energy of the simple pendulum at any instant while oscillating.
b) Velocity of the bob at its mean position.

22. Define commercial unit of electrical energy. State how it is related to S.I unit of electrical energy. *(Children's Academy, Mumbai)* **[2]**

23. a) What are different forms of kinetic energy? *(Children's Academy, Mumbai)* **[2]**
b) Is it possible for a body to have a more than form of kinetic energy simultaneously? Justify with an example. **[2]**

24. Define the SI unit of work. How the magnitude of work related in CGS and SI system**.** *(Christ Academy, Bangalore)* **[3]**

25. A uniform meter scale balances horizontally on a knife edge placed 55cm mark, when a mass of 25g is suspended from one end. Calculate the mass of the scale. *(Christ Academy, Bangalore)* **[2]**

26. Answer the following questions. *(Christ Academy, Bangalore)* **[2]**
a) "A secondary cell is used in solar panel." State one suitable reason for this.
b) "A uniform circular motion is an accelerated motion." Justify your answer.

27. Justify and give a proper reason whether the work done in the following cases is positive or negative. *(Christ Academy, Bangalore)* **[2]**
a) Work done by a man in lifting a bucket out of a well by means of rope tied to the bucket.
b) Work done by friction on a body sliding down an inclined plane.

28. An engine can pump 30,000 litres of water to a vertical height of 45 metres in 10 minutes. Calculate the work done by the machine and its power. (Density of water = 10^3 kg/m^3, 1000 litres = 1 m^3, g = 9.8 ms^{-2}) *(Christ Academy, Bangalore)* **[2]**

29. A body is acted upon by two forces each of magnitude F, but in opposite directions. State the effect of forces if: (i) both forces act at the same point of the body (ii) The two forces act at two different points of the body at a separation r. *(St. Johns Universal School, Mumbai)* **[2]**

30. Write any two points of differences between watt and watt hour? *(St. Johns Universal School, Mumbai)* **[2]**

31. A ball is placed on a compressed spring. *(St. Johns Universal School, Mumbai)* **[2]**
a) What form of energy does the spring possess?
b) What happens when you release the spring?

32. What is the velocity ratio of a single fixed pulley? How does friction in the pulley bearing affect it? *(St. Johns Universal School, Mumbai)* **[2]**

33. Two bodies have masses in the ratio 5:1 and kinetic energies in the 125:9. Calculate the ratio of their velocities. *(St. Johns Universal School, Mumbai)* **[2]**

PART 4

Previous Years' Board Questions

1. A coolie raises a load upwards against the force of gravity then the work done by the load is: *[ICSE Sem 1, 2021]* **[1]**
a) Zero
b) Positive work
c) Negative work
d) None of these

2. The energy change during photosynthesis in plants is: *[ICSE Sem 1, 2021]* **[1]**
a) Heat to Chemical Energy
b) Light to Chemical Energy
c) Chemical to Light Energy
d) Chemical to Heat Energy

3. Which of the following is the correct mathematical relation? *[ICSE Sem 1, 2021]* **[1]**
a) Power = Force/Velocity
b) Power = Force × Acceleration
c) Power = Force/Acceleration
d) Power = Force × Velocity

4. 1 Joule = ………. erg: *[ICSE Sem 1, 2021]* **[1]**
a) 10^9
b) 10^7
c) 10^5
d) 10^6

5. The usable form of mechanical energy is: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**
a) Elastic Potential Energy
b) Kinetic Energy
c) Gravitational Potential Energy
d) None of these

6. One Horse Power is equal to: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**
a) 100 W
b) 735 W
c) 764 W
d) 746 W

7. If A and B of the same mass can climb the third floor of the same building in 3 minutes and 5 minutes respectively, then the ratio of the powers of A is to B in an ideal situation. *[ICSE Specimen Paper Sem 1, 2021]* **[1]**
a) 1 : 1
b) 3 : 5
c) Insufficient information
d) 5 : 3

8. Work done by a body moving on a circular track is zero at every instant because:

[ICSE Specimen Paper Sem 1, 2021] **[1]**

a) Displacement is zero

b) Displacement is perpendicular to the centripetal force

c) There is no force acting

d) Reason is not mentioned in the other options

9. In an electric cell while in use the change in energy is from: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**

a) Chemical to Mechanical Energy

b) Chemical to Electrical Energy

c) Electrical to Mechanical Energy

d) Electrical to Chemical Energy

10. A body of mass 200 g falls, freely from a height of 15 m. [g = 10 ms^{-2}] *[ICSE Sem 1, 2021]* **[4]**

(A) When the body reaches 10 m above the ground its potential energy will be:

a) 20,000 J b) 10 J c) 10,000 J d) 20 J

(B) The gain in kinetic energy of the body when it reaches 10 m above the ground is:

a) 20 J b) 10 J c) 30 J d) 25 J

(C) The total mechanical energy it will possess, when it is just about to strike the ground is:

a) 30,000 J b) 20,000 J c) 30 J d) 20 J

(D) The velocity is ms^{-1} with which the body will hit the ground is:

a) 30 b) 10 c) $10\sqrt{3}$ d) $10\sqrt{2}$

11. A woman draws water from a well using a fixed pulley. The mass of the bucket and the water together is 10 kg. The force applied by the woman is 200 N. The mechanical advantage is - (g = 10 ms^{-2}): *[ICSE Sem 1, 2021]* **[1]**

a) 2 b) 20 c) 0.05 d) 0.5

12. A single fixed pulley is used because: *[ICSE Sem 1, 2021]* **[1]**

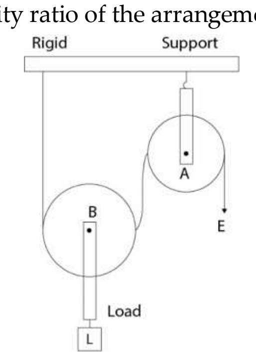
a) It changes the direction of applied effort conveniently

b) It multiplies speed

c) It multiplies effort

d) Its efficiency is 100%

13. In the diagram shown below, the velocity ratio of the arrangement is: *[ICSE Sem 1, 2021]* **[1]**



a) 1 b) 2 c) 3 d) 0

14. Mechanical advantage (M.A.), load (L), and effort (E) are related as: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**

a) M.A. = L x E

b) M.A. = $\frac{E}{L}$

c) M.A. x E = L

d) M.A. x L = E

15. Which one of the following statements is correct? *[ICSE Specimen Paper Sem 1, 2021]* **[1]**

a) A machine is used to have more output energy as compared to input energy.

b) Mechanical advantage of a machine can never be greater than 1.

c) If a machine gives convenience of direction, then its mechanical advantage should be greater than 1.

d) For a given design of a machine, even if the mechanical advantage increases, the velocity ratio remains the same.

16. If a block and tackle system with convenient direction has 3 movable pulleys then its velocity ratio: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**

a) is either 6 or 7

b) should be 6

c) should by 7

d) is 3

17. A pulley system has velocity ratio 5 and is used to lift a load of 100 kgf through a vertical height of 15 m. Find the distance through which effort is moved: *[ICSE Sem 1, 2021]* **[1]**

a) 15 m b) 75 m c) 3 m d) None

18. Answer the following. *[ICSE 2020]* **[2]**

a) Define moment of force.

b) Write the relationship between the S.I. and CGS unit of moment of force.

19. Answer the following. *[ICSE 2020]* **[3]**

a) With reference to the direction of action, how does a centripetal force differ from a centrifugal during uniform circular motion?

b) Is centrifugal force the force of reaction of centripetal force?

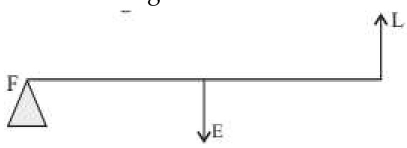
c) Compare the magnitudes of centripetal and centrifugal force.

20. Define a kilowatt hour. How is it related to joule? *[ICSE 2020]* **[2]**

21. A satellite revolves around a planet in a circular orbit. What is the work done by the satellite at any instant? Give a reason. *[ICSE 2020]* **[2]**

22. *[ICSE 2020]* **[2]**

a) Identify the class of the lever shown in the diagram below:



b) How is it possible to increase the M. A. of the above lever without increasing its length?

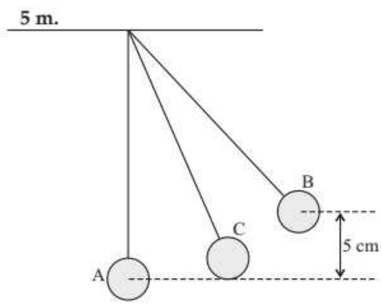
23. Give one example of each when: *[ICSE 2020]* **[2]**

a) Chemical energy changes into electrical energy.

b) Electrical energy changes into sound energy.

24. A crane 'A' lifts a heavy load in 5 seconds, whereas another crane 'B' does the same work in 2 seconds. Compare the power of crane 'A' to that of crane 'B'. *[ICSE 2020]* **[2]**

25. The figure below shows a simple pendulum of mass 200 g. It is displaced from the mean position A to the extreme position B. The potential energy at the position A is zero. At position B the pendulum bob is raised by 5m. *[ICSE 2020]* **[3]**



a) What is the potential energy of the pendulum at the position B?

b) What is the total mechanical energy at point C?

c) What is the speed of the bob at the position A when released from B?

(Take g = 10 ms^{-2} and there is no loss of energy.)

26. A block and tackle system of pulleys has velocity ratio 4. *[ICSE 2020]* **[2]**

a) Draw a neat, labelled diagram of the system clearly indicating the points of application and direction of load and effort.

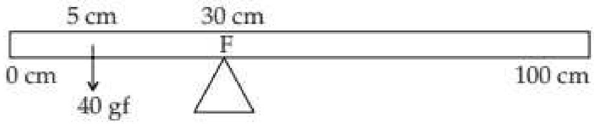
b) What will be its V. R. if the weight of the movable block is doubled?

27. *[ICSE 2019]* **[2]**

a) Define couple.

b) State the S.I. unit of moment of couple.

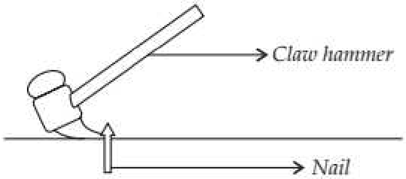
28. A uniform meter scale is in equilibrium as shown in the diagram: *[ICSE 2019]* **[3]**



a) Calculate the weight of the meter scale.

b) Which of the following options is correct to keep the ruler in equilibrium when 40 gf weight is shifted to 0 cm mark? F is shifted towards 0 cm *Or* F is shifted towards 100 cm

29. The diagram below shows a claw hammer used to remove a nail: *[ICSE 2019]* **[2]**



a) To which class of lever does it belong?

b) Give one more example of the same class of lever mentioned by you in (a) for which the mechanical advantage is greater than one.

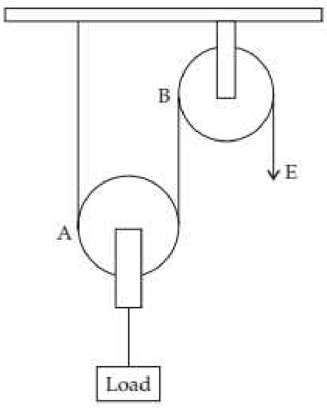
30. Two bodies A and B have masses in the ratio 5:1 and their kinetic energies are in the ratio 125:9. Find the ratio of their velocities. *[ICSE 2019]* **[3]**

31. A body of mass 10 kg is kept at a height of 5 m. It is allowed to fall and reach the ground. (Take g = 10 m/s^2.) *[ICSE 2019]* **[2]**

a) What is the total mechanical energy possessed by the body at the height of 2 m assuming it is a frictionless medium?

b) What is the kinetic energy possessed by the body just before hitting the ground?

32. The diagram below shows a pulley arrangement: *[ICSE 2019]* **[3]**



a) Copy the diagram and mark the direction of tension on each strand of the string.

b) What is the velocity ratio of the arrangement?

c) If the tension acting on the string is T, then what is the relationship between T and effort E?

d) If the free end of the string moves through a distance x, find the distance by which the load is raised.

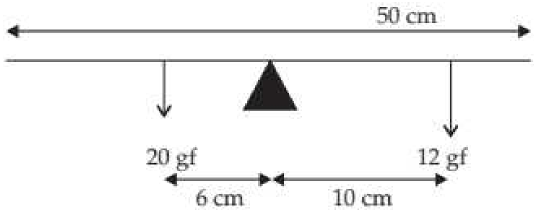
33. *[ICSE 2018]* **[2]**

a) Why is the motion of a body moving with a constant speed around a circular path said to be accelerated?

b) Name the unit of physical quantity obtained by the formula $\frac{2K}{v^2}$

Where K: kinetic energy, v: linear velocity.

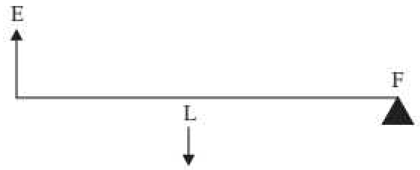
34. A half metre rod is pivoted at the centre with two weights of 20 gf and 12 gf suspended at a perpendicular distance of 6 cm and 10 cm from the pivot respectively as shown below: *[ICSE 2018]* **[3]**



a) Which of the two forces acting on the rigid rod causes clockwise moment?
b) Is the rod in equilibrium?
c) The direction of 20 kgf^* force is reversed. What is the magnitude of the resultant moment of the forces on the rod?

** Likely a printing error in board paper. We suggest you use 'gf' instead of 'kgf'.*

35. The diagram below shows a lever in use: *[ICSE 2018]* **[2]**



a) To which class of levers does it belong?
b) Without changing the dimensions of the lever, if the load is shifted towards the fulcrum what happens to the mechanical advantage of the lever?

36. *[ICSE 2018]* **[2]**

a) State and define the S.I. unit of power.
b) How is the unit horsepower related to the S.I. unit of power?

37. State the energy changes in the following cases while in use: *[ICSE 2018]* **[2]**

a) An electric iron
b) A ceiling fan

38. *[ICSE 2018]* **[2]**

a) Derive a relationship between S.I. and C.G.S. unit of work.
b) A force acts on a body and displaces it by a distance S in a direction at an angle θ with the direction of force. What should be the value of to get the maximum positive work?

39. Why is a jack screw provided with a long arm? *[ICSE 2017]* **[2]**

40. A uniform half metre rule balances horizontally on a knife edge at 29 cm mark when a weight of 20 gf is suspended from one end. *[ICSE 2017]* **[3]**

a) Draw a diagram of the arrangement.
b) What is the weight of the half metre rule?

41. *[ICSE 2017]* **[3]**

a) A boy uses a single fixed pulley to lift a load of 50 Kgf to some height. Another boy uses a single moveable pulley to lift the same load to the same height. Compare the effort applied by them. Give a reason to support your answer.
b) How does uniform circular motion differ from uniform linear motion?
c) Name the process used for producing electricity using nuclear energy.

42. If the power of a motor be 100 kW, at what speed can it raise a load of 50,000N? *[ICSE 2017]* **[2]**

43. Which class of lever will always have M.A. >1 and why? *[ICSE 2017]* **[2]**

44. A boy uses a single fixed pulley to lift a load of 50 kgf to some height. Another boy uses a single movable pulley to lift the same load to the same height. Compare the effort applied by them. Give a reason to support your answer. *[ICSE 2017]* **[2]**

45. A pulley system with V.R. = 4 is used to lift a load of 175 kgf through a vertical height of 15 m. The effort required is 50 kgf in the downward direction. ($g = 10\ N\ kg^{-1}$) Calculate: *[ICSE 2017]* **[4]**

a) Distance moved by the effort
b) Work done by the effort
c) M.A. of the pulley system
d) Efficiency of the pulley system

46. A stone of mass 'm' is rotated in a circular path with a uniform speed by tying a strong string with the help of your hand. Answer the following questions: *[ICSE 2016]* **[3]**

a) Is the stone moving with a uniform or variable speed?

b) is the stone moving with a uniform acceleration? In which direction does the acceleration act?

c) What kind of force acts on the hand and state its direction?

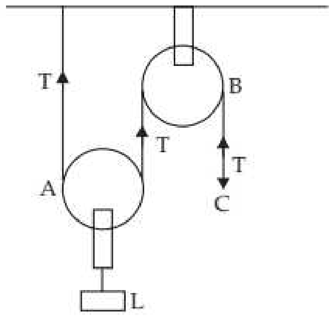
47. A boy weighing 40 kgf climbs up a stair of 30 steps each 20 cm high in 4 minutes and a girl weighing 30 kg does the same in 3 minutes. Compare: *[ICSE 2016]* **[4]**

a) The work done by them

b) The power developed by them

48. With reference to the terms Mechanical Advantage, Velocity Ratio and efficiency of a machine, name and define the term that will not change for a machine of a given design**.** *[ICSE 2016]* **[2]**

49. From the diagram given below, answer the questions that follow: *[ICSE 2016]* **[3]**



a) What kind of pulleys are A and B?

b) State the purpose of pulley B.

c) What effort has to be applied at C to just raise the load L = 20 kgf?

(Neglect the weight of pulley A and friction)

50. A pulley system has three pulleys. A load of 120 N is overcome by applying an effort of 50 N. Calculate the Mechanical Advantage and Efficiency of this system. *[ICSE 2016]* **[2]**

51. *[ICSE 2015]* **[2]**

a) On what factor does the position of the centre of gravity of a body depend?

b) What is the S.I. unit of the moment of force?

52. Name the factors affecting the turning effect of a body. *[ICSE 2015]* **[2]**

53. *[ICSE 2015]* **[2]**

a) Define equilibrium.

b) In a beam balance when the beam is balanced in a horizontal position, it is in equilibrium.

54. Explain the motion of a planet around the sun in a circular path. *[ICSE 2015]* **[2]**

55. How is work done by a force measured when the force: *[ICSE 2015]* **[2]**

a) Is in the direction of displacement

b) Is at an angle to the direction of displacement

56. State the energy changes in the following while in use: *[ICSE 2015]* **[2]**

a) Burning of a candle

b) A steam engine

57. A scissor is a.........multiplier. *[ICSE 2015]* **[2]**

58. Rajan exerts a force of 150 N in pulling a cart at a constant speed of 10 m/s. Calculate the power exerted. *[ICSE 2015]* **[2]**

59. Draw a simplified diagram of a lemon crusher, indicating direction of load and effort. *[ICSE 2015]* **[2]**

60. *[ICSE 2015]* **[3]**

a) Name the physical quantity measured in terms of horsepower.

b) A nut is opened by a wrench of length 20 cm. If the least force required is 2 N, find the moment of force needed to loosen the nut.

c) Explain briefly why the work done by a fielder when he takes a catch in a cricket match is negative.

61. A block and tackle system has V.R. = 5. *[ICSE 2015]* **[4]**

a) Draw a neat, labelled diagram of a system indicating the direction of its load and effort.

b) Rohan exerts a pull of 150 kgf. What is the maximum load he can raise with this pulley system if its efficiency = 75%?

62. What is the weight of a body placed at the centre of the earth? *[ICSE 2014]* **[2]**

63. Is it possible to have an accelerated motion with a constant speed? Explain. *[ICSE 2014]* **[2]**

64. *[ICSE 2014]* **[2]**

a) When does a force do work?

b) What is the work done by the moon when it revolves around the earth?

65. What is the principle of an ideal machine? *[ICSE 2014]* **[2]**

66. The conversion of part of the energy into an undesirable form is called. *[ICSE 2014]* **[2]**

67. Calculate the change in the Kinetic energy of a moving body if its velocity is reduced to $1/3^{rd}$ of the initial velocity. *[ICSE 2014]* **[2]**

68. State the energy changes in the following devices while in use: *[ICSE 2014]* **[2]**

a) A loudspeaker

b) A glowing electric bulb

69. *[ICSE 2014]* **[2]**

a) A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero?

b) Draw a diagram to show how a single pulley can be used to have its ideal M.A.= 2.

70. *[ICSE 2014]* **[2]**

a) A man having a box on his head, climbs up a slope and another man having an identical box walks the same distance on a levelled road. Who does more work against the force of gravity and why?

b) Two forces each of 5 N act vertically upwards and downwards respectively on the two ends of a uniform metre rule which is placed at its mid-point as shown in the diagram. Determine the magnitude of the resultant moment of these forces about the midpoint.

71. *[ICSE 2013]* **[2]**

a) Where is the centre of gravity of a uniform ring situated?

b) 'The position of the centre of gravity of a body remains unchanged even when the body is deformed.' State whether the statement is true or false.

72. *[ICSE 2013]* **[3]**

a) With reference to their direction of action, how does a centripetal force differ from a centrifugal force?

b) State principle of conservation of energy

c) Name the form of energy which a body may possess even when it is not in motion.

73. A force is applied on a body of mass 20 kg moving with a velocity of 40 ms^{-1}. The body attains a velocity of 50 ms^{-1} in 2 second. Calculate the work done by the body. *[ICSE 2013]* **[2]**

74. A type of single pulley is very often used as a machine even though it does not give any gain in mechanical advantage. *[ICSE 2013]* **[2]**

a) Name the type of pulley used.

b) For what purpose is such a pulley used?

75. *[ICSE 2013]* **[2]**

a) In what way does an 'Ideal machine differ from a 'Practical machine?

b) Can a simple machine act as a force multiplier and a speed multiplier at the same time?

76. A girl of mass 35 kg climbs up from the first floor of a building at a height 4 m above the ground to the third floor at a height 12 m above the ground. What will be the increase in her gravitational potential energy? [g = 10 ms^{-2}] *[ICSE 2013]* **[2]**

77. Which class of lever found in the human body is being used by a boy: *[ICSE 2013]* **[2]**

a) When he holds a load on the palm of his hand.

b) When he raises the weight of his body on his toes?

78. *[ICSE 2013]* **[2]**

a) State the principle of conversation of energy.

b) Name the form of energy which a body may possess even when it is not in motion.

79. A block and tackle system of pulleys has a velocity ratio 4. *[ICSE 2013]* **[3]**

a) Draw a labelled diagram of the system clearly indicating the points of application and directions of load and effort.

b) What is the value of the mechanical advantage of the given pulley system if it is an ideal pulley system?

80. A boy of mass 30 kg is sitting at a distance of 2m from the middle of a seesaw. Where should a boy of mass 40 kg sit to balance the seesaw? *[ICSE 2012]* **[2]**

81. *[ICSE 2012]* **[2]**

a) What is meant by the term 'moment of force'?

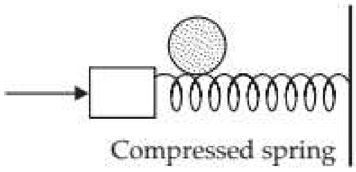
b) If the moment of force is assigned a negative sign, then will the turning tendency of the force be clockwise or anti-clockwise?

82. *[ICSE 2012]* **[2]**

a) Which of the following remains constant in uniform circular motion. Speed or Velocity or both?

b) Name the force required for uniform circular motion. State its direction.

83. A ball is placed on a compressed spring, When the spring is released, the ball is observed to fly away. *[ICSE 2012]* **[2]**



a) What form of energy does the compressed spring possess?

b) Why does the ball fly away?

84. A body of mass 0.2 kg falls from a height of 10 m to a height of 6 m above the ground. Find the loss in potential energy taking place in the body. [g = 10 ms^{-2}] *[ICSE 2012]* **[2]**

85. State the class of levers and the relative position of load (L), effort (E) and fulcrum (F) in each of the following cases. *[ICSE 2012]* **[2]**

a) A bottle opener b) Sugar tongs

86. A moving body weighing 400 N possesses 500 J of kinetic energy. Calculate the velocity with which the body is moving. (g = 10 ms-4) *[ICSE 2012]* **[2]**

87. Define one newton. *[ICSE 2011]* **[2]**

88. Where does the position of centre of gravity lie for *[ICSE 2011]* **[2]**

a) A circular lamina b) A triangular lamina

89. A man can open a nut by applying a force of 150 N by using a lever handle of length 0.4 m. What should be the length of the handle if he is able to open it by applying a force of 60 N? *[ICSE 2011]* **[2]**

90. A uniform metre scale can be balanced at the 70.0 cm mark when a mass of 0.05 kg is hung from the 94.0 cm mark. *[ICSE 2011]* **[2]**

a) Draw a diagram of the arrangement.

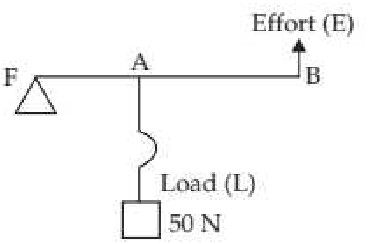
b) Find the mass of the metre scale.

91. Name a machine which can be used to: *[ICSE 2011]* **[2]**

a) Multiply force

b) Change the direction of force applied

92. The diagram below shows a lever in use. *[ICSE 2011]* **[2]**



a) To which class of lever does it belong?

b) If FA = 40 cm, AB = 60 cm, then find the mechanical advantage of the lever.

93. A ball of mass 200 g falls from a height of 5 m. What will be its kinetic energy when it reaches the ground? (g = 9.8 ms^{-2}) *[ICSE 2011]* **[2]**

94. *[ICSE 2011]* **[3]**

a) What is meant by an ideal machine?

b) Write a relationship between the mechanical advantage (M.A.) and velocity ratio (V.R.) of an ideal machine.

c) A coolie carrying a load on his head and moving on a frictionless horizontal platform does no work. Explain the reason why.

95. Draw a diagram to show the energy changes in an oscillating simple pendulum. Indicate in your diagram how the total mechanical energy in it remains constant during the oscillation. *[ICSE 2011]* **[2]**

96. *[ICSE 2010]* **[3]**

a) Define the term momentum.

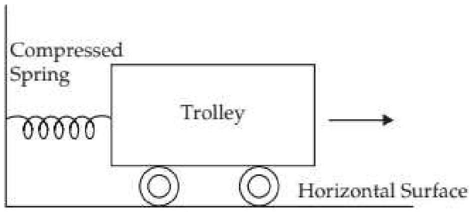
b) How is force related to the momentum of a body?

c) State the condition when the change in momentum of a body depends only on the change in its velocity.

97. A body is acted upon by a force. State two conditions under which the work done could be zero. *[ICSE 2010]* **[2]**

98. A spring is kept compressed by a small trolley of mass 0.5 kg lying on a smooth horizontal surface as shown in the figure given below: *[ICSE 2010]* **[2]**

When the trolley is released, it is found to move at a speed of 2 ms^{-1}



What potential energy did the spring possess when compressed?

99. *[ICSE 2010]* **[2]**

a) Why is the mechanical advantage of a lever of the second order always greater than one?

b) Name the type of single pulley that has a mechanical advantage greater than one?

100. A body of mass 50 kg has a momentum of 3000 kg ms^{-1}. Calculate: *[ICSE 2010]* **[2]**

a) The kinetic energy of the body

b) The velocity of the body

101. *[ICSE 2010]* **[2]**

a) Write a relation expressing the mechanical advantage of a lever.

b) Give two reasons as to why the efficiency of a single movable pulley system is always less than 100%.

102. *[ICSE 2009]* **[2]**

a) With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name the term that will not change for a machine of a given design.

b) Define the term stated by you in part (a).

103. What is the SI unit of energy? How is the electron volt (eV) related to it? *[ICSE 2009]* **[2]**

104. State the energy changes that take place in the following when they are in use: *[ICSE 2009]* **[2]**

a) a photovoltaic cell

b) an electromagnet

105. A body of mass 5 kg is moving with a velocity of 10 ms^{-1}. What will be the ratio of its initial kinetic energy and final kinetic energy, if the mass of the body is doubled and its velocity is halved? *[ICSE 2009]* **[2]**

106. 6.4 kJ of energy causes a displacement of 64 m in a body in the direction of force in 2.5 seconds. Calculate -

a) The force applied

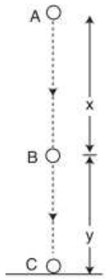
b) Power in horsepower (hp). (Take 1 hp = 746 W) *[ICSE 2009]* **[2]**

107. A pulley system comprises two pulleys, one fixed and the other movable. *[ICSE 2009]* **[2]**

a) Draw a labelled diagram of the arrangement and clearly show the directions of all the forces acting on it.

b) What change can be made in the movable pulley of this system to increase the mechanical advantage of the system?

108. An object of mass 'm' is AO + allowed to fall freely from point A as shown in the figure. Calculate the total mechanical energy of the object at: *[ICSE 2009]* **[4]**



a) Point A b) Point B c) Point C

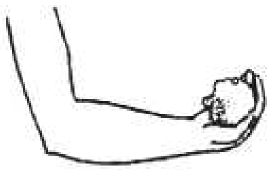
d) State the law which is verified by your calculations in parts (a), (b) and (c).

109. When an arrow is shot from a bow, it has kinetic energy in it. Explain briefly from where does it get its kinetic energy? *[ICSE 2008]* **[2]**

110. What energy conversions take place in the following when they are working – *[ICSE 2008]* **[2]**

a) Electric toaster b) Microphone

111. Copy the diagram of the forearm given below, indicate the positions of Load, Effort and Fulcrum. *[ICSE 2008]* **[2]**



112. In what way will the temperature of water at the bottom of a waterfall be different from the temperature at the top? Give a reason for your answer. *[ICSE 2008]* **[2]**

113. *[ICSE 2008]* **[3]**

a) A stone of mass 64.0 g is thrown vertically upward from the ground with an initial speed of 20.0 m/s. The gravitational potential energy at the ground level is considered to be zero. Apply the principle of conservation of energy and calculate the potential energy at the maximum height attained by the stone. (g = 10 ms^{-2}).

b) Using the same principle, state what will be the total energy of the body at its half-way point?

114. Define 'Joule', the SI unit of work and establish a relationship between the SI and CGS unit of work. *[ICSE 2008]* **[2]**

115. *[ICSE 2008]* **[2]**

a) Draw a labelled diagram of a block and tackle system of pulleys with two pulleys in each block. Indicate the directions of the load, effort and tension in the string.

b) Write down the relation between the load and the effort of the pulley system.

116. Which class of levers has a mechanical advantage always greater than one? What change can be brought about in this lever to increase its mechanical advantage? *[ICSE 2007]* **[2]**

117. Two bodies, A and B of equal mass are kept at heights 20 m and 30 m respectively. Calculate the ratio of their potential energies. *[ICSE 2007]* **[2]**

118. *[ICSE 2007]* **[2]**

a) Define a kilowatt hour. How is it related to the joule?

b) How can the work done be measured when force is applied at an angle to the direction of displacement?

119. *[ICSE 2007]* **[2]**

i. What is the main energy transformation that occurs in:

a. Photosynthesis in green leaves b. Charging of a battery

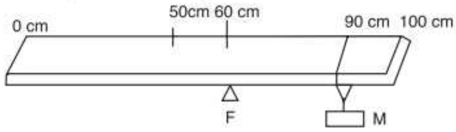
ii. Write an expression to show the relationship between mechanical advantage, velocity ratio and efficiency for a simple machine.

120. A block and tackle pulley system has a velocity ratio 3. *[ICSE 2007]* **[2]**

a) Draw a labelled diagram of this system. In your diagram, clearly indicate the points of application and the directions of the load and effort.

b) Why should the lower block of this pulley system be of negligible weight?

121. A uniform metre scale is kept in equilibrium when supported at the 60 cm mark and a mass Mis suspended from the 90 cm mark as shown in the figure. State with reasons, whether the weight of the scale is greater than, less than or equal to the weight of mass M. *[ICSE 2006]* **[2]**



122. State the amount of work done by an object when it moves in a circular path for one complete rotation. Give a reason to justify your answer. *[ICSE 2006]* **[2]**

123. Calculate the height through which a body of mass 0.5 kg should be lifted if the energy spent for doing so is 1.0 joule. (g = 10 ms^{-2}). *[ICSE 2006]* **[2]**

124. A pulley system has a velocity ratio of 4 and an efficiency of 90%. Calculate: *[ICSE 2006]* **[2]**

i. The mechanical advantage of the system.

ii. The effort required to raise a load of 300 N by the system.

125. Show that for the free fall of a body, the sum of the mechanical energy at any point in its path is constant. *[ICSE 2006]* **[3]**

Unit 2 LIGHT

REVISION NOTES

Lens, Reflection & Refraction

1. **Refraction**: Refraction is the phenomenon that causes the ray to diverge from its initial path, when a ray of light travels from one optical medium to another.

2. **Incident Ray:** A light ray that is moving towards another optical medium is referred to as an incident ray.

3. **Point of Incidence**: The point at which an incident ray interacts with a different optical medium is referred to as the point of incidence.

4. **Angle of Incidence**: The angle of incidence is the angle formed between the incident ray and the normal.

5. **Angle of Refraction:** The refracted ray's angle with the normal is referred to as the angle of refraction.

6. **Normal**: A normal line is a perpendicular drawn at the point of incidence.

7. **Refracted Ray:** A refracted ray is a light ray that deviates from its path when it enters another optical medium.

8. **Angle of Emergence:** The term "angle of emergence" refers to the angle that the emergent ray creates with the normal.

9. **Emergent Ray:** A light ray that appears from another optical medium is referred to as an emergent ray.

10. **The direction in which a ray of light bends depends upon:**
    a) The medium through which ray of light is.
    b) Optical density of two mediums that cause refraction to occur.

11. At the point of incident, a light beam always bends in the direction of normal when it travels obliquely from an optically rarer medium to an optically denser one.

12. When a ray of light always bends in the opposite direction from normal when it is passing from an optically dense media to an optically rarer medium.

13. There is no refraction when a light ray enters another optical medium normally.

14. **Snell's Law of Refraction:** Snell's law is a principle that describes the relationship between the angles of incidence and refraction of a light wave as it passes from one medium to another. It is a mathematical expression that can be used to predict the path of light as it travels through different materials with different refractive indices.

The law is named after the Dutch mathematician Willebrord Snellius, who formulated it in the early 17th century. It is also known as the "law of refraction" or the "Snell-Descartes law."

15. The ray of incidence, the ray of refraction, and the normal to the incident ray all lie in the same plane at the point of incidence.

16. **Refractive Index:** The ratio of the sine of the angle of incidence to the sine of the angle of refraction in another optical medium is known as the refractive index. As long as there is no shift in the medium, the quantity will remain the same.

17. **Lateral Displacement:** This refers to the perpendicular shift in the direction of an incident ray as it emerges from an optical slab.

18. **It is found experimentally that:**
    a) Lateral displacement is directly proportional to thickness of optical slab.
    b) Lateral displacement is directly proportional to refractive index.
    c) Lateral displacement is directly proportional to angle of incidence.
    d) Lateral displacement is inversely proportional to wavelength of light.

19. **Speed of Light: In a vacuum, the speed of light is always** 3×10^8 ms^{-1}, regardless of the colour or wavelength.

20. **If the light travels through any other optical medium it is slowed down. The extent of slowing depends upon:**
    a) Optical density of the medium.
    b) Color or wavelength of light.
    The value of refractive index so obtained is called **Absolute Refractive Index**.

21. **Real Depth**: Real depth refers to the actual depth at which an object is positioned in a substance that refracts light.

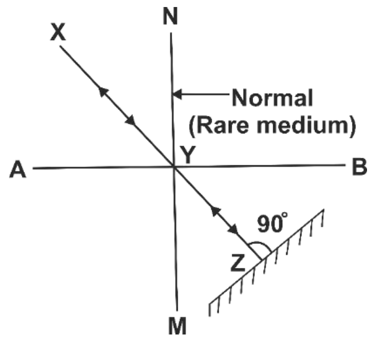
22. **Apparent Depth:** The depth at which an object appears to eye, in a refracting material is called apparent depth.

23. **Total Internal Reflection:** Total internal reflection is a phenomenon that occurs when a wave, such as a light wave, travels from a medium with a higher refractive index to a medium with a lower refractive index and is incident upon the boundary between the two media at an angle greater than the critical angle.

    When this happens, the wave is completely reflected back into the original medium, rather than being transmitted into the second medium. This can be observed when light travels through a fiber optic cable or when light is reflected off the surface of a diamond.

24. **Critical Angle:** The critical angle is the angle of incidence at which total internal reflection occurs. It is determined by the refractive indices of the two media.

25. **Conditions for Total Internal Reflection:**
    a) Light must move from an optically denser medium to an optically rarer one.
    b) The angle of incidence must be greater than the critical angle if it is in an optically denser medium.



26. **Principle of Reversibility of Light:** This principle states that the path that light takes can be reversed. The concept of reversibility states that if a ray of light travels from point X to point Z along one path, then it will move in the opposite direction along the same path when travelling from point Z to point X. To put it another way, the direction that light travels can be reversed.

27. **Totally Reflecting Prism:** The totally reflecting prism is an isosceles glass prism that has one angle that is equal to 90°.

28. **Prism**: It is a piece of glass or any other transparent material, bounded by two triangular and three rectangular surfaces.

29. **Mirage**: The phenomenon due to which the images of distant trees are visible in the hot desert when no water is around is called mirage.

30. **Refracting Surfaces:** The rectangular surfaces of a prism are referred to as refracting surfaces.

31. **Refracting Edge:** The line along where two refracting surfaces of a prism meet is called refracting edge.

32. **Angle of Prism**: The angle formed by the intersection of two surfaces that refract light is known as the angle of prism.

33. **Angle of Deviation**: The angle that is created between the incident ray and the emergent ray, when it passes through prism is called angle of deviation.

34. **Angle of Minimum Deviation:** It is the least angle of deviation for a particular angle of incidence for refraction in a prism.

35. **The Magnitude of Angle of Deviation depends upon:**
    a) Angle of incidence
    b) Refracting angle of prism
    c) Refractive index of the material of prism
    d) Wavelength of incident of light.

36. **Difference Between Reflection and Total Internal Reflection:**

Reflection	Total Internal Reflection
Occurs when light hits a surface and is reflected back	Occurs when light travels from a higher refractive index medium to a lower refractive index medium and is reflected back into the higher refractive index medium
Can occur at any angle of incidence	Can only occur when the angle of incidence is greater than the critical angle
Can be partially or fully reflected	Is always fully reflected
Can be specular (mirror-like) or diffuse (scattered)	Is always specular (mirror-like)
Examples include a mirror, a pond of water, a glossy surface	Examples include fiber optic cables, the inside of a gemstone, the border between air and water or glass

37. **Refracting Periscope**: A refracting periscope is a type of optical instrument that uses lenses and mirrors to allow the viewer to see objects that are not in their direct line of sight. It consists of two main components: **the objective lens**, which is located at one end of the periscope and focuses light from the object being viewed; and **the eyepiece**, which is located at the other end of the periscope and magnifies the image for the viewer. The objective lens and eyepiece are separated by a series of prisms or mirrors that bend the light path and allow the image to be viewed from an angle.

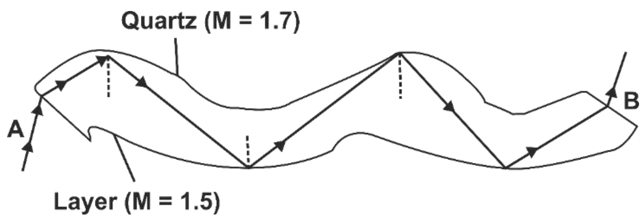
Refracting periscopes are commonly used in military and naval applications to allow soldiers and sailors to see over obstacles or around corners without exposing themselves to danger. They are also used in other fields, such as engineering and surveying, to view objects at a distance or at difficult angles.

38. **Advantage of Refracting Periscope over Reflecting Periscope:**

a) The final image is very bright in comparison to that of a reflecting periscope, because the totally reflecting prisms do not absorb any light.

b) The presence of moisture or dust, etc., has very little impact on the quality of the image created by the refracting periscope, whereas the reflecting periscope becomes inoperable. As a result, it is able to perform its functions with the same level of efficacy in the ocean as it does in other adverse weather circumstance.

39. **Optical Fibre:** An optical fibre is a device that works on the principle of complete internal reflection and allows for the transmission of a light signal from one location to another with almost a negligible loss of energy.



40. In optical terminology, a lens is a piece of transparent optical material that has either one or two spherical surfaces.

41. **Lens are Divided into Two Broad Classes:**
    a) Converging lens or convex lens
    b) Diverging lens or concave lens

42. **Converging Lens**: A converging lens is a piece of transparent material that has one or two spherical surfaces, and it is constructed in such a way that it is thicker in the middle and tapers off toward the edges. Converging lens are of three kinds:
    a) Double convex lens
    b) Plano convex lens
    c) Concave convex lens

43. **Diverging Lens:** A diverging lens is a piece of transparent material that has one or two spherical surfaces, and it is constructed in such a way that it is thicker at the edges and tapers in the middle.
    Diverging lens are of three kinds:
    a) Double concave lens
    b) Plano concave lens and
    c) Convexo concave lens

44. **Principal Axis**: An imaginary line joining the centre of curvature of two spherical surfaces of a lens is called principal axis.

45. **Optical Centre:** The term "optical centre" refers to a location inside the lens that is located on the principal axis and is designed in such a way that any ray of light that passes through it does not experience any refraction.

46. **First Principal Focus**: This is a location on the principal axis of a lens that, after refraction, causes the light rays that originate from that point to travel in a direction that is parallel to the principal axis.

47. **Second Principal Focus:** The Second Principal Focus is a position on the principal axis of the lens that is situated in such a way that rays of light that are travelling in a direction that is parallel to the principal axis either actually meet at this point or appear to meet at this point.

48. **Aperture**: The term "aperture" refers to the effective width of a lens through which the process of refraction takes place.

49. **Focal Length**: This term refers to the distance that between the optical centre of the lens and the principal focus.

50. **Focal Plane**: It is a vertical plane passing through principal focus of lens.

51. **Principal Foci:** Due to the fact that the lens is transparent, it is possible for light to travel through the lens in any direction. Therefore, provided that the medium on either side of the lens is the same, there will be two primary foci that are located at equal distances from the optical centre of the lens. Both of these points are referred to as the first and second focus points, respectively.

52. A convex lens will always produce real and inverted images, with the exception of when the object is between O and F, in which case it will produce a virtual and erect image.

53. A concave lens will always provide a virtual picture that is erect and diminished in size.

54. A concave lens can be used as:

a) Eye lens for Galileo telescope and

b) Correcting shortsightedness

55. The degree to which a lens converges or diverges light is referred to as its power. The unit of measurement for it is the dioptre.

56. The power of a lens with a focal length of one metre is denoted by one dioptre.

57. **Accommodation of Human Eye**: Accommodation of the human eye is the ability of the ciliary muscles to change the focal length of the crystalline lens in order to concentrate the image of a distant or nearer object, clearly on the retina.

58. **Power of Lens**: The power of lens is the measure of convergence or divergence produced by it.

$$P = \frac{1}{f\ (in\ m)} = \frac{100}{f\ (in\ cm)}$$

where, f = focal length and P = Power

59. **Units of Power of Lens:**

a) The power of a lens is measured in dioptres, which is represented by the letter 'D.'

b) One dioptre is the convergence or divergence produced by a lens of focal length 1 metre.

c) The power of convex lens is considered positive and is denoted as +D.

d) The power of concave lens is considered negative and is denoted as –D.

60. **Simple Microscope or Magnifying Glass:** This device is made out of a convex lens that has a short focal length and is fixed on a metallic frame that has a handle. The lens is set at such a distance from the object that the virtual, erect, and magnified image that is created by it is at the shortest distance possible for distance vision (25 cm for normal eye).

61. **Magnifying Power of Simple Microscope:**

It is the ratio between the angle subtended by the image on the eye to the angle subtended by the object on the eye, when positioned at the least distance of clear vision.

$$M = 1 + \frac{D}{f}$$

Where 'm' is magnification, 'D' is least distance of distinct vision and 'f' is focal length of lens.

62. **Uses of Simple Microscope:**

a) Reading glass

b) To observe lines of hand by palmists

c) To observe weave patterns of clothing

d) To read Vernier scale on the instruments, such as spectrometer travelling microscope

63. **f – Numbers**: The size of aperture is expressed as f – numbers.

$$f - number = \frac{Focal\ length\ of\ camera\ lens}{Diameter\ of\ diaphragm\ of\ aperature}$$

64. **Photographic Camera**: This is an instrument that is used to record a permanent image of an object on photographic film or a photographic plate. This is accomplished with the use of a convex lens.

- **Principle**: It is founded on the premise that if an item is placed beyond 2F of a convex lens, it will always generate a real, inverted, and diminished image between F_2 and $2F_2$ on the other side of the lens.

65. **Human Eye:** In many ways, the structure of the human eye and the way it works are strikingly similar to those of a photographic camera. The human eye is nearly spherical in shape, with slight bulge in the front part.

66. **Radius of Curvature:** The radius of curvature of a lens refers to the curvature of the lens surface. It is defined as the radius of the imaginary sphere that best fits the surface of the lens. The radius of curvature is an important parameter in lens design, as it determines how the lens will refract light and how it will affect the focus of the image.

67. **Optical Centre:** The central point 'O' in the lens is called the optical centre.

68. **Centre of Curvature**: There are two centres of curvature in a lens. These are the locations of the centres of the two spherical surfaces that come together to create the lens.

69. Images formed by lenses can be either real or virtual.

70. **Real Image**: It is said that an image is real if the rays of light, after being reflected by the lens, actually meet at a spot. In every case, the genuine image is seen upside down. It is possible to bring it into sharp focus on a screen.

71. **Virtual Image:** An image is said to be virtual if the rays of light that seem to come from a point after being refracted by the lens. A virtual picture is one that is always standing erect. On a screen, it is impossible to bring it into focus.

Functions of Parts of An Eye

1. **Sclerotic**: This layer's job is to shield and protect the vital internal components of the eye, and it also houses those components.

2. **Cornea**: The cornea serves the purpose of acting as a window to the outside world, as it is responsible for allowing light to enter the eye.

3. **Choroid**: The choroid is responsible for the darkening of the eye from the inside, preventing any internal reflection from occurring.

4. **Iris**: The purpose of the iris is to regulate the amount of light that enters the eye.

5. **Aqueous Humor:** It stops the anterior region of the eye from collapsing as a result of changes in the pressure of the surrounding atmosphere, it keeps the cornea moist by washing our eyes.

6. **Ciliary Muscles**: The job of the ciliary muscles is to change the focal length of the crystalline lens. This is done in order to ensure that images of objects at varying distances are sharply focused on the retina.

7. **Yellow Spot**: Its purpose is to produce a picture that is very distinct; more specifically, when we wish to conduct a very in-depth analysis of an object, the image of the object is brought into focus at this point.

8. **Blind Spot**: It has no function. Any image formed at this spot is not visible.

9. **Retina**: The job of the retina is to first receive the optical image of an object and then to convert that image into optical pulses, which are then ultimately transmitted to the brain via the optic nerve.

10. **Optic Nerve:** Its job is to transmit visual information from the eye to the brain.

11. **Crystalline lens**: Its purpose is to bring into sharp focus on the retina images of objects located at varying distances from the camera.

Spectrum

1. **Spectrum:** A band of colours that appear on a screen when polychromatic light splits into its component colours is referred to as a Spectrum.

2. **Polychromatic Light: Polychromatic light is a type of light that combines several colours (or wave bands)**. E.g. sunlight (white light), candlelight etc. are polychromatic lights.

3. **Monochromatic Light:** The term "monochromatic light" refers to light that only consists of a single colour (or only comprises of a single wavelength). E.g. Red light, blue light.

4. **Colour:** Colour is a term that refers to the sensation that is formed in the brain as a result of the stimulation of the retina by an electromagnetic wave of a specific wavelength.

5. **Solar Spectrum:** The band of seven colours (VIBGYOR) that appears on the screen when white light is broken down into its component colours is referred to as the solar spectrum.

6. **Pure Spectrum:** A spectrum is said to be a pure spectrum when the distinct bands of colour have sharply defined boundaries and do not blend into one another at any point.

7. **Impure Spectrum:** An impure spectrum is a spectrum in which the various bands of colour do not have strong, well- defined borders but instead melt into one other.

8. **White Colour:** White colour is the sensation that is formed in the brain when the retina is stimulated for all the colours of the visible light.

9. **Black Colour:** It is the sensation that occurs when the retina is not stimulated in any way because there is no visible light falling on it.

10. **Dispersion:** Dispersion is the phenomena that occurs when a polychromatic light (white light), is passed through a prism; it causes the light to break up into its component colours.

11. **Invisible Spectrum:** The Invisible Spectrum, the portions of the spectrum that do not excite the retina and are therefore incapable of being seen are referred to collectively as the invisible spectrum.

12. **Refrangibility:** Refrangibility is the term used to describe the angle through which light of a specific wavelength might deviate when it travels through a prism.

13. **Refractive Index:** Refractive index of a material for red light is least and violet light is maximum.

14. **Seven Colours:** Seven colours of light that have been dispersed can be recombined into its original state by employing either another inverted equilateral prism or Newton's colour disc.

15. **VIBGYOR:** The acronym VIBGYOR stands for the colours Violet, Indigo, Blue, Green, Yellow, Orange, and Red. The term "VIBGYOR" is a helpful memory aid that can be used to recall the order of the colours in the spectrum.

16. **Electromagnetic Spectrum:** The complete electromagnetic spectrum in the increasing order of their wavelengths (or decreasing order of their frequencies) is given below:
a) Gamma Rays, b) X-Rays, c) Ultraviolet Rays, d) Visible Lights, e) Infrared Radiations, f) Microwaves, and g) Radio waves.

Electromagnetic Spectrum	Wave-length	Discovered by	Source	Detection	Properties	Uses
Radio Waves	> 1 mm	James Clerk Maxwell, Hertz	Natural (e.g. lightning) or man-made (e.g. radio transmitters)	Radio antenna	Low energy, long wavelength, low frequency	Communication (e.g. radio and television broadcasting), navigation (e.g. GPS), remote sensing (e.g. radar)
Microwaves	1 mm to 1 cm	James Clerk Maxwell, Hertz	Natural (e.g. cosmic microwave background radiation) or man-made (e.g. microwave ovens)	Antenna	Intermediate energy, intermediate wavelength, intermediate frequency	Communication (e.g. mobile phones), cooking (e.g. microwave ovens), radar (e.g. weather forecasting)
Infrared radiation	1 cm to 750 nm	William Herschel	Natural (e.g. heat radiation from objects) or man-made (e.g. infrared lamps)	Thermal detector	Low energy, long wavelength, low frequency	Temperature measurement, night vision, remote control
Visible light	750 nm to 400 nm	Isaac Newton	Natural (e.g. sunlight) or man-made (e.g. light bulbs)	Eye, camera	Low energy, intermediate wavelength, intermediate frequency	Sight, photography, color perception
Ultraviolet radiation	400 nm to 10 nm	Johann Wilhelm Ritter	Natural (e.g. sunlight) or man-made (e.g. UV lamps)	UV detector	Intermediate energy, short wavelength, high frequency	Sterilization, tanning, fluorescence
X-rays	10 nm to 0.01 nm	Wilhelm Röntgen	Man-made (e.g. x-ray machines)	X-ray film	High energy, short wavelength, high frequency	Medical imaging (e.g. x-ray), material analysis
Gamma rays	< 0.01 nm	Paul Villard	Natural (e.g. radioactive decay) or man-made (e.g. nuclear explosions)	Geiger counter	Very high energy, very short wavelength,	Medical treatment (e.g. cancer therapy), material analysis

	very high frequency

17. Common Properties of Electromagnetic Waves:

a) They are transverse waves.
b) They obey the laws of reflection and refraction.
c) Electromagnetic waves travel with the speed of light, i.e. $3 \times 10^8 \, ms^{-1}$ in air or vacuum.
d) They are not affected by electric or magnetic waves.

18. Scattering: Scattering is the process of absorbing light energy and then reemitting it.

a) **Scattering of light:** Light from the sun enters the earth's atmosphere and is scattered (i.e., spreads in all directions) by the air molecules and dust particles that make up the atmosphere. Scientist Rayleigh was the first to investigate how light scatters. The scattering of light is not same for all wavelengths of incident light.

b) **Application of Scattering:** Some effects of scattering of sunlight by the earth's atmosphere are:
   i) Red colour of the sun at sunrise and sunset
   ii) White colour of clouds
   iii) White colour of sky at noon
   iv) Blue colour of the sky
   v) Black colour of the sky in the absence of atmosphere
   vi) Use of red light for the danger signal

19.

Sr No.	Discovery	Discovered by
1	Gamma Rays	Becquerel And Curie
2	X- Rays	Roentgen
3	Ultraviolet Rays	Ritter
4	Visible Light	Newton
5	Infrared Rays	Hershel
6	Heat Radiation	Hershel
7	Microwaves	Hertz
8	Ultrahigh frequency (UHF)	Marconi
9	Very High Frequency (VHF)	Marconi
10	Radio Frequency (RF)	Marconi
11	Power Frequency (PF)	Marconi

PART 1

Multiple Choice Questions (MCQs)

1. What is the change in the direction of a ray of light when it travels from one medium to another called?

a) Reflection of light
b) Refraction of light
c) Velocity
d) Deviation

2. Given the following mediums, in which medium does light travel the fastest?

a) Air
b) Water
c) Glass
d) Wood

3. What is the velocity of light in a vacuum (air)?

a) 4 x 10^8 m/s
b) 3.4 x 10^8 m/s
c) 3 x 10^8 m/s
d) 3.8 x 10^8 m/s

4. Red + _________ + Blue = White.

a) Green
b) Yellow
c) Violet
d) Orange

5. White - Red = ________.

a) Pink
b) Cyan
c) Yellow
d) Grey

6. What is the refractive index of water?

a) 2.40
b) 1.31
c) 2.42
d) 1.33

7. The angle of deviation decreases with the increase in?

a) Wavelength of light
b) Deviation of light
c) Velocity
d) Reflection

8. What is a point in a lens at which a ray of light suffers no refraction called?

a) Focal point
b) Optical centre
c) Spectrum
d) None

9. Which colour has the least angle of deviation?

a) Red
b) Blue
c) Green
d) Yellow

10. Which radiations are used for sterilising purposes?

a) Ultraviolet
b) Gamma
c) Infrared
d) Electro Magnetic

11. What will not change when light travels from one medium to another?

a) Velocity
b) Refraction
c) Reflection
d) Frequency

PART 2

Important Questions

I. Answer the Following Questions

1. What is 'refraction of light'? **[2]**
2. What is the cause of refraction of light? **[2]**
3. State the Laws of Refraction. **[2]**
4. State the conditions for no refraction. **[2]**
5. What is refractive index? **[2]**
6. What is absolute refractive index? **[2]**
7. What are the factors affecting refractive index? **[2]**
8. State the principle of reversibility of light. **[2]**
9. Define Lateral displacement. Write the factors on which lateral displacement

depends. **[2]**

10. Define prism. **[2]**

11. Can a prism transmit rays at all angles of incidence? What is the unit of refractive index? **[2]**

12. How lateral displacement produced by an optical block is related to: **[2]**

a) Thickness of block?
b) Refractive index of block?
c) Wavelength of incident light?
d) Angle of incidence?

13. What is meant by dispersion of light? **[2]**

14. What is lateral inversion? Explain with a suitable example. **[2]**

15. State the factors which determine angle of deviation. **[2]**

16. Write necessary conditions for total internal reflection. **[2]**

17. What is the nature, size and position of the image formed of an object at infinity from a concave mirror? Explain how it is used as a doctor's mirror. **[2]**

18. How can an image formed in a plane mirror be located? **[2]**

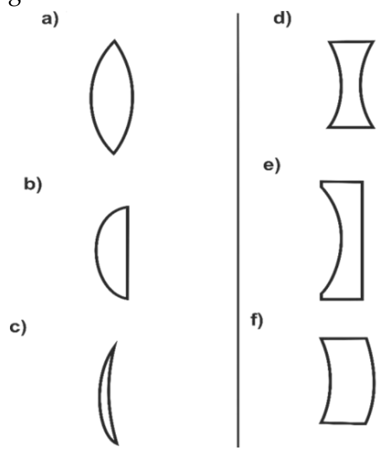
19. What is a lens? **[2]**

20. How many types of lenses are there? **[2]**

21. Define **[2 marks each]**

a) Principal Axis
b) Focal Plane
c) Focal Length
d) Optical Centre
e) First Principal Focus
f) Second Principal Focus

22. Different types of lenses. Fig. are given below. Name them. **[2 marks each]**



23. What do you understand by the term power of lens? Express the formula for power when focal length is in a) metres b) centimetres **[2]**

24. State two applications each of a convex lens and concave lens. **[2]**

25. Why are reflecting prisms used in periscopes? **[2]**

26. What rules are there for geometric construction of images for lenses? **[4]**

27. Write the nature, size and position of image when object is anywhere between optical centre and infinity in case a of a concave lens. **[2]**

28. Write the nature, size and position of image when the object is at infinity in case of a concave lens. **[2]**

29. Write the uses of simple microscope. **[2]**

30. Give relative position of object and image for convex lens. Also give nature and size of the image. **[3]**

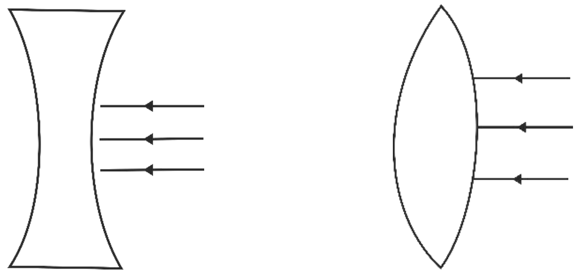
31. Draw ray diagrams to show how lens can be used as: **[2 marks each]**

a) Burning Glass
b) Astronomical Telescope
c) Photographic Camera
d) Terrestrial Telescope
e) Cine Projectors
f) Spotlight or Search Light
g) Galileo Tele-scope
h) Simple Microscope
i) Correcting Short Sightedness

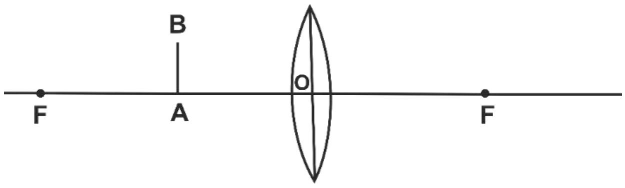
State the position of the object, image, and nature of image.

32. Draw a diagram to show the convergent action of a converging lens by treating it as a combination of prisms with the bases towards the centre of the lens. **[2]**

33. Copy and complete the following ray diagrams. In the diagrams indicate the focal length of the lenses. **[2]**



34. An object is place in front of a convex lens as shown below. Copy the diagram and complete it to show the refraction of two rays emerging from the point B. Indicate the position and nature of the image formed. **[3]**

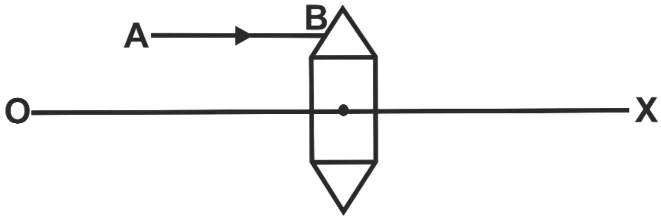


35. The diagram below shows a lens as a combination of a glass block and two prisms. Copy the diagram and answer the following questions. **[3]**

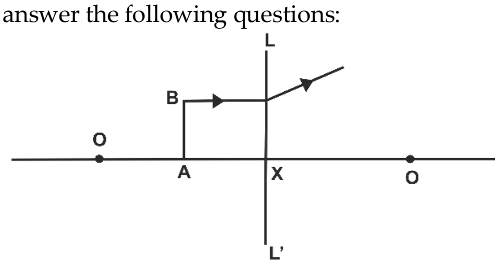
a) Name the lens formed by the combination.

b) What is the line OX called?

c) Complete the ray diagram and show the path of the incident ray AB after passing through the lens.



36. Study the diagram below and answer the following questions: **[4]**



a) Name the lens LL'.

b) What is the points O and O' called?

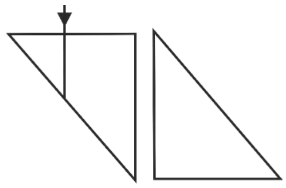
c) Between which points will the image of the object AB be formed?

d) What is the nature of the image?

37. Distinguish between real and virtual images. **[2]**

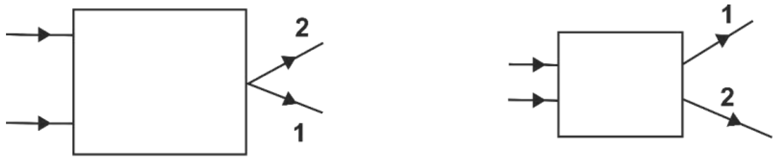
38. Distinguish between a convex and a concave lens. **[2]**

39. Two isosceles right- angle glass prisms are placed near each other as shown in the figure. Complete the path of the light ray entering the first isosceles right-angled glass prism till it emerges from the second identical prism. **[2]**



40. Can you obtain a real image with the help of a concave lens? **[2]**

41. Figures 'a' and 'b' are shown below. The incident and transmitted rays through lens kept in a box in each case. Draw the lens and complete the path rays through it. **[3]**



(a) (b)

42. How will you decide whether a given 5 pieces of glass is a convex lens or a plane glass plate? **[2]**

43. What happens to the image formed by a convex lens if its lower part is blackened? **[2]**

44. What is a mirage? **[2]**

45. Write about magnification produced by: **[2]**

a) Convex lens b) Concave lens

46. On what factors does the focal length of a lens depend? **[2]**

47. Where should an object be placed so a real and inverted image of the same size as the object is obtained using a convex lens? **[2]**

48. What is the refractive index of an opaque body? **[1]**

49. What is the unit of refractive index? **[1]**

50. What is the refractive index of **[2]**

a) vacuum and b) water?

51. What causes refraction of light? **[2]**

52. Define one diopter. **[2]**

53. a) Express the formula for magnifying of a microscope. **[2]**

b) What type of lens can be used as a magnifying glass.

54. Which type of lens has (i) negative power and (ii) positive power? **[2]**

55. "The refractive index of glass for which white light is 1.5." Explain. **[2]**

56. Define angle of incidence. **[2]**

57. Define angle of deviation? **[2]**

58. What is a prism? **[2]**

59. Give any two characteristics of the image produced by a concave lens. **[2]**

60. Give any two characteristics of the image formed by a convex lens. **[2]**

61. Which lens is used for projecting the image on the screen? **[2]**

62. How is the power of a lens related to its focal length? **[2]**

63. Name one factor that affects the lateral displacement of light as it passes through a rectangular glass slab. **[2]**

64. Define **[2]**

a) Spectrum b) Dispersion of light

65. Which colour of white light is deviated (a) the most (b) the least. **[2]**

66. What is an impure spectrum? **[2]**

67. Define pure spectrum and mention three conditions required to get a pure spectrum. **[3]**

68. Name the instrument used to obtain a pure spectrum. **[2]**

69. The wavelengths for the light of red and blue colours are roughly 7×10^{-7} m and 4×10^{-7} m respectively. Which colour has the greater speed in glass? **[2]**

70. Why does dispersion of light by glass prism take place? **[2]**

71. A wave has a wavelength of 0.01 Å. Name the wave. **[2]**

72. Name the region beyond **[2]**

a) The red end b) The violet end of spectrum

73. Name the radiation of wavelength. **[2]**

a) Longer than 8×10^{-7} m b) Shorter than 3.8×10^{-7} m

74. Two waves A and B have wavelength 0.01 Å and 9000 Å respectively. Name the two waves. Compare the speeds of these waves when they travel in vacuum. **[2]**

75. State the relation between the speed (C), frequency (f) and wavelength (λ) of electromagnetic waves. **[2]**

76. A rock salt prism is used instead of a glass prism to obtain the infrared spectrum. Why? **[2]**

77. Name the factors on which the deviation produced by a prism depends. **[2]**

78. How does the deviation produced by a triangular prism depend on the colours (or wavelengths) of light incident on it? Which colour deviates the most and which the least? **[2]**

79. Explain briefly how white light gets dispersed by a prism with the aid of a neat, labelled diagram. **[2]**

80. How does the speed of light in glass change on increasing the wavelength of light? **[2]**

81. Which colour of white light travels (a) fastest & (b) slowest, in glass? **[2]**

82. What is the range of wavelength of the spectrum of white light in (i) Å (ii) nm? **[2]**

83. Write the approximate wavelengths for (i) blue and (ii) red light. **[2]**

84. Name four colours of the spectrum of white light which have wavelength longer than blue light. **[2]**

85. Which colour has the greater speed in glass? **[2]**

86. Name the material of prism required for obtaining the spectrum of **[2]**

a) Ultraviolet light b) Infrared radiations

87. Name the waves a) of lowest wavelength b) used for taking photographs in dark c) produced by the changes in the nucleus of an atom d) of wavelength nearly 0.1 m. **[2]**

88. Name the radiation whose wavelength is from 4000 Å to 8000 Å. **[1]**

89. Name the scientist who discovered the visible part of spectrum or (visible light). **[1]**

90. Name the scientist who first studied the scattering of light. **[1]**

91. Name the radiation which is used for satellite communications. **[1]**

92. A wave has a wavelength 10^{-3} nm. a) Name the wave. b) State its one property different from light. **[2]**

93. Name the region just beyond a) the red end, and b) the violet end of the spectrum. **[2]**

94. Name the radiation which can be detected by a) a thermopile b) a solution of silver chloride. **[2]**

95.

a) Name the high energetic invisible electromagnetic wave which helps in the study of structure of crystals **[1]**

b) State one more use of the wave named in part (a) **[1]**

96. A wave has wavelength 50 Å **[2]**

a) Name the wave

b) State its speed in vacuum and

c) State its one uses

97. Name the radiations of wavelength just (i) longer than 8×10^{-7} m (ii) shorter than 4×10^{-7} m **[2]**

98. Wavelength and frequency are given. Fill up the name of the wave. **[2]**

No.	Name of Wave	Wavelength in nm	Frequency
a)		< 0.01	> 10^{19} Hz
b)		0.01 – 1.0	3×10^{19} to 3×10^{16} Hz
c)		1.0 – 400	3×10^{16} to 7.5×10^{14} Hz
d)		400 – 800	7.5×10^{14} to 3.75×10^{14} Hz
e)		800 - 10^6	3.75×10^{14} to 3×10^{11} Hz

		(800 nm to 1 mm)	
f)		10^6 - 10^{10} (1 mm to 10 m)	3 x 10^{11} to 3 x 10^7 Hz
g)		Above 10^{10} (> 10m)	Below 3 x 10^7 Hz

99. Name two sources of Gamma rays. **[2]**

100. Name the scientist who first discovered the ultraviolet part of the spectrum. **[2]**

101. Name the source of infrared radiations. **[2]**

102. Name the source of microwaves. **[2]**

103. State the harmful effect of a) ultraviolet radiations and b) infrared radiations. **[2]**

104. State the uses of microwaves. **[2]**

105. What are radio waves? State their uses. **[2]**

106. Name the radiation that cause fluorescence on zinc sulphide screen. **[2]**

107. Name the radiations that affect the photographic plate. **[2]**

108. Give any three properties that are common to all electromagnetic waves. **[3]**

109. Name three properties of ultraviolet radiation which are similar to visible light **[3]**

110. Red roses with their green leaves are arranged in a vase kept in a dark room. What colour will the roses and leaves appear when viewed in a) green light b) red light c) blue light? **[3]**

111. Write the range of wavelength of **[2]**

a) Infrared Spectrum b) Ultraviolet Spectrum

112. How do infrared rays differ from γ - rays in wavelength? **[2]**

113. How do infrared rays differ from γ- rays in penetrating power? **[2]**

114. Name the constituent colour of white light for which the deviation produced by the glass prism is least and the refractive index of glass is maximum. **[2]**

115. Arrange the following electromagnetic radiations in increasing order of their Wavelengths: Micro-waves, X-rays, infrared radiations, γ rays, radio waves and ultraviolet rays. [2]

116. [2]

a) Name the high energetic invisible electromagnetic waves which help in the study of the structure of crystal.

b) State an additional use of the waves mentioned in part a).

117. **[2]**

a) A ray of light passes from water to air. How does the speed of light change?

b) Which colour of light travels fastest in any medium except air?

118. **[2]**

a) Name a prism required for obtaining a spectrum of ultraviolet light.

b) Name the radiation which can be detected by a thermopile.

119. Name the radiations**:** **[3]**

a) That is used for photography at night.

b) That is used for detection of fractures in bones.

c) Whose wavelength range is from 100 Angstrom to 40,000 Angstrom (Or 10 nm to 400 nm?)

120. Why is the colour red used as a sign of danger? **[2]**

121. **[2]**

a) What is meant by dispersion of light?

b) In the atmosphere which colour of light gets scattered the least?

122. A ray of light PQ is incident normally on the hypotenuse of a right-angled prism ABC as shown in the diagram below: **[3]**

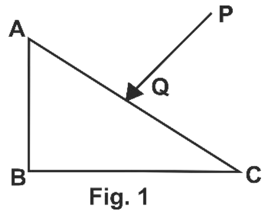


Fig. 1

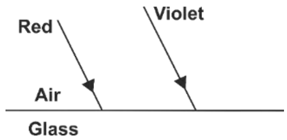
a) Copy the diagram and complete the path of the ray PQ till it emerges from the Prism.
b) What is the value of the angle of deviation of the ray?
c) Name an instrument where this action of the prism is used?

123. Which characteristics property of light is responsible for the blue colour of the sky? **[2]**

124. Suggest one way in each case by which we can detect the presence of: **[2]**

a) Infrared radiations
b) Ultraviolet radiations

125. Two parallel rays of red and violet colours travelling through air, meet the air-glass boundary as shown in the given figure **[2]**



a) Will their paths inside the glass be parallel? Give a reason for your answer.
b) Compare the speed of the two rays inside the glass.

126. **[2]**

a) Why is white light considered to be polychromatic in nature?
b) Give the range of the wavelength of those electromagnetic waves which are visible to us.

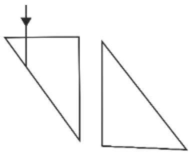
127. Why are infrared radiations preferred over ordinary visible light for taking photographs in fog? **[2]**

128. A high energy invisible electromagnetic rays helps us to study the structure of crystals. Name these rays and give another important use of these rays. **[2]**

129. How does the speed of light in glass change on increasing the wavelength of light? **[2]**

130. What is meant by primary colours? Name. **[2]**

Two isosceles right-angled glass prisms are placed near each other as shown in the figure below. Complete the path of the light ray entering the first isosceles right-angled glass prism till it emerges from the second identical prism.



131. Give one use of the electromagnetic radiations given below: **[2]**

a) Microwaves
b) Ultraviolet radiations
c) Infrared radiations

132. Name any two electromagnetic waves which have a frequency higher than that of violet light. State one use of each. **[2]**

133. A glass slab is placed over a page on which the word VIBGYOR is printed with each letter in its corresponding colour. **[2]**

a) Will the image of all the letters be in the same place?
b) If not, state which letter will be raised to the maximum. Give a reason for your answer.

134. Name any four regions of electromagnetic spectrum, (other than visible light) in increasing order of wavelength. **[2]**

135. Name the extreme colours in a pure spectrum of light. **[2]**

136. State the equation for the relation between frequency and wavelength of light in vacuum. **[2]**

137. Explain why in day light an object appears red when seen through a red glass and black when seen through a blue glass? **[2]**

138. Name the extreme colours in pure spectrum of light. **[2]**

139. Fill in the blanks: **[2]**

a) A piece of red cloth appears red in white light because it _____ blue and green and ____ only red.

b) Blue + ________ = Cyan

c) Green + Magenta = _______

140. How would you show the presence of UV and IR rays in the spectrum? **[2]**

141. **[4]**

a) Draw a diagram to show that white light can be split up into different colours.

b) Draw another diagram to show how the colours can be combined to give the effect of white light.

142. Define dispersion of light. **[2]**

143. Explain briefly how white light gets dispersed by a prism. **[2]**

144. Give the approximate range of wavelengths in vacuum associated with UV rays and visible light. **[2]**

145. A TV station transmits waves of frequency 200 MHz. Calculate the wavelength of the waves if their speed in air is 3.0×10^8 ms^{-1}. **[2]**

146. Give one useful and one harmful effect of ultraviolet radiations on the human body. **[2]**

147. What is the wavelength of the electromagnetic wave whose frequency is 10^{12} Hz? Name this electromagnetic wave. **[2]**

148. Write down the colour spectrum produced when white light is passed through a prism. Which of these colours is deviated most? **[2]**

149. What will be the colour of an object which appears green in white light and black in red light? **[2]**

150. **[4]**

a) White light is passed through a yellow filter. What colour is seen on a screen placed at the end?

b) If the light emerging from the yellow filter is passed through a red filter, what will be seen on the screen placed at the end?

151. A green shirt is observed in blue light. What colour it will appear to be and why? **[2]**

II. Give reason-based questions & answers

1. Why do the stars twinkle and not the planets? **[2]**

2. Why do the faces of people sitting around a campfire appear to shimmer? **[2]**

3. Why a coin placed in a water tank appears raised? **[2]**

4. Why sun appears bigger during sunset or sunrise? Or why does the rising sun appear bigger? **[2]**

5. An empty test tube is kept in a beaker filled with water. Why does its surface shine like a mirror? **[2]**

6. Why do diamonds sparkle? **[2]**

7. Images formed by totally reflecting prisms are brighter than the images formed by ordinary reflected light. Why? **[2]**

8. Explain why a welder keeps a special kind of glass between the object to be welded and his eyes? **[2]**

9. An object appears green when viewed through white light. Explain this observation. **[2]**

10. Why are infrared radiations used for photography in fog? **[2]**

11. A green shirt is observed in blue light. What colour it will appear to be and why? **[2]**

12. Explain why in daylight an object appears red when seen through a red glass and black when seen through a blue glass? **[2]**

13. Explain why? **[2]**

a) Rock salt prism is used instead of glass prism to obtain infrared spectrum.

b) Ultraviolet bulbs have quartz envelopes instead of glass.

14. What causes the scattering of light? **[2]**

15. Quartz prisms are required for obtaining the spectrum of ultraviolet light. Give reason. **[2]**

16. Why are danger signals made red? **[2]**

17. What will be the colour of the sky to a person seeing it from outer space? Explain your answer. **[2]**

18. What is the cause of dispersion of white light by a prism? **[2]**

19. Why is the sky blue on a sunny, clear day? **[2]**

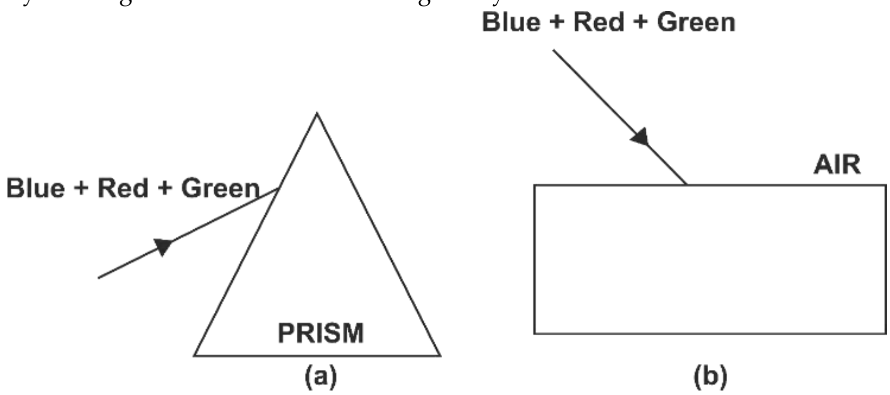
20. Why does the sun appear reddish at sunrise and sunset? Explain. **[2]**

21. Why is infrared radiation used as a signal during a war? **[2]**

22. The sky is seen as white colour at noon. Why? **[2]**

III. Figure based questions & answers

1. The light (blue + red + green) is incident on a prism and on a parallel sided glass slab. Complete the diagrams by drawing the refracted and the emergent rays. **[2]**



2. A beam consisting of red, blue and yellow colours is incident normally on the face AB of an isosceles right-angled prism ABC as shown in Fig. Complete the diagram to show the refracted and the emergent rays. **[2]**
(Given that the critical angle of glass-air interface for yellow colour is 45°)

3. Describe an experiment to show that a prism does not itself produce colours, it only separates the various colours. **[4]**

4. Explain Newton's colour disc. **[4]**

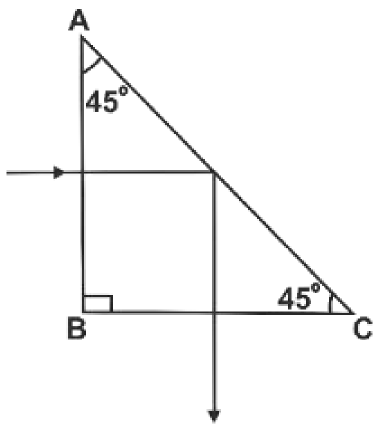
5. A beam of white light is incident normally on a surface of an equilateral triangular prism. **[3]**

a) Draw a diagram showing the emergence of light from the prism.

b) State the assumption you made while drawing the diagram.

c) What phenomenon is exhibited by light?

6. A ray of light passes through a right-angled prism as shown in the figure. State the angles of incidence at the faces AC and BC. **[2]**



PART 3

ICSE School Prelim Questions

1. The speed of light in water is 2.25×10^8 m/s. If the speed of light in a vacuum be 3×10^8 m/s, calculate the refractive index of water. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**

2. An object is placed in front of a lens between its optical centre and the focus. The image formed is virtual, erect and diminished. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**

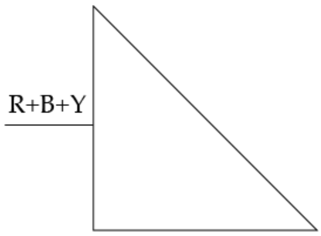
a) Name the lens.

b) Draw a ray diagram to show the image formation.

3. What is scattering of light? In the visible spectrum, which light is scattered the most and why? *(Maneckji Cooper Education Trust School, Mumbai)* **[3]**

4. Name the subjective property of light related to its wavelength and the subjective property of sound related to its frequency. *(Maneckji Cooper Education Trust School, Mumbai)* **[2]**

5. In the diagram given below a narrow beam of light is incident on a right-angled isosceles prism. The critical angle of the material of the prism for yellow colour of white light is 45°. Complete the diagram to show the path of blue, yellow and red colour of white light till they emerge out of the prism. *(Dhirubhai Ambani International School, Mumbai)* **[2]**



6. We can burn a piece of paper by focusing the sun's rays using a particular type of lens. *(Dhirubhai Ambani International School, Mumbai)* **[3]**

a) Name the type of lens used for the above purposes.

b) Draw a ray diagram to support your answer.

7.

a) What device other than a plane mirror can be used to turn a ray of light by 180°? Draw a diagram in support of your answer.

b) Name an instrument in which this device is used.

(Dhirubhai Ambani International School, Mumbai) **[2]**

8. A traveller in the desert often sees what appears to be a sheet of water a short distance ahead of him.

a) Name the phenomenon of light responsible for the above.

b) State two conditions necessary for the above phenomenon to take place.

(Dhirubhai Ambani International School, Mumbai) **[2]**

9. A converging lens is used to obtain an image of an object placed in front of it. The inverted image is formed between F_2 and $2F_2$ of the lens.

a) Where is the object placed?

b) Draw a ray diagram to illustrate the formation of the image obtained.

(Dhirubhai Ambani International School, Mumbai) **[2]**

10. A glass slab is placed over a page on which the word VIBGYOR is printed-with each letter in its corresponding colour.

a) Will the image of all letters be in the same place? If not, state which will be raised to the maximum and why?

b) Name any two electromagnetic waves which have a frequency higher than that of violet light. State one use each?
(Dhirubhai Ambani International School, Mumbai) **[2]**

11. Name the radiations: *(Lilavati Podar High School, Mumbai)* **[3]**
a) Used for photography at night.
b) Used for detection of fractures in bones
c) Whose wavelength range is from 100A to 4000A (or 10 nm to: 400 nm)

12. Draw a neat, labelled diagram of a convex lens forming a real and magnified image.
(Lilavati Podar High School, Mumbai) **[2]**

13. An object 2cm high is placed at a distance of 25 cm from the optical centre of a concave lens of focal length 15 cm. Calculate (a) the position of the image, and (b) the size of the image.
(Lilavati Podar High School, Mumbai) **[3]**

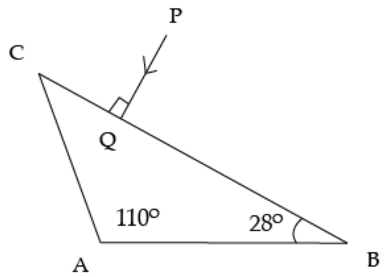
14. In which conditions will the light ray moving from liquid to glass pass straight without bending? Will the glass be visible then? *(Children's Academy, Mumbai)* **[2]**

15. Complete the following sentence: If half part of a convex lens is covered then, the focal length and intensity of the image will.. *(Children's Academy, Mumbai)* **[2]**

16. Draw a curve showing the variation in the angle of deviation with the angle of incidence at the surface of prism. *(Children's Academy, Mumbai)* **[2]**

17. a) What do you mean by power of lens?
b) Name the SI unit of power of lens.
c) Which has more power, thick or thin lens**.**
(Children's Academy, Mumbai) **[3]**

18. a) A light ray passes from denser medium to rarer medium at an angle of incidence 'i' corresponding to which angle of refraction is 90%, what is angle 'i' called?
b) In the given figure, a ray of light PQ is incident normally on side BC of the triangle CAB. Complete the path of ray PQ till it emerges out of prism. Mark in the diagram the angle wherever necessary.
(Children's Academy, Mumbai) **[3]**

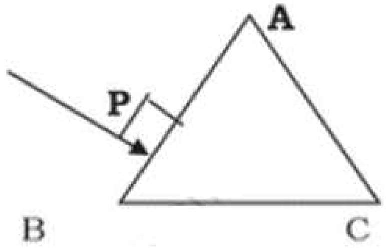


19. Name the type of lens used in the following cases: *(Christ Academy, Bangalore)* **[2]**
a) Eye lens in a Galilean telescope b) Remedy for Hypermetropia.

20. Identify the part of electromagnetic spectrum which is: *(Christ Academy, Bangalore)* **[2]**
a) Produced by bombarding a metal target by high-speed electrons.
b) Adjacent to radar system used in aircraft navigation.

21. A postage stamp kept below a rectangular glass block of refractive index 1.5 when viewed from vertically above it appears to be raised by 7.0 mm. Calculate the thickness of the glass block.
(Christ Academy, Bangalore) **[3]**

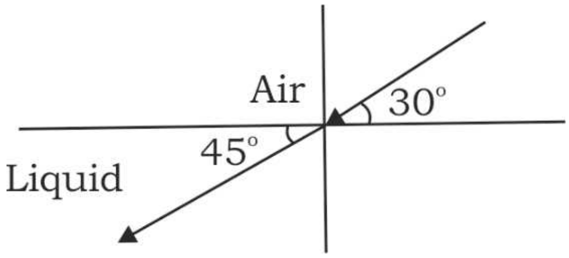
22. Copy the diagram given below of an equilateral triangle prism and complete the path of the light ray till it emerges out of the prism. The critical angle of glass is 42°.



(St. Johns Universal School, Mumbai) **[3]**

23. The apparent depth of a liquid in a vessel is 15 cm, and the shift is 5 cm. Find the refractive index of the liquid. *(St. Johns Universal School, Mumbai)* **[2]**

24. Answer the questions from the following diagram



Write the values of angle of incidence and angle of refraction (a) Find refractive index and name the law used to find refractive index. *(St. Johns Universal School, Mumbai)* **[2]**

25. Define the term focus of a convex lens. Is it real or virtual? *(St. Johns Universal School, Mumbai)* **[2]**

26. Ranbir claims to have obtained an image twice the size of the object with a concave lens. Is he correct? Give reasons for your answer. *(Arya Vidya Mandir, Mumbai)* **[2]**

27. Absolute refractive index of a medium is less than one. Is this statement true or False? Justify your answer. *(Arya Vidya Mandir, Mumbai)* **[2]**

28. The Sun appears red at sunrise.

a) Name the property of light responsible for this.

b) Define the property of light mentioned above. *(Arya Vidya Mandir, Mumbai)* **[2]**

29. The diagram given below shows a 30° - 60° - 90° glass prism ABC.
Copy the diagram and complete the path of the ray PQ of light incident normally on side AC of the glass prism whose critical angle is 42°. *(Arya Vidya Mandir, Mumbai)* **[2]**

30. PQ and PR are two light rays emerging from the object P as shown in the figure below.

a) What is the special name given to the angle of incidence angle PQN and ray PQ?

b) Copy the ray diagram and complete it to show the position of the image of the object P when seen obliquely from above.

c) Name the phenomenon that occurs if the angle of incidence angle PQN is increased further.

(Arya Vidya Mandir, Mumbai) **[3]**

31. How will you distinguish between a convex lens and a concave lens - *(Arya Vidya Mandir, Mumbai)* **[2]**

a) by touching them

b) without touching them

PART 4

Previous Years' Board Questions

1. The deviation produced by an equilateral prism does not depends on: *[ICSE Sem 1, 2021]* **[1]**

a) The angle of incidence
b) The size of the prism
c) The material of the prism
d) The colour of light used

2. The refractive index of a diamond is 2.4. It means that: *[ICSE Sem 1, 2021]* **[1]**

a) The speed of light in vacuum is equal to $\frac{1}{2.4}$ times the speed of light in diamond.
b) The speed of light in the diamond is 2.4 times the speed of light in vacuum.
c) The speed of light in vacuum is 2.4 times the speed of light in the diamond.
d) The wavelength of light in diamond is 2.4 times the wavelength of light in vacuum.

3. When a light ray enters from a denser medium to a rarer medium: *[ICSE Specimen Paper Sem 1, 2021]* **[1]**

a) The light ray bends towards the normal.
b) Angle of incidence is less than angle of refraction.
c) Speed of light decreases.
d) Speed of light remains unchanged.

4. The principle of reversibility of light states that: *[ICSE Sem 1, 2021]* **[1]**

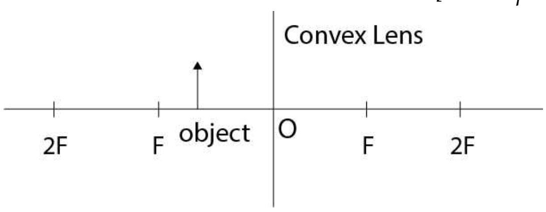
a) Angle of incidence is equal to angle of reflection.
b) The path of a light ray is reversible.
c) There is no change in path of ray of light when it passes from one medium to another.
d) $n = \frac{\sin i}{\sin r}$

5. An object of height 10 cm is placed in front of a convex lens of focal length 20 cm at a distance 25 cm from the lens. Is it possible to capture this image on a screen? *[ICSE Sem 1, 2021]* **[1]**

Select a correct option from the following:

a) Yes, as the image formed will be real
b) Yes, as the image formed will be erect
c) No, as the image formed will be virtual
d) No, as the image formed will be inverted

6. From the diagram shown below, identify the characteristics of the image that will be formed.
[ICSE Specimen Paper Sem 1, 2021] **[1]**



a) Real
b) Diminished
c) Formed within the focal length
d) Virtual

7. The colour of white light which deviated least by a prism is: *[ICSE Sem 1, 2021]* **[1]**

a) Green
b) Yellow
c) Red
d) Violet

8. The wavelength range of visible lights is: *[ICSE Sem 1, 2021]* **[1]**

a) 40 nm to 80 nm
b) 4000 nm to 8000 nm
c) 4 nm to 8 nm
d) 400 nm to 800 nm

9. The region of spectrum which extends beyond violet and of visible spectrum is called ………. spectrum. *[ICSE Sem 1, 2021]* **[1]**

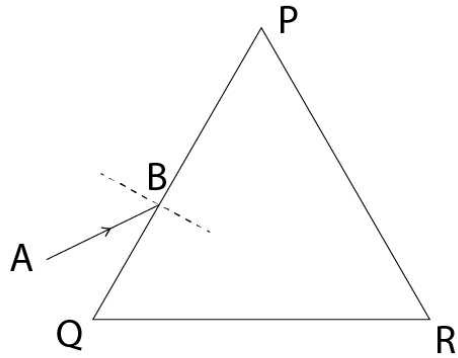
a) ultraviolet
b) infrared
c) electromagnetic
d) none of these

10. ………. rays produce heating effect on being absorbed by material objects. *[ICSE Sem 1, 2021]* **[1]**

a) Ultraviolet
b) Infrared
c) X-rays
d) Gamma rays

11. A ray of light falls normally on a rectangular glass slab. Draw a ray diagram showing the path of the ray till it emerges out of the slab. *[ICSE 2020]* **[2]**

12. Complete the path of the monochromatic light ray AB incident on the surface PQ of the equilateral glass prism PQR till it emerges out of the prism due to refraction. *[ICSE 2020]* **[2]**

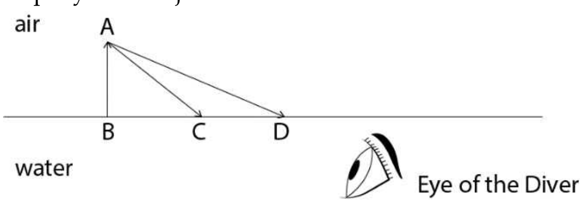


13. A pond appears to be 2.7 m deep. If the refractive index of water is $\frac{4}{3}$, find the actual depth of the pond. *[ICSE 2020]* **[2]**

14. The wave lengths for the light of red and blue colours are nearly 7.8 x 10^{-7}m and 4.8 x 10^{-7}m respectively. *[ICSE 2020]* **[2]**

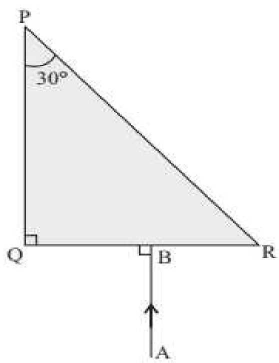
a) Which colour has the greater speed in a vacuum?
b) Which colour has a greater speed in glass?

15. A diver in water looks obliquely at an object AB in air. *[ICSE 2020]* **[2]**



a) Does the object appear taller, shorter or of the same size to the diver?
b) Show the path of two rays AC and AD starting from the tip of the object as it travels towards the diver in water and hence obtain the image of the object.

16. Complete the path of the ray AB through the glass prism in PQR till it emerges out of the prism. Given the critical angle of the glass as 42°. *[ICSE 2020]* **[2]**



17. Where should an object be placed in front of a convex lens in order to get: *[ICSE 2020]* **[2]**

a) an enlarged real image

b) enlarged virtual image?

18. A lens of focal length 20 cm forms an inverted image at a distance 60 cm from the lens. *[ICSE 2020]* **[3]**

a) Identify the lens.

b) How far is the lens present in front of the object?

c) Calculate the magnification of the image.

19. Give reasons for the following: During the day: *[ICSE 2020]* **[2]**

a) Clouds appear white

b) Sky appears blue

20. *[ICSE 2019]* **[2]**

a) Define critical angle.

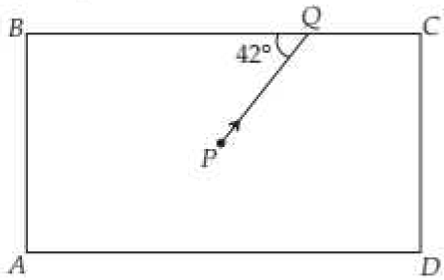
b) State one important factor which affects the critical angle of a given medium.

21. *[ICSE 2019]* **[2]**

a) What is the relation between the refractive index of water with respect to air (${}_a\mu_w$) and the refractive index of air with respect to water (${}_w\mu_a$).

b) If the refractive index of water with respect to air (${}_a\mu_w$) is $\frac{5}{3}$. Calculate the refractive index of air with respect to water (${}_w\mu_a$).

22. The diagram below shows a light source P embedded in a rectangular glass block ABCD of critical angle 42°. Complete the path of the ray PQ till it emerges out of block. [Write necessary angles.] *[ICSE 2019]* **[2]**



23. How does the angle of deviation formed by a prism change with the increase in the angle of incidence? Draw a graph showing the variation in the angle of deviation with the angle of incidence at a prism surface. *[ICSE 2019]* **[3]**

24. *[ICSE 2019]* **[2]**

a) If the lens is placed in water instead of air, how does its focal length change?

b) Which lens, thick or thin has greater focal length?

25. A virtual, diminished image is formed when an object is placed between the optical centre and the principal focus of a lens. *[ICSE 2019]* **[2]**

a) Name the type of lens which forms the above image.

b) Draw a ray diagram to show the formation of the image with the above stated characteristics.

26. An object is placed at a distance of 24 cm in front of a convex lens of focal length 8 cm. *[ICSE 2019]* **[3]**

a) What is the nature of the image so formed?

b) Calculate the distance of the image from the lens.

c) Calculate the magnification of the image.

27. Electromagnetic radiation is used for photography in fog. *[ICSE 2019]* **[2]**

a) Identify the radiation.

b) Why is this radiation mentioned by you ideal for this purpose?

28. *[ICSE 2018]* **[2]**

a) Why is the ratio of the velocities of light of wavelengths 4000 Å and 8000 Å in vacuum 1:1?

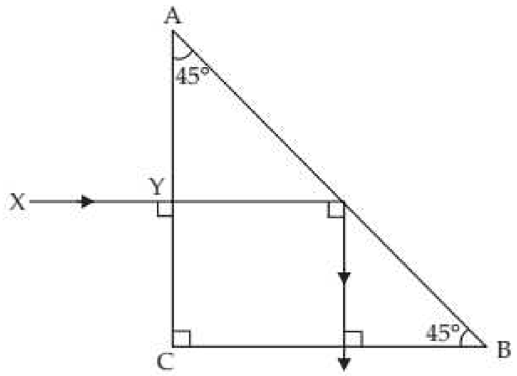
b) Which of the above wavelengths has a higher frequency?

29. *[ICSE 2018]* **[2]**

a) State the relation between the critical angle and the absolute refractive index of a medium.

b) Which colour of light has a higher critical angle? Red light or Green light.

30. A ray of light XY passes through a right-angled isosceles prism as shown below: *[ICSE 2018]* **[3]**



a) What is the angle through which the incident ray deviates and emerges out of the prism?

b) Name the instrument where this action of prism is put into use.

c) Which prism surface will behave as a mirror?

31. Draw the diagram of a right-angled isosceles prism which is used to make an inverted image erect. *[ICSE 2018]* **[2]**

32. The power of a lens is -5 D. *[ICSE 2018]* **[2]**

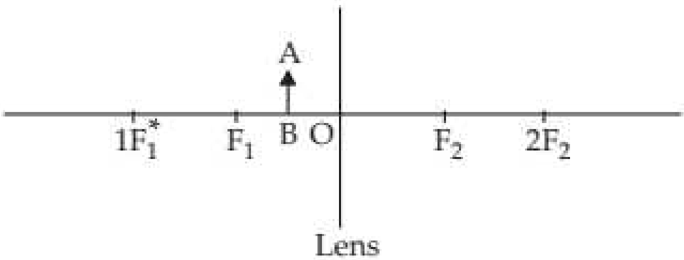
a) Find its focal length. b) Name the type of lens.

33. State the position of the object in front of a converging lens if: *[ICSE 2018]* **[2]**

a) It produces a real and same size image of the object.

b) It is used as a magnifying lens.

34. An object AB is placed between O and F_1 on the principal axis of a converging lens as shown in the diagram. *[ICSE 2018]* **[2]**



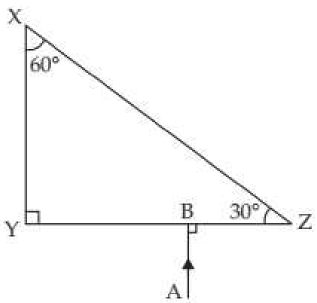
** Mark is an error by the Council. We suggest you to use '$2F_1$' instead of '$1F_1$'.*

Copy the diagram and by using three standard rays starting from point A, obtain an image of object AB.

35. An object is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Find: *[ICSE 2018]* **[2]**

a) the position of the image b) nature of the image.

36. The following diagram shows a 60°, 30°, 90° glass prism of critical angle 42°. Copy the diagram and complete the path of incident ray AB emerging out of the prism marking the angle of incidence on each surface. *[ICSE 2018]* **[2]**



37. *[ICSE 2018]* **[2]**

a) Define scattering.

b) The smoke from a fire looks white.

Which of the following statements is true?

(i) Molecules of the smoke are bigger than the wavelength of light.

(ii) Molecules of the smoke are smaller than the wavelength of light.

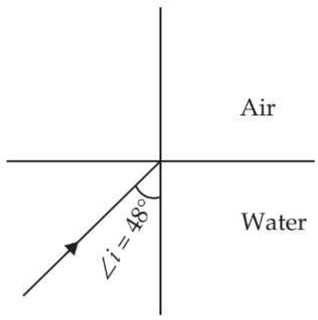
38. How is the refractive index of a material related to: *[ICSE 2017]* **[2]**

a) real and apparent depth

b) velocity of light in vacuum or air and the velocity of light in a given medium

39. State the conditions required for total internal reflection of light to take place. *[ICSE 2017]* **[2]**

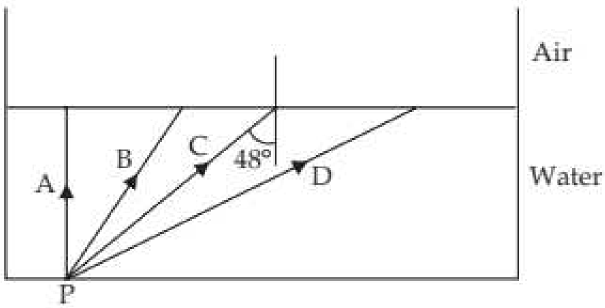
40. A ray of light travels from water to air as shown in the diagram given below: *[ICSE 2017]* **[2]**



a) Copy the diagram and complete the path of the ray. (Critical angle for water is 48°).

b) State the condition so that total internal reflection occurs in the above diagram.

41. The diagram below shows a point source P inside a water container. Four rays A, B, C, D starting from the source P are shown up to the water surface. *[ICSE 2017]* **[2]**



a) Show in the diagram the path of these rays after striking the water surface. The critical angle for water air surface is 48°.

b) Name the phenomenon which the rays B and D exhibit.

42. A lens forms an upright and diminished image of an object when the object is placed at the focal point of the given lens. *[ICSE 2017]* **[2]**

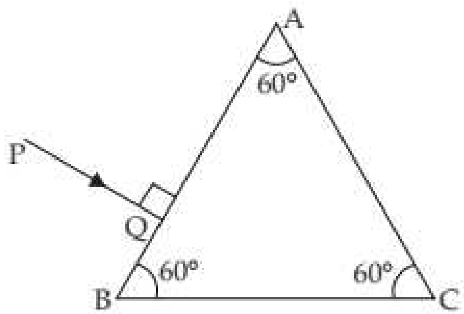
a) Name the lens.

b) Draw a ray diagram to show the image formation.

43. Draw a ray diagram to show the refraction of a monochromatic ray through a prism when it suffers minimum deviation. *[ICSE 2017]* **[2]**

44. A boy uses blue colour of light to find the refractive index of glass. He then repeats the experiment using red colour of light. Will the refractive index be the same or different in the two cases? Give a reason to support your answer. *[ICSE 2016]* **[2]**

45. Copy the diagram given below and complete the path of light ray till it emerges out of the prism. The critical angle of glass is 42°. In your diagram mark the angles wherever necessary. *[ICSE 2016]* **[2]**



46. State the dependence of angle of deviation: *[ICSE 2016]* **[2]**

a) On the refractive index of the material of the prism.

b) On the wavelength of light.

47. *[ICSE 2016]* **[3]**

a) Write a relationship between angle of incidence and angle of refraction for a given pair of media.

b) When a ray of light enters from one medium to another having different optical densities, it bends. Why does this phenomenon occur?

c) Write one condition where it does not bend when entering a medium of different optical density.

48. A lens produces a virtual image between the object and the lens. *[ICSE 2016]* **[2]**

a) Name the lens.

b) Draw a ray diagram to show the formation of this image.

49. What do you understand by the term 'Scattering of light'? Which colour of white light is scattered the least and why? *[ICSE 2016]* **[2]**

50. Name one factor that affects the lateral displacement of light as it passes through a rectangular glass slab. *[ICSE 2015]* **[2]**

51. The speed of light in glass is 2×10^5km/s. What is the refractive index of glass? *[ICSE 2015]* **[2]**

52. Jatin puts a pencil into a glass container having water and he is surprised to see the pencil in a different state. *[ICSE 2015]* **[3]**

a) What change is observed in the appearance of the pencil?

b) Name the phenomenon responsible for the change.

c) Draw a ray diagram showing how the eye sees the pencil.

53. *[ICSE 2015]* **[2]**

a) Where should an object be placed so that a real and inverted image of the same size as the object is obtained using a convex lens?

b) Draw a ray diagram to show the formation of the image as specified in the part (a).

54. *[ICSE 2015]* **[2]**

a) Name the high energetic invisible electromagnetic waves which help in the study of the structure of crystals.

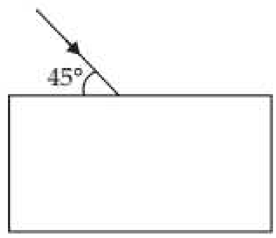
b) State an additional use of the waves mentioned in part (a).

55. *[ICSE 2015]* **[2]**

a) Why does the Sun appear red at sunrise?

b) Name the subjective property of light related to its wavelength.

56. Draw the diagram given below and clearly show the path taken by the emergent ray: *[ICSE 2014]* **[2]**



57. A ray of light passes from water to air How does the speed of light change? *[ICSE 2014]* **[2]**

58. Name the factors affecting the critical angle for the pair of media. *[ICSE 2014]* **[2]**

59. Light passes through a rectangular glass slab and through a triangular glass prism. In what way does the direction of the two emergent beams differ and why? *[ICSE 2014]* **[3]**

60. A lens forms an erect, magnified and virtual image of an object. *[ICSE 2014]* **[2]**

a) Name the lens.

b) Draw a labelled ray diagram to show the image formation.

61. *[ICSE 2014]* **[3]**

a) Define the power of a lens.

b) The lens mentioned in 6 (b) above is of focal length 25 cm. Calculate the power of the lens.

62. Ranbir claims to have obtained an image twice the size of the object with a concave lens. Is he correct? Give a reason for your answer. *[ICSE 2014]* **[2]**

63. Which colour of light travels fastest in any medium except air? *[ICSE 2014]* **[2]**

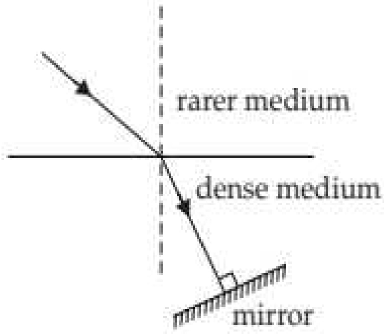
64. *[ICSE 2014]* **[2]**

a) Name a prism required for obtaining a spectrum of ultraviolet light.

b) Name the radiations which can be detected by a thermopile.

65. Why is the colour red used as a sign of danger? *[ICSE 2014]* **[2]**

66. A ray of light is moving from a rarer medium to a denser medium and strikes a plane mirror placed at 90° to the direction of the ray as shown in the diagram. *[ICSE 2013]* **[2]**



a) Copy the diagram and mark arrows to show the path of the ray of light after it is reflected from the mirror.

b) Name the principle you have used to mark the arrows to show the direction of the ray.

67. *[ICSE 2013]* **[2]**

a) The refractive index of glass with respect to air is 1.5. What is the value of the refractive index of air with respect to glass?

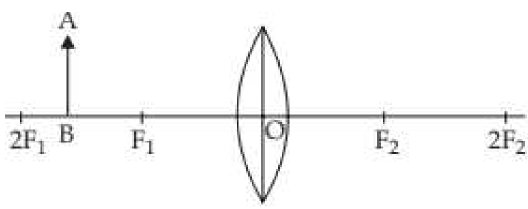
b) A ray of light is incident as a normal ray on the surface of separation of two different mediums. What is the value of the angle of incidence in this case?

68. *[ICSE 2013]* **[2]**

a) Can the absolute refractive index of a medium be less than one?

b) A coin placed at the bottom of a beaker appears to be raised by 4.0 cm. If the refractive index of water is 4/3, find the depth of the water in the beaker.

69. An object AB is placed between $2F_1$ and F_1 on the principal axis of a convex lens as shown in the diagram: *[ICSE 2013]* **[2]**



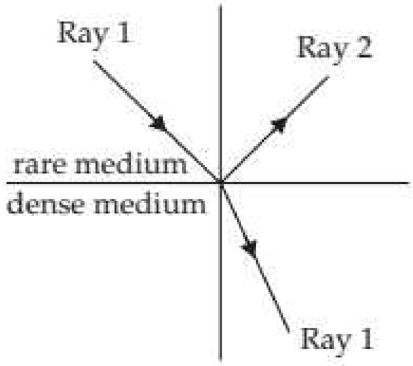
Copy the diagram and using three rays starting from point A, obtain the image of the object formed by the lens.

70. Name the radiations: *[ICSE 2013]* **[3]**

a) That are used for photography at night.
b) Used for detection of fracture in bones.
c) Whose wavelength range is from 100 Å to 4000 Å (or 10 nm to 400 nm).

71. *[ICSE 2012]* **[2]**

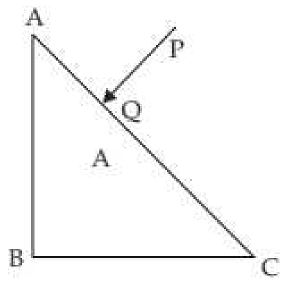
a) Define the term refractive index of a medium in terms of velocity of light.
b) A ray of light moves from a rare medium to a dense medium as shown in the diagram below. Write down the number of the ray which represents the partially reflected ray.



72. *[ICSE 2012]* **[3]**

a) What is meant by the term 'critical angle?
b) How is it related to the refractive index of the medium?
c) Does the depth of a tank of water appear to change or remain the same when viewed normally from above?

73. A ray of light PQ is incident normally on the hypotenuse of a right-angled prism ABC as shown in the diagram given below: *[ICSE 2012]* **[3]**



a) Copy the diagram and complete the path of the ray PQ till it emerges from the prism.
b) What is the value of the angle of deviation of the ray?
c) Name an instrument where this action of the prism is used.

74. You are provided with a printed piece of paper. Using this paper how will you differentiate between a convex lens and a concave lens? *[ICSE 2012]* **[2]**

75. A converging lens is used to obtain an image of an object placed in front of it. The inverted image is formed between F_2 and $2F_2$ of the lens. *[ICSE 2012]* **[2]**

a) Where is the object placed?
b) Draw a ray diagram to illustrate the formation of the image obtained.

76. *[ICSE 2012]* **[2]**

a) What is meant by 'Dispersion of light'?
b) In the atmosphere which colour of light gets scattered the least?

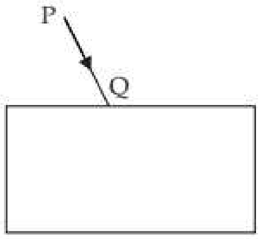
77. A ray of light incident at an angle of incidence 'i' passes through an equilateral glass prism such that the refracted ray inside the prism is parallel to its base and emerges from the prism at an angle of emergence 'e'. *[ICSE 2012]* **[2]**

a) How is the angle of emergence 'e' related to the angle of incidence 'i'?
b) What can you say about the value of the angle of deviation in such a situation?

78. In the diagram below, PQ is a ray of light incident on a rectangular glass block. *[ICSE 2011]* **[2]**

a) Copy the diagram and complete the path of the ray of light through the glass block. In your diagram, mark the angle of incidence by letter 'i' and the angle of emergence by the letter 'e'.

b) How are the angles 'i' and 'e' related to each other?



79. A ray of monochromatic light enters a liquid from air as shown in the diagram given below: *[ICSE 2011]* **[2]**

a) Copy the diagram and show in the diagram the path of the ray of light after it strikes the mirror and re-enters the medium of air.

b) Mark in your diagram the two angles on the surface of separation when the ray of light moves out from the liquid to air.

80. How is the refractive index of a medium related to its real depth and apparent depth? *[ICSE 2011]* **[2]**

81. State the laws of refraction of light.

Write a relation between the angle of incidence (i), angle of emergence (e), angle of prism (A) and angle of deviation (d) for a ray of light passing through an equilateral prism. *[ICSE 2011]* **[3]**

82. *[ICSE 2011]* **[2]**

a) When does a ray of light falling on a lens pass through it undeviated?

b) Which lens can produce a real and inverted image of an object?

83. An object is placed in front of a lens between its optical centre and the focus and forms a virtual, erect and diminished image. *[ICSE 2011]* **[2]**

a) Name the lens which formed this image.

b) Draw a ray diagram to show the formation of the image with the above stated characteristics.

84. Which characteristic property of light is responsible for the blue colour of the sky? *[ICSE 2011]* **[2]**

85. *[ICSE 2011]* **[2]**

a) Suggest one way, in each case, by which we can detect the presence of:

A. Infra-red radiations
B. Ultraviolet radiations

b) Give one use of Infra-red radiations.

86. *[ICSE 2010]* **[2]**

a) What is meant by refraction of light?
b) What is the cause of refraction of light?

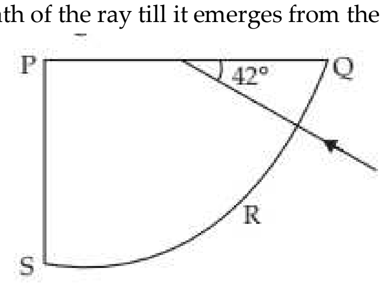
87. An erect, magnified and virtual image is formed, when an object is placed between the optical centre and principal focus of a lens. *[ICSE 2010]* **[3]**

a) Name the lens.

b) Draw a ray diagram to show the formation of the image with the above stated characteristics.

88. 'The refractive index of diamond is 2.42'. What is meant by this statement? *[ICSE 2010]* **[2]**

89. A ray of light enters a glass slab PQRS, as shown in the diagram. The critical angle of the glass is 42°. Copy this diagram and complete the path of the ray till it emerges from the glass slab. *[ICSE 2010]* **[2]**



Mark the angles in the diagram wherever necessary.

90. A stick partly immersed in water appears to be bent. Draw a ray diagram to show the bending of the stick when placed in water and viewed obliquely from above. *[ICSE 2010]* **[2]**

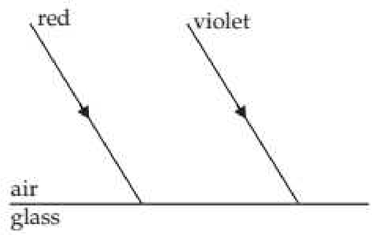
91. A ray of monochromatic light is incident from air on a glass slab: *[ICSE 2010]* **[3]**

a) Draw a labelled ray diagram showing the change in the path of the ray till it emerges from the glass slab.

b) Name the two rays that are parallel to each other.

c) Mark the lateral displacement in your diagram.

92. Two parallel rays of Red and Violet travelling through air, meet the air-glass boundary as shown in the below figure: *[ICSE 2010]* **[2]**



a) Will their paths inside the glass be parallel? Give a reason for your answer.

b) Compare the speeds of the two rays inside the glass.

93. We can burn a piece of paper by focusing the sun rays by using a particular type of lens. *[ICSE 2010]* **[2]**

a) Name the type of lens used for the above purpose.

b) Draw a ray diagram to support your answer.

94. A ray of light strikes the surface of a rectangular glass block such that the angle of incidence is (a) 0° (b) 42°. Sketch a diagram to show the approximate path taken by the ray in each case as it passes through the glass block and emerges from it. *[ICSE 2009]* **[3]**

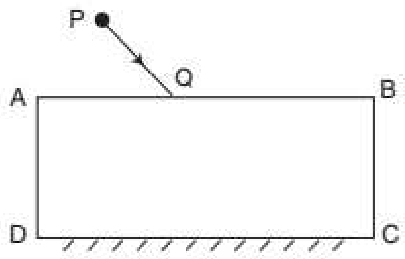
95. State the conditions required for total internal reflection of light to take place. *[ICSE 2009]* **[2]**

96. How does the value of angle of deviation produced by a prism change with an increase in the: *[ICSE 2009]* **[2]**

a) Value of angle of incidence.

b) Wavelength of incident light?

97. The diagram below shows a ray of white light PQ coming from an object P and incident on the surface of a thick glass plane mirror. Copy the diagram and complete it to show the formation of three images of the object P as formed by the mirror. Which image will be the brightest image? *[ICSE 2009]* **[2]**



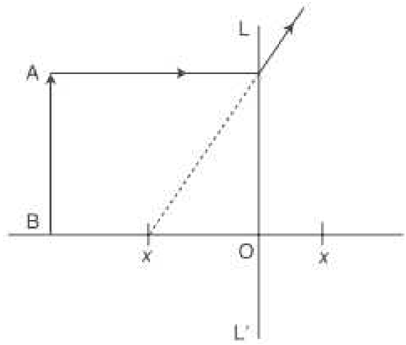
98. Copy and complete the following table: *[ICSE 2009]* **[2]**

Type of lens	Position of Object	Nature of Size of Image	Size of image
Convex	At F		
Concave	At infinity		

99. *[ICSE 2009]* **[2]**

a) Copy and complete the diagram to show the formation of the image of the object AB.

b) What is the name given to x?



100. *[ICSE 2009]* **[2]**

a) Why is white light considered to be polychromatic in nature?

b) Give the range of the wavelength of those electromagnetic waves which are visible to us.

101. *[ICSE 2008]* **[2]**

a) A monochromatic beam of light of wavelength i passes from air into a glass block. Write an expression to show the relation between the speed of light in air and the speed of light in glass.

b) As the ray of light passes from air to glass, state how the wavelength of light changes. Does it increase, decrease or remain constant?

102. *[ICSE 2008]* **[2]**

a) Draw a labelled ray diagram to illustrate: (1) critical angle, (2) total internal reflection, for a ray of light moving from one medium to another.

b) Write a formula to express the relationship between refractive index of the denser medium with respect to rarer medium and its critical angle for that pair of media.

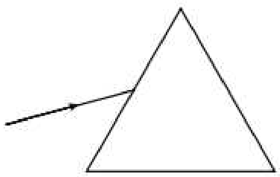
103. *[ICSE 2008]* **[3]**

a) A linear object is placed on the axis of a lens. An image is formed by refraction in the lens. For all positions of the object on the axis of the lens, the positions of the image are always between the lens and the object.

b) Name the lens. Draw a ray diagram to show the formation of the image of an object placed in front of the lens at any position of your choice except infinity.

104. *[ICSE 2008]* **[2]**

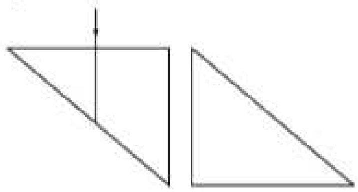
a) The diagram below shows a ray of light incident on an equilateral glass prism placed in minimum deviation position.



Copy the diagram and complete it to show the path of the refracted ray and the emergent ray.

b) How are angle of incidence and angle of emergence related to each other in this position of the prism?

105. Complete the path of the light ray entering the first isosceles right-angled glass prism till it emerges from the second identical prism. *[ICSE 2008]* **[2]**



106. State Snell's Law of Refraction of light. *[ICSE 2007]* **[2]**

107. Mention one difference between reflection of light from a plane mirror and total internal reflection of light from a prism. *[ICSE 2007]* **[2]**

108. *[ICSE 2007]* **[2]**

a) With the help of a well-labelled diagram show that the apparent depth of an object, such as a coin, in water is less than its real depth.

b) How is the refractive index of water related to the real depth and the apparent depth of a column of water?

109. An object is placed in front of a converging lens at a distance greater than twice the focal length of the lens. Draw a ray diagram to show the formation of the image. *[ICSE 2007]* **[2]**

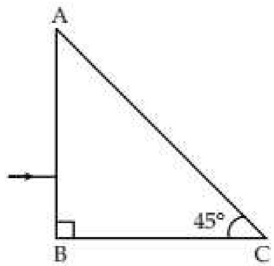
110. Why are infra-red radiation preferred over ordinary visible light for taking photographs in fog? *[ICSE 2007]* **[2]**

111. *[ICSE 2007]* **[2]**

a) A particular type of high energy invisible electromagnetic rays help us to study the structure of crystals. Name these rays and give another important use of these rays.

b) How does the speed of light in glass change on increasing the wavelength of light?

112. The diagram given below shows a right-angled prism with a ray of light incident on the side AB. (The critical angle for glass in 42°) *[ICSE 2007]* **[2]**



a) Copy the diagram and complete the path of the ray of light in and out of the glass prism.

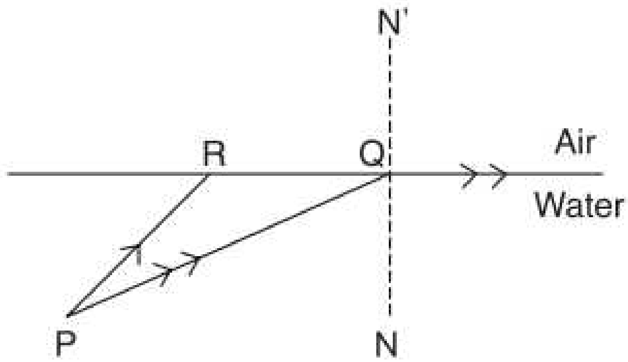
b) What is the value of the angle of deviation shown by the ray?

113. PQ and PR are two light rays emerging from the object P as shown in the figure below: *[ICSE 2006]* **[3]**

a) What is the special name given to the angle of incidence ($\angle PQN$) of ray PQ?

b) Copy the ray diagram and complete it to show the position of the image of the object P when seen obliquely from above.

c) Name the phenomenon that occurs if the angle of incidence $\angle PQN$ is increased still further.



114. An object is placed in front of a convex lens such that the image formed has the same size as that of the object. Draw a ray diagram to illustrate this. *[ICSE 2006]* **[2]**

Unit 3

SOUND

REVISION NOTES

1. **Sound:** Sound is a form of energy that results in the sensation of hearing. It is produced by the periodic vibration of an object, which causes it to move back and forth. However, not all vibrating objects create sound. The human ear is capable of detecting sounds with frequencies ranging from 20 Hz to 20,000 Hz, which is known as the audible range.

2. Sounds with frequencies lower than 20 Hz are classified as **infrasonic or subsonic**, while those with frequencies higher than 20,000 Hz are called **ultrasonic**.

3. Sound travels in waves, which are mechanical in nature, and unlike electromagnetic waves that carry light, sound waves require a medium to propagate. In air, the speed of sound is approximately 332 ms^{-1} (although it is generally taken as 340 ms^{-1}).

4. **Longitudinal Wave:** A wave that vibrates particles of the medium along the direction of its propagation is referred to as a longitudinal wave.

5. **Reflection of sound:** When a sound wave strikes a surface and reflects back, this phenomenon is known as the reflection of sound. Sound waves are reflected by rough surfaces like brick walls, hillsides, and hedges.

6. **Echo:** An echo is a sound that is reflected from a large surface like a wall or a cliff. The sound that we hear after reflection is known as an echo. The sensation of a sound persists in our ears for approximately 0.1 second, which is called the persistence of hearing.

7. **Condition for formation of echoes:**
   a) a minimum distance of 17m between the listener and the reflector of sound is required to hear an echo clearly
   b) the minimum distance is not constant and varies in different media due to changes in temperature and sound speed
   c) a large reflecting body is needed for the production of an echo
   d) the minimum distance required for the production of an echo varies in different media
   e) the intensity of sound should be sufficient to be heard after reflection

8. **Echoes have various applications, such as:**
   a) fishermen, trawler men, dolphins, bats, ships, and submarines utilize the phenomenon of echo
   b) it is useful for detecting the position of submarines and icebergs in the sea
   c) the detecting system is called SONAR (SOUND NAVIGATION AND RANGING), and it is frequently used to measure sea depths by timing echoes from the seabed
   d) RADAR (RADIO DETECTION AND RANGING) is used to locate enemy aircraft and find the distance of the moon and planets

e) megaphones and speaking tubes work based on the principle of reflection of sound
f) echoes are used in ultrasonography to obtain images of human organs (they are also used in cardiographs)

9. **Free Vibrations** - Free vibration is a type of vibration in which a force is applied once, and the structure or part is allowed to vibrate at its natural frequency.

10. **Natural Time Period:** The time period of a body executing free vibrations is called natural time period.

11. **Natural Frequency**: The number of vibrations executed by a body freely vibrating in one second is called natural frequency.

12. **Damped Vibrations**: The periodic vibrations of continuously decreasing amplitude are called damped vibrations.

13. **Forced Vibrations:** The amplitude of forced vibrations depends upon the frequency of applied force and the natural frequency of the body. When the difference between this frequency is large, the amplitude of forced vibrations is very small.

    When the strings of a guitar, a sitar etc. are made to vibrate by plucking, they produce *forced vibrations*. As the surface area of air in the wind box is large, these forced vibrations produce a loud sound.

14. **Resonance**: When a body vibrates under the influence of an external periodic force whose natural frequency is equal to its own natural frequency, it executes vibrations of increasing amplitude. This phenomenon is called *resonance*.

15. **Resonance Vibrations**: These are the vibrations of a body under external periodic force of frequency of the body. The amplitude of vibration is very large. Resonance is used in radio, old television receivers and toys as well.

16. **Amplitude**: The maximum displacement of a particle about its mean position is called amplitude.

17. **Frequency**: The number of vibrations executed by a vibrating particle of a medium about its mean position in one second is called frequency.

18. The three characteristics of sound are *pitch, loudness and quality*.
    Pitch: The Pitch of a sound is the physical cause which enables us to distinguish a sharp or shrill sound from a dull or flat sound. The greater the frequency, greater is the pitch and sharp is the sound.

    Loudness: It is the property of all sounds whether musical or noise by which a loud sound can be distinguished from the faint one, both having the same pitch.
    i) Loudness depends upon intensity or amplitude of the wave. However, loudness is not the same as intensity.
    ii) Loudness is a sensation while intensity is a measurable quantity.
    iii) Loudness is a subjective quantity while intensity is an objective quantity.

    Loudness depends on the amplitude, distance, surface area of a vibrating body and density of medium.

    Weber- Fechner's law: Loudness of sound increases with the intensity of a sound according to Weber – Fechner's Law.

$L = K \log_{10} I$
L is called *sensation of loudness* and I is the *intensity of sound*.

Quality: Timbre (or Quality) is the characteristic of sound wave that distinguishes two sound waves (generally produced from different sources) having same loudness and pitch. It depends on the shape of the waveform. For example, it is possible for a note produced by a flute and a piano to have same pitch and loudness, but always sound different.

19. **Unit of Loudness:** The loudness of sound is typically measured in decibels (dB), which is named after Alexander Graham Bell, the scientist who invented the telephone. The unit of sound is expressed in decibel, and the sound level can be calculated using the formula: Sound level (in dB) = $10log_{10}\left(\frac{I}{I_0}\right)$, where I represents the sound intensity and I_0 is the zero-level sound, which equals 10^{-12} Wm^{-1} at a frequency of 100 Hz. Exposure to sound levels consistently above 120 dB may lead to headaches and hearing loss.

20. An **electromagnetic wave** can propagate without the need for a material medium since it remains unaffected by electric or magnetic fields. It travels at a constant speed of 3×10^8 ms^{-1}.

21. Light waves belong to the category of transverse electromagnetic waves. The electromagnetic radiation spectrum encompasses an extensive range of frequencies, varying from 10 to 10^{26} Hertz (cycles) per second. Depending on their unique properties, the electromagnetic spectrum can be categorized into eight distinct bands.

22. a) **Radio waves** are utilized for transmitting radio signals.
b) **Television waves** are employed for broadcasting TV programs.
c) **Microwaves** serve as a means of telecommunication for long-distance communication, such as telephony and telegraphy.
d) **X-rays** are widely used in hospitals, diagnostic centers, and nursing homes for medical purposes.
e) **Gamma radiations** are generated by the nucleus of an atom when high-energy particles suddenly disintegrate. They are utilized in the treatment of cancer.
f) **Infrared rays** are created by exciting the outer electronic shell to a high degree. They assist us in perceiving our surroundings.
g) **Visible radiation** enables us to perceive our surroundings.
h) **Ultraviolet rays** aid in the formation of healthy bones by being absorbed by the skin to produce vitamin D.
i) **Secondary cosmic radiation** originates from beyond our solar system, from the cosmos itself.

23. Harmful **Sounds:** Thunder - 110dB, pop concert - 120 to 140dB, and airplane taking off - 130 to 140dB.

24. **Noise** refers to sound that is considered unwanted and has a negative impact on the ears.

25. **Musical sounds** are those that are pleasant to the ears and are generally accepted.

26. **Musical sounds** have distinct **characteristics** that can be described as follows:

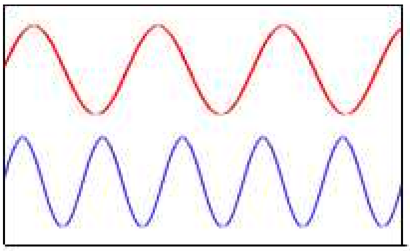
Pitch: This is the subjective sensation of how high or low a note sounds, and it's solely determined by the frequency of the musical sound. Pitch is independent of the loudness or quality of the sound.

Loudness: This is the perceived volume of the sound and depends on several factors, including:

- **Amplitude -** Loudness is directly proportional to the square of the sound wave's amplitude.

- **Medium density -** Loudness is directly proportional to the density of the medium through which the sound travels.
- **Distance -** Loudness is inversely proportional to the square of the distance between the source of the sound and the observer.

27. Musical sounds have a periodic and regular waveform, whereas noise has an irregular and sudden waveform. The waveforms of tuning forks, guitars, violins, and clarinet bells differ from each other. The frequencies that compose musical sounds are in small whole number ratios, which is not the case for noise.

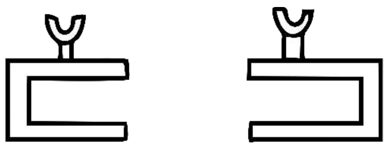


Tuning forks

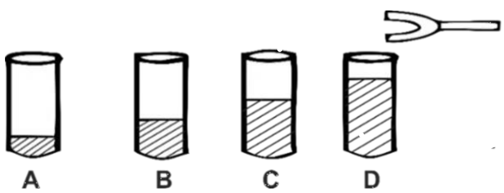
Violins

IMPORTANT DIAGRAMS

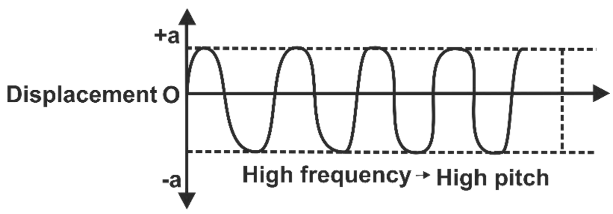
1. Resonance with tuning forks

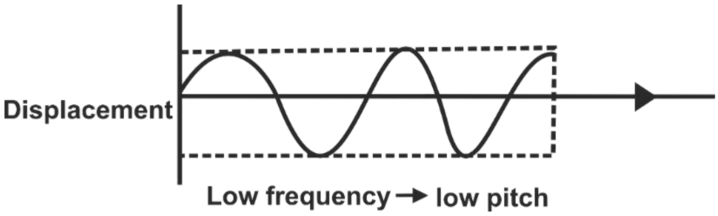


2. Resonance in air column



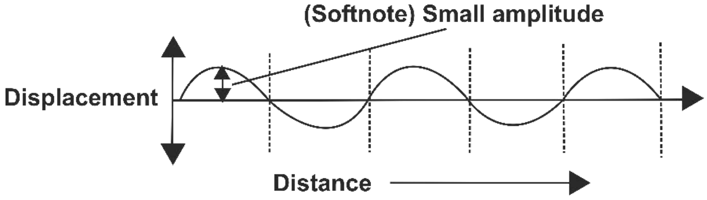
3. Waves of different pitch



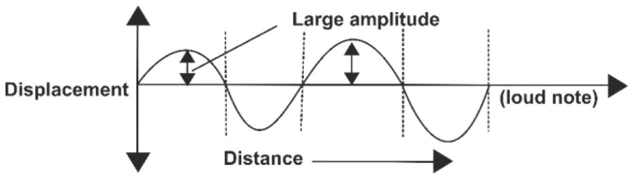


4. Waves of different amplitude

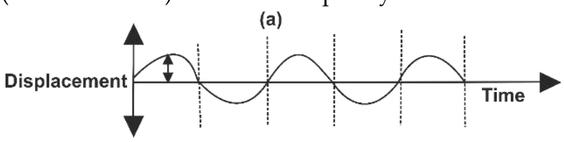
Small amplitude (Soft note)



Large amplitude (Loud note)



5. Waves of same amplitude (same loudness) and same frequency but of different wave forms.



PART 1

Multiple Choice Questions (MCQs)

1. Resonance is a special case of

a) Frequency
b) Forced vibration
c) Damped vibration
d) Free vibration

2. Bel is the unit of

a) Loudness
b) Intensity
c) Frequency
d) Amplitude

3. Sound belongs to the category of

a) Longitudinal waves
b) Transverse wave
c) X-rays
d) Gamma ray

4. Which of the following is not an example of *damped* vibration?

a) Vibration of simple pendulum in air.
b) Vibration of tuning fork in air.
c) Vibration of stringed instrument in air.

d) Vibration produced in the diaphragm of a gramophone.

5. Product of frequency and time period is equal to

a) Three

b) Four

c) One

d) Two

6. Pitch of a note increases with an ___________.

a) Increase in frequency

b) Decrease in frequency

c) Independent of frequency

d) Increase in amplitude

7. Intensity of sound at any point is:

a) Directly proportional to amplitude.

b) Inversely proportional to amplitude.

c) Directly proportional to square of amplitude.

d) Inversely proportional to square of amplitude.

8. Acceleration of a particle vibrating in simple harmonic motion depends -

a) Only upon its displacement at that instant

b) Upon its time period

c) Upon both of the above

d) None of the above

PART 2

Important Questions

I. Answer the following questions.

1. What is sound? **[2]**
2. What is a tuning fork? **[2]**
3. What is a Sonometer? **[2]**
4. What is persistence of hearing? **[2]**
5. Explain with example the meaning of free or natural vibrations. **[2]**
6. State causes of vibration. **[2]**
7. What do you mean by a) damped vibrations b) forced vibrations and c) resonance? Give their examples. **[4]**
8. Explain the term resonant vibrations. **[2]**
9. Sound is produced by vibratory motion, so why doesn't a vibrating pendulum make sound? **[2]**
10. Why are soldiers asked to walk out of step while crossing bridges? **[2]**
11. Why are stringed musical instruments (such as Guitar) provided with large sound boxes? **[2]**
12. Will the sound be audible if the string is set into vibration on the moon surface? **[2]**
13. Why does rear view mirror of a motor bike start vibrating violently, at a particular speed of motor bike? **[2]**
14. A tuning fork (vibrating) is held close to ear one hears a faint hum. The same placed on table, such that its handle is in contact with table, one hears loud sound. Explain. **[2]**
15. Why does a wine glass start rattling when a note of some frequency is struck by a piano? **[2]**
16. Why do qualities of sound of same pitch differ when emitted by different instruments? **[2]**
17. Why can a person easily recognize the horn of his own car, no matter most of the cars use the factor made horns of same quality? **[2]**
18. Why is loud sound heard during acoustic resonance? **[2]**

19. Give the difference between free vibrations and damped vibrations. **[2]**
20. Differentiate between free and forced vibrations. **[2]**
21. Write distinction between forced and resonant vibrations. **[2]**
22. Name the factors that affect the frequency of a stretched string. **[2]**
23. What is resonance? Give the conditions under which resonance occurs. Give an example of the phenomenon based on resonance. **[3]**
24. Name the phenomenon used while tuning a radio set. Define it. **[2]**
25. **[2]**
a) Name the two frequencies associated with a body undergoing forced vibrations.
b) What happens when these two frequencies are equal?
26. How does the medium affect the amplitude of the vibrations of a body? **[2]**
27. Determine the factors affecting the frequency of air column notes. **[2]**
28. When we open a gas tap for a few seconds, the sound of escaping gas is heard but the smell of gas comes later, why? **[2]**
29. A person walking past a railway line in the middle of a night, hears a ringing sound along with sound of his footsteps. Explain. **[2]**
30. State three factors which determine loudness of sound. **[2]**
31. Why is the ceiling of concert halls made curved? **[2]**
32. State the laws of vibrations of (Stretched strings). **[2]**
33. Describe an experiment illustrating the phenomenon of resonance. **[3]**
34. Draw graph for (i) Displacement: time graph for free vibrations (in vacuum) & (ii) Displacement: time graph for damped vibrations. **[4]**
35. Without changing the length of a string, its tension is increased 4 times. What happens to its frequency of vibrations? **[2]**
36. **[4]**
a) Draw "Energy-time curve" and "displacement – time curve" for damped vibrations.
b) Draw "Energy-time curve" and displacement – time curve for undamped vibrations.
37. Name the characteristic which helps us to distinguish between a man's voice and women's voice, even without seeing them. **[2]**
38. Name three characteristics of sound. **[3]**
39. What determines the characteristics of sound? **[2]**
40. What is bel? **[1]**

II. Fill in the blanks [1 mark each]

1. Speed of sound is ______ in solids, liquids, and gases.
2. The vibrations which take place under the influence of external periodic force are called __________.
3. The phenomenon of setting a body into oscillation with its natural frequency by another body vibrating with the same frequency is called ________.
4. The sound becomes _______ if the amplitude increases.
5. Note of the lowest frequency for a vibrating string is called _________ or ________.
6. The speed of sound changes with the change in ________.
7. RADAR stands for _______.
8. The vibrations which take place under the influence of external periodic force are called ________.
9. The vibrations produced in sound boxes of stringed musical instruments are _____.

III. State True or False [1 mark each]

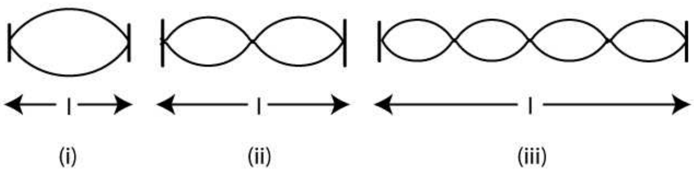
1. Product of frequency and period is equal to one.
2. Distance between the consecutive crest and trough is half the length of wavelength.
3. At resonance the amplitude of vibration is zero.

4. In case of undamped vibrations, the amplitude of vibration remains constant.
5. Intensity of sound depends upon the density of medium.
6. Resonance is used in radio and television receivers.

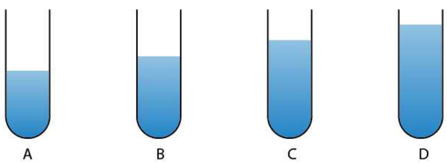
PART 3

ICSE School Prelim Questions

1. What do you understand by the natural vibrations of a body? Give one example.
(Purwanchal Vidyamandir, Kolkata) **[2]**
2.
   a) Name one factor on which the frequency of sound emitted due to vibration in an air column depends.
   b) How does the frequency depend on the factor stated in part (a)? *(Purwanchal Vidyamandir, Kolkata)* **[2]**
3. The diagram below shows three ways in which the string of an instrument can vibrate.



   a) Which of the diagrams shows the principal note?
   b) What vibration has a frequency four times that of the first?
   c) What is the ratio of the frequency of vibrations in the diagram (i) and (ii)?
(Purwanchal Vidyamandir, Kolkata) **[3]**
4. How do the damped vibrations differ from free vibrations? Give one example of each. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**
5. Why is a loud sound heard at resonance? *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**
6. Figure A, B, C and D represent the test tubes each of height 20 cm which are filled with water up to heights of 12 cm, 14 cm, 16 cm, and 18 cm respectively. If a vibrating tuning fork is placed over the mouth of test tube D, a loud sound is heard. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[3]**



   a) Describe the observations with the tubes A, B and C when the vibrating tuning fork is placed over the mouth of these tubes.
   b) Give the reason for your observation in each tube.
   c) State the principle illustrated in the above experiment.
7. Why are the stringed instruments like guitar provided with a hollow soundbox?
(Rishi Aurobindo Memorial Academy, Kolkata) **[2]**
8. What do you understand by loudness of sound? *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**
9. State three factors which affect the loudness of sound heard by a listener.
(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra) **[3]**
10. How does the wave pattern of a loud note differ from the soft note? Draw a diagram.
(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra) **[2]**

11. Draw a diagram to show the wave pattern of high pitch note and a low pitch note, but of the same loudness. *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)* **[2]**

12. Draw a sketch showing the displacement of a body executing damped vibrations, against time. *(Aryans School, Kolkata)* **[2]**

13. Name the factor that determines: *(Howard Memorial English School, Kolkata)* **[2]**

a) Loudness of the sound heard
b) Pitch of the note

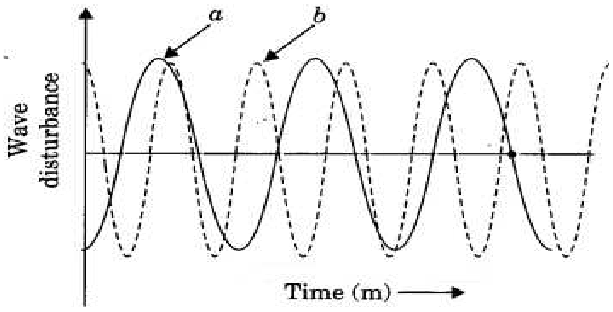
14. Voice of which of the following is likely to have a minimum frequency and why? *(IEM Public School, Kolkata)* **[2]**

a) Baby girl
b) Baby boy
c) A man
d) A woman

15.

a) Name the characteristic of sound which enables a person to differentiate between two sounds with equal loudness but having different frequencies.
b) Define the characteristic named by you in (a). *(Seraphim's Assembly School, Kolkata)* **[2]**

16. In the figure below, which of the two diagrams (a) and (b) best illustrates the human male voice? Give a reason for your answer. *(Pramila Memorial Institute, Kolkata)* **[2]**



17. A tuning fork of frequency 256 Hz will resonate with another tuning fork of what frequency? *(Aryans School, Kolkata)* **[2]**

18. What adjustments would you make for tuning a stringed instrument for it to emit a note of a desired frequency? *(Aryans School, Kolkata)* **[2]**

19. When a troop crosses a suspension bridge, the soldiers are asked to break steps. Explain. *(Seraphim's Assembly School, Kolkata)* **[2]**

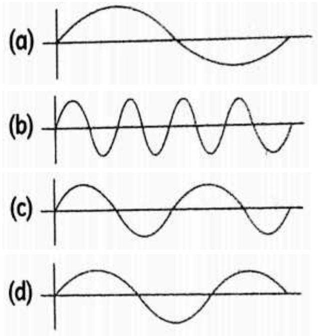
PART 4

Previous Years' Board Questions

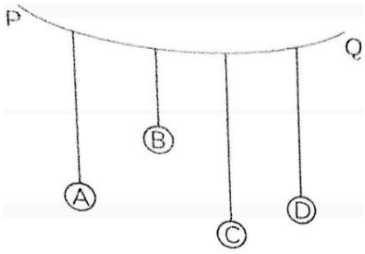
1. Free vibrations are: *[ICSE Sem 2, 2022]* **[1]**

a) The vibrations under the influence of a periodic force
b) The vibrations with larger amplitude
c) The vibrations when the frequency continuously decreases
d) The vibrations with a constant frequency and constant amplitude

2. The diagram below shows four sound waves. Which sound has the highest pitch? *[ICSE Sem 2, 2022]* **[1]**



3. Pendulum A, B, C and D are tied to flexible string PQ and are at rest. Pendulum C is disturbed. Which of the following statements is true? *[ICSE Specimen Paper Sem 2, 2022]* **[1]**



a) Only pendulum C will start vibrating
b) Pendulums A, B and D will also start vibrating but A and D will vibrate with the maximum amplitude.
c) Pendulums A, B and D will also start vibrating.
d) Vibrations of pendulum C are forced vibrations.

4. Resonance is: *[ICSE Specimen Paper Sem 2, 2022]* **[1]**

a) A forced vibration in which amplitude remains constant.
b) A forced vibration in which frequency of forced vibration is greater than the free vibrations of the body.
c) A forced vibration, in which frequency of forced vibration is equal to the free vibrations of the body.
d) A forced vibration, in which frequency of forced vibration is less than the free vibrations of the body.

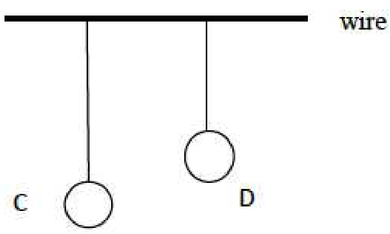
5. *[ICSE 2019]* **[2]**

a) Define resonant vibrations.
b) Which characteristic of sound, makes it possible to recognize a person by his voice without seeing him?

6. What do you understand by free vibrations of a body? *[ICSE 2019]* **[2]**

7.

a) It is observed that during march-past we hear a base drum distinctly from a distance compared to the side drums.
   i) Name the characteristic of sound associated with the above observation.
   ii) Give a reason for the above observation.
b) A pendulum has a frequency of 4 vibrations per second. An observer starts the pendulum and fires a gun simultaneously. He hears the echo from the cliff after 6 vibrations of the pendulum. If the velocity of sound in air is 340 m/s, find the distance between the cliff and the observer.
c) Two pendulums C and D are suspended from a wire as shown in the figure given below. Pendulum C is made to oscillate by displacing it from its mean position. It is seen that D also starts oscillating.



   i) Name the type of oscillation that C will execute.
   ii) Name the type of oscillation that D will execute.

iii) If the length of D is made equal to C, then what difference will you notice in the oscillations of D?

iv) State the phenomenon when the length of D is equal to that of C. *[ICSE 2019]* **[4]**

8. Two waves of the same pitch have amplitudes in the ratio 1:3. *[ICSE 2019]* **[2]**

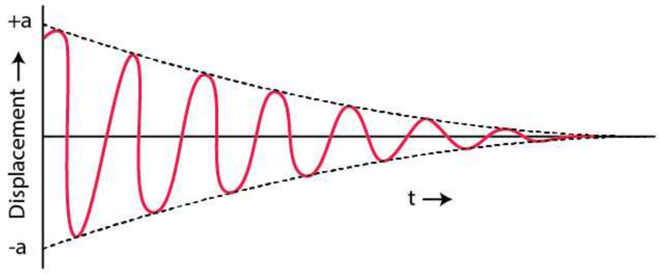
State the ratio of their -

a) intensities; and

b) frequencies

9. A man playing a flute can produce notes of different frequencies. On closing the holes near his mouth, the pitch of the note produced increase or decrease? Give a reason. *[ICSE 2019]* **[2]**

10. The below given figure shows the displacement-time graph of a vibrating body. *[ICSE 2018]* **[3]**

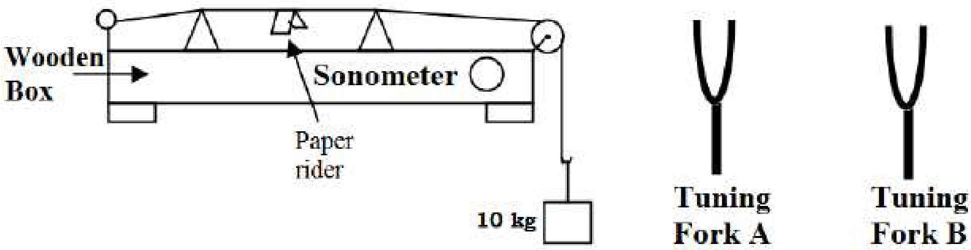


a) Name the kind of vibration.

b) Why is the amplitude of vibrations gradually decreasing?

c) What happens to the vibrations of the body after some time?

11. *[ICSE 2018]* **[3]**



The diagram above shows a wire stretched over a sonometer. Stems of two vibrating tuning forks A and B are touched to the wooden box of the sonometer. It is observed that the paper rider (a small piece of paper folded at the centre) present on the wire flies off when the stem of vibrating tuning fork B is touched to the wooden box, but the paper just vibrates when the stem of vibrating tuning fork A is touched to the wooden box.

a) Name the phenomenon when the paper rider just vibrates.

b) Name the phenomenon when the paper rider flies off.

c) Why does the paper rider fly off when the stem of tuning fork B is touched to the box?

12. What are damped vibrations? Give one example of damped vibration. *[ICSE 2017]* **[2]**

13. Name the phenomenon that causes a loud sound when the stem of a vibrating tuning fork is kept pressed on the surface of a table. *[ICSE 2017]* **[2]**

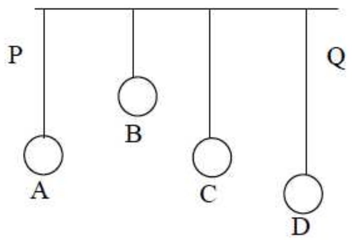
14. State two ways of increasing the frequency of vibrations of a stretched string. *[ICSE 2016]* **[2]**

15. *[ICSE 2016]* **[2]**

a) Name the phenomenon involved in tuning a radio set to a particular station.

b) Define the phenomenon.

16. In the diagram below, A, B, C, and D are four pendulums connected by a single elastic string PQ. The lengths of A and C are equal while the length of pendulum B is smaller than that of D. Pendulum A is set into a mode of vibrations. *[ICSE 2015]* **[3]**



a) Name the type of vibrations taking place in pendulums B and D.

b) What is the state of pendulum C?

c) State the reason for the type of vibrations in pendulums B and C.

17. Where can a body execute free vibrations? *[ICSE 2014]* **[2]**

18. State two ways in which Resonance differs from Forced Vibrations. *[ICSE 2012]* **[2]**

19. When acoustic resonance takes place, a loud sound is heard. Why does this happen? Explain. *[ICSE 2011]* **[2]**

20. *[ICSE 2009]* **[2]**

a) A person is tuning his radio set to a particular station. What is the person trying to do in order to tune it?

b) Name the phenomenon involved in tuning the radio set.

21. *[ICSE 2008]* **[2]**

a) Sometimes when a vehicle is driven at a particular speed, a rattling sound is heard. Name the phenomena that occurs and explain why it occurs.

b) Suggest one way by which the rattling sound could be stopped.

Unit 4 ELECTRICITY & MAGNETISM

REVISION NOTES

Understanding the basics
Electricity is the flow of electric charge through a conductor, such as a wire. Current electricity refers to the movement of electric charges through a conductor. This movement of charges is what we use to power electronic devices and appliances.

Here are some basic concepts and examples of current electricity:

- **Electric charge:** The fundamental property of matter that gives rise to all electrical phenomena. Electric charges can be positive or negative.
- **Electric current:** The flow of electric charge through a conductor. Electric current is measured in amperes (A).
- **Voltage:** The potential difference in electric potential between two points in a circuit. Voltage is measured in volts (V).
- **Resistance:** The opposition to the flow of electric current in a circuit. Resistance is measured in ohms (Ω).
- **Circuit:** A closed path through which electric current can flow.
- **Conductors:** Materials that allow electric current to flow through them easily. Examples of conductors include copper and aluminum.
- **Insulators:** Materials that do not allow electric current to flow through them easily. Examples of insulators include rubber and plastic.
- **Semiconductors:** Materials that have a moderate level of conductivity, between that of conductors and insulators. Examples of semiconductors include silicon and germanium.

Elements used in an Electric Circuit with Symbols

1. **Connecting wire:** A connecting wire is represented by a straight line. It is usually made of copper and is provided with a cotton installation. The resistance of a connecting wire is considered practically negligible.

2. **Resistor or Fixed Resistance**: A resistor or fixed resistance wire is represented by zigzag line. Two thick dots at the ends represent brass terminals in which this wire is fixed. The resistance wire is generally alloy such as nichrome, manganin, constantan, etc.

3. **Variable Resistance**: A resistance whose magnitude can be altered when designed is called variable resistance.

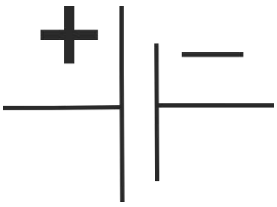
Variable Resistance is of two kinds:

a) **Rheostat or Unknown Variable Resistance:** In this kind of resistance, its magnitude of resistance can be altered, but change in resistance is not known.

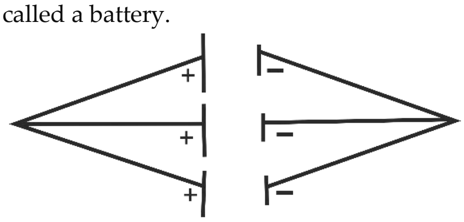
b) **Resistance box**: In this kind of resistance the change in magnitude of resistance is known.

4. **Cell**: A cell is a device that converts chemical energy into electrical energy. It consists of two electrodes (positive and negative) separated by an electrolyte, which is a substance that allows ions to move freely between the electrodes. When the cell is connected to a circuit, a chemical reaction occurs between the electrodes, causing ions to flow through the electrolyte and generate an electric current.

A thin long line represents the positive terminal of cell, whereas thick and short line represents negative terminal of cell.



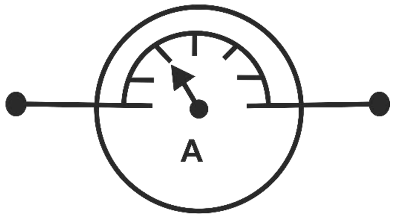
5. **Battery**: A combination of two or more cells is called a battery.



6. **Plug key** or **single key** is an electric switch.

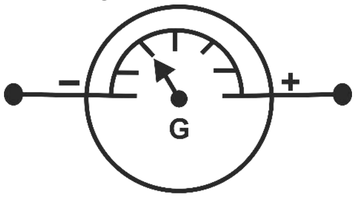
Figure 1 shows closed plug key, when current flows in electric circuit.
Figure 2 shows open plug key, when current does not flow in electric circuit.

7. **Ammeter**: It is a device used for measuring current in an electric circuit in *Amperes*.

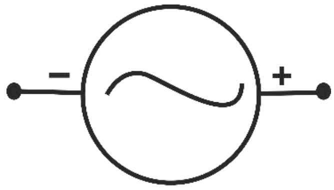


8. **Voltmeter**: It is a device used for measuring potential difference between two points in an electric circuit. It measures p.d in volts.

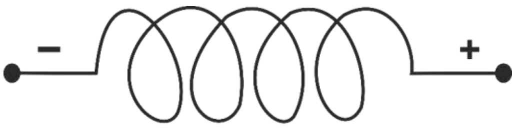
9. **Galvanometer**: It is a device used for detecting the flow of current in electric circuit.



10. **Alternating current**: A current which changes its direction rapidly on its own is called alternating current.

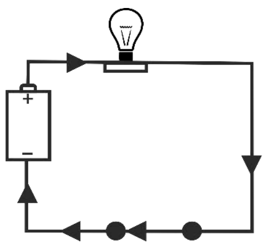


11. **Solenoid or Inductor**: It is an insulated copper coil with large number of turns. It behaves like a magnet on the passage of electric current. The given figure shows the symbol for inductor.

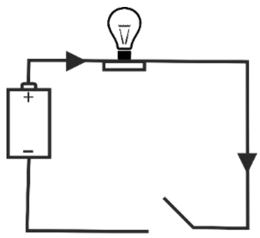


12. **Electric circuit**: An electric circuit is a closed path through which electric current flows. It is composed of conductors, such as wires, that allow the current to flow, and devices, such as resistors and switches, that control and use the current.

a) **Closed Electric Circuit**: A closed electric circuit is a circuit in which there is a complete path for the electric current to flow. In a closed circuit, the electric current flows through the conductors and devices in the circuit, allowing electrical energy to be used or transformed.



b) **Open Electric Circuit**: An open electric circuit is a circuit in which there is a break or interruption in the path that the electric current is flowing through. In an open circuit, no current flows because the flow of charge is blocked by the break in the circuit.



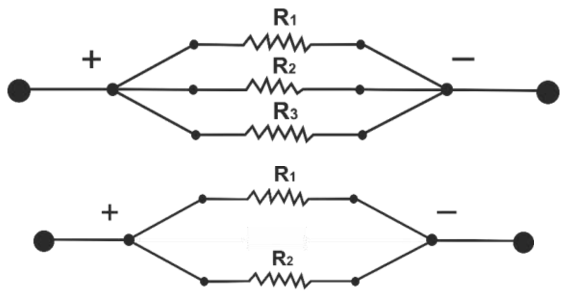
13. **Electric Resistance:** Electric resistance is a measure of the opposition to the flow of electric current in an electrical conductor. It is the property of a material that determines the amount of current that can flow through it for a given voltage. The resistance of a conductor is typically measured in **ohms (Ω)**.

14. **Resistor**: A resistor is an electrical component that is used to resist the flow of electric current in a circuit. It is a passive device, which means that it does not have the ability to generate or supply electrical energy, but rather it consumes electrical energy in the form of electric current.

    A zig -zag line represents a resistor.

15. **Series Circuit:** In a series circuit, the components are connected one after the other, so that the current flows through each component in turn. The current flows in a single path, and the same current flows through each component. The voltage across each component is different, depending on the resistance of the component.

16. **Parallel Circuit:** In a parallel circuit, the components are connected side by side, so that each component is connected to the same voltage source. The current divides among the components, with some flowing through one component and some flowing through another. The total current flowing through the circuit is the sum of the currents flowing through each component. The voltage across each component is the same, since they are all connected to the same voltage source.



17. **Current Electricity:** The flowing charge through a conductor is called current electricity or conventional current.

18. **Electronic Current**: The current due to moving electrons is called electronic current.

19. **Unit of Electric Charge**: The **unit** of electric charge is **coulomb**. One coulomb is equivalent to total charge **6.25×10^{18} Electrons**.

20. The charge on one electron is equivalent to **1.6×10^{-19}C.**

21. **Electric Current:** The rate flow of charge is called electric current.

22. **Ampere**: One ampere is defined as 1 coulomb of charge flowing through a cross-section of a conductor in 1 second. Unit of current is ampere (A). Smaller units are milli-ampere (mA) and micro-ampere (MA).

23. Electric potential is the condition which determines the direction of flow of charge.

24. **Potential Difference:** Potential difference, also known as voltage, is the measure of the electric potential energy per unit charge in an electric circuit. It is the energy required to move a unit of electric charge from one point to another within an electric field.

$$\text{Potential difference (v)} = \frac{\text{Work done(w)}}{\text{Amount of charge (Q)}}$$

Potential difference is measured in **volts**.

One Volt: If one joule of work done in moving a charge of one coulomb, then its potential difference is one volt.

25. **Electric Cell:** An electric cell is a device which maintains a constant potential difference across an electric circuit by converting chemical energy to electric energy.

26. **Electromotive Force (emf):** Electromotive force is the potential difference across the terminal of a cell when it is not doing any external work. It is a constant quantity for a given cell.

27. **Units of Resistance:** Resistance is measured in **ohms** (Ω). If one ampere of current flows through a conductor when its ends are connected at a potential difference of one volt, it is said to have a resistance of one ohm.

28. **Electric Conductance:** Electric conductance is a measure of the ability of a material to conduct electric current. It is the reciprocal of electric resistance and is expressed in units of siemens (S). The conductance of a material is directly proportional to the cross-sectional area of the material and the number of free electrons it contains, and inversely proportional to its length. Materials with a high conductance, such as metals, are good conductors of electricity, while materials with a low conductance, such as insulators, are poor conductors of electricity.

29. **Resistance**:
    a) Resistance of conductor is directly proportional to its length.
    b) Resistance of conductor is inversely proportional to its area of cross section.
    c) Resistance of conductor depends upon the nature of conductor.
    d) Resistance of pure metals increases with the rise in temperature.
    e) Resistance of alloys such as German silver, constantan, eureka, manganin hardly changes with rise in temperature.
    f) Resistance of ionic compounds, carbon, and vulcanized rubber decreases with the rise in temperature.

30. **Specific Resistance:** Specific resistance, also known as **resistivity**, is a measure of the resistance of a material to the flow of electric current. It is defined as the resistance of a unit length of a material with a unit cross-sectional area. Specific resistance is typically measured in ohm-meters (Ωm).

    The specific resistance of a material is determined by its atomic structure and the way that its electrons are arranged. Materials that have a high specific resistance, such as rubber and glass, are poor conductors of electricity and are used in insulating materials. Materials that have a low specific resistance, such as copper and aluminum, are good conductors of electricity and are commonly used in electrical wiring.

31. **Ohm's Law**: If all the physical conditions of a conductor remain the same, the current flowing through it is directly proportional to the potential difference between its ends.

    Ohm's Law can be experimentally verified only when:
    a) The temperature of the conductor does not change.
    b) The current flowing through conductor is not very large.

32. **Ohmic resistance:** The resistors which obey ohm's law are called ohmic resistances. All metals and metallic alloys are ohmic resistances.

33. **Non-ohmic resistances:** The resistors which do not obey ohm's law are called non-ohmic resistances.
    a) The total resistance in series circuit is equal to the sum of resistance of all the resistors connected in series.
    b) The total resistance in series circuit is greater than any of the individual resistance in series.

34. **Internal Resistance:** Internal resistance is the resistance to the flow of electric current within a device or component. It is a measure of the opposition to the flow of current within the device, and is typically expressed in ohms (Ω).

35. **Cell in Series:** Cell in series can give large current only if the internal resistance of cells is very small or negligible as compared to external resistance.

36. **Cell in parallel:** Cell in parallel can give large current only if the internal resistance of cells is large as compared to external resistance which may be negligible.

37. **Potential:** Potential is that state of conductors which determines the direction of flow of charge when two conductors are connected by a metallic wire.

38. The conductor having excess electrons is said to be at a **negative or having lower potential.**

39. The conductor having deficit of electrons is said to be at **positive potential.**
    a) The electric current is said to flow from higher potential to lower potential in a direction opposite to the direction of flow of electrons.
    b) The flow of current continues as long as there is a potential difference between the two points.

40. **Volt** is the unit of potential difference.

41. **Factors affecting the resistance of a wire -**
    a) Nature of the material of the conductor
    b) Length of the wire
    c) Thickness of the wire

d) Temperature of the wire

42. **Conductivity**: The reciprocal of resistivity is called conductivity. It is abbreviated by the symbol σ, called **Sigma**.
SI Unit is $Ohm^{-1}M^{-1}$ or Siemen $metre^{-1}$.

$$\sigma = \frac{1}{p} = \frac{L}{RA}$$

43. Resistance and resistivity of alloys such as manganin and constantan do not change with increase in temperature.

44. The resistance of semiconductors such as carbon, silicon and germanium decrease with an increase in temperature.

45. **Unit of Resistance** is **ohm**.
Ohm is denoted by the symbol Ω (omega).
1 kilo-ohm = 10^3 ohms.
1 mega – ohm = 10^6 ohm.

46. **Conductance:** The reciprocal of resistance is called conductance.
Conductance = $\frac{1}{Resistance}$
Its unit is mho or Siemen.

47. **Limitations of Ohm's law**
a) Ohm's law does not apply to vacuum tubes, metal rectifiers and electricity through gases.
b) Ohm's law is applicable only when the temperature is constant.

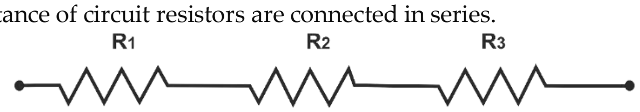
48. **Ohmic Conductors:** The conductors that obey Ohm's law are called the ohmic conductors. All metallic conductors such as copper, silver, aluminum etc. are the ohmic conductors.

49. **Non-Ohmic Conductors**: The conductors that do not obey ohm's law are called non-ohmic conductors. Examples – Diode valves, triode valves, transistors, electrolytes etc. do not obey Ohm's law.

50. **Super Conductors:** Super Conductor is a conductor that loses its electrical resistance at low temperature and its conductivity increases.
Example: Helium is a super conductor at 4.2 K (-268.8°C)

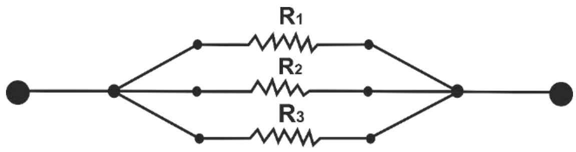
51. **Equivalent Resistance**: If the total resistance is connected in parallel or series, it is called an equivalent resistance. In electrical circuits, resistance indicates how much energy will be needed to move the charges, i.e., current, through the circuit. The equivalent resistance of a network is the single resistor that can replace the entire network, such that for a particular voltage as V, we will get the same current as I.
The equivalent resistance of the system is the sum of the separate resistance.

52. We connect resistors (a) in series (b) in parallel for two reasons -
a) To increase the resistance of circuit resistors are connected in series.



$R_s = R_1 + R_2 + R_3$

b) To decrease the resistance of a circuit to pass heavy current, the resistors are connected in parallel.

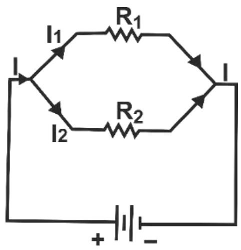


$Rp = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

53. a) **Special Cases**: If two resistors are connected in parallel,

$$Rp = \frac{R_1\ R_2}{R_1 + R_2}$$

$$R_P = \frac{\text{Product of two resistors}}{\text{Sum of two resistors}}$$



If I is the current drawn from the battery current, I flowing in resistor R is given by

$I_1 = (\frac{r2}{r1+r2})I$

Whereas current I flowing in resistor R_2 is given by, $I_1 = (\frac{r1}{r1+r2})I$

b) **'n' identical resistors are in parallel**: If 'n' identical resistors are connected in parallel, the equivalent resistor R_P is given by

$\frac{1}{Rp} = \frac{1}{R} + \frac{1}{R} - \frac{1}{R} + \cdots n$ times

or $\frac{1}{Rp} = \frac{n}{R}$ or $Rp = \frac{R}{N} = \frac{Value\ of\ one\ resistor}{No.of\ resistor}$

54. Difference between Resistance & Resistivity

Resistance	**Resistivity (specific resistance)**
It is measured by the potential difference required across the ends of a conductor to flow 1 A current through it.	It is measured by the resistance offered by 1m length of a wire of that material of area of cross section $1m^2$.
It depends upon the material, temperature, length and area of cross- section of the conductor.	It depends only on the material and temperature of the conductor.
It is the opposition given to the flow of current by the material of a conductor.	It is the property of a conductor due to which it resists the flow of current through it.
Its SI unit is ohm (Ω).	Its SI unit is ohm-metre (Ω m).

55. Difference between ohmic Conductor & Non-Ohmic Conductor

Ohmic Conductor	**Non - Ohmic Conductor**
It obeys the Ohm's law.	It does not obey the Ohm's law.

The V-I graph is a straight line.	The V-I graph is not a straight line.
The slope of V-I graph is same at all values of V or I.	The slope of V-I graph is different at different values of V or I.

56. Difference between E.M.F of cell & terminal voltage a cell.

E.M.F of the cell	**Terminal Voltage a cell**
It is the amount of work done in moving a unit positive charge through the whole circuit, i.e., inside and outside the cell.	It is the amount of work done in moving a unit positive charge in the circuit outside the cell.
It does not depend on the amount of current drawn from the cell.	It depends on the amount of current drawn from the cell.
It is equal to the terminal voltage when cell is not in use, while greater than the terminal voltage when cell is in use.	It is equal to the E.M.F of cell when cell is not in use, while less than the E.M.F when cell is in use.

57. Difference between Resistivity & Conductivity.

Resistivity	**Conductivity**
Resistivity of a conducting wire is the property of its material due to which it offers a resistance to the flow of current through it.	The reciprocal of resistivity is called conductivity.
Its SI unit is Ohm meter (Ωm).	Its SI unit is Ohm^{-1} m^{-1} or Siemen meter $^{-1}$.

58. Factors affecting the Internal Resistance of a cell are

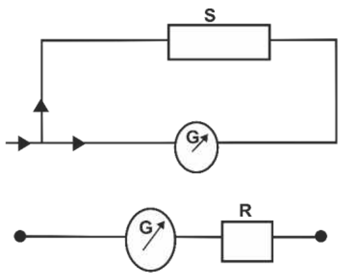
a) Surface area of electrodes
b) Distance between electrodes
c) Temperature of the electrolyte
d) Concentration of the electrolyte

59. A moving coil Galvanometer can be converted to serve both as -

a) An Ammeter
b) A Voltmeter

A moving coil Galvanometer can be converted into an Ammeter by connecting a (suitable) low resistance shunt in parallel with it.

To convert the Galvanometer into a Voltmeter, we simply connect a (suitable) high resistance in series with it.



[Converting a Galvanometer (1) An Ammeter (2) Voltmeter]

60. Relation between E.M.F, P.D, Internal Resistance and External Resistance

a) **Internal Resistance =** $\frac{\textbf{External resistance} \times \textbf{Drop−in potential across terminals of all}}{\textbf{P.D across of Ext.Resistance}}$

$$r = \frac{R(E - v)}{v}$$

b) Drop in potential at the terminal of cell is the product of current drawn from the cell and internal resistance of cell.
E-V = Ir

c) If a large current is drawn from cell i.e., external resistance is low, then drop in potential is very large.
(E.M.F - E, P.D - V, internal resistance - r & external resistance - R)

61. Cells in series can give a large current only if their internal resistance is so small that it can be neglected is negligible with respect to external resistance.
Current in external circuit = $\frac{\textbf{Total E.m.f}}{\textbf{Total resistance of circuit}}$

$$I = \frac{nE}{R + nr}$$

If 'r' is so small that it is negligible, then $I = n\frac{e}{R}$
It is for this reason that lead acid accumulators are connected in series.
Cell can give maximum current in parallel only if external resistance is very small and internal resistance is large. $I = \frac{nE}{r}$

Electrical Power & Energy & Household Circuits

62. Electrical energy is the most desirable form of energy as it can be converted to heat energy, light energy, mechanical energy, chemical energy, sound energy, etc. and it is non-polluting in nature.

63. **Unit**: The International System of Unit (SI) of electrical energy is joule (J).

64.

Sr.no.	Appliance	Electrical energy is converted into
a)	Loudspeaker	Electrical energy to Sound energy
b)	Cells	Chemical energy to Electrical energy
c)	Electric bulb or tube light	Electrical energy to Light energy

65. The Electrical energy consumed by an electrical appliance can be calculated in kilowatt-hours (kWh) by using the following formula:

Energy (kWh) = Power in kW × time in hr.

$$= \frac{\textbf{Power in Watt} \times \textbf{time in hour}}{\textbf{1000}}$$

$$= \frac{\text{V (Volt)} \times 1 \text{ (Ampere)} \times \text{t (hour)}}{1000}$$

66. **High tension wires -** In case of high voltage and heavy current for long distance power transmission, high tension wires are used. These wires are made by twisting together a number of thin wires insulated from each other so as to provide a large surface area.

Characteristics of high-tension wires

a) They are non–corrosive.
b) Provide a large surface area so the resistance becomes very less.
c) They have low resistance.

67. **Safety precautions to be followed while using electricity:**

a) All naked wires and joints should be covered with a proper insulating tape.
b) All the electrical appliances must be properly earthed to avoid electrical shocks.
c) Use the fuse wire of proper rating and material. Now MCB are preferred.
d) All connections at plugs and switches must be light.
e) Never touch any part of the operating circuits without rubber shoes or rubber gloves.
f) Electrical appliance should never be touched with wet hands because it forms a conducting layer.
g) Do not use water as fire extinguisher in case of fire due to electricity.

68. **Colour coding of wires:**

Wire	**Colour**	
	New Convention	**Old convention**
Live	Brown	Red
Neutral	Light blue	Black
Earth	Green or Yellow	Green

69. Electric work is said to be done when a charge flows through a conductor at some potential difference. Unit of electrical work (or electric energy) is Joule. **1 joule = 1 coulomb × 1 volt.**

70. One unit of electric work is (1 joule) said to be done when a charge of 1 coulomb flows through a conductor at a potential difference of 1 volt.

71. Rate of doing electric work is called electric power.

72. **One watt:** When a current of 1 ampere, flows through a conductor at a potential difference of 1 volt, then electric power is said to be one watt.
S.I unit of electric power is watt.

73. **Watt hour:** Watt hour is the amount of electric work done when the power of 1W is maintained in a conductor for one hour. **1Wh = 3600 J.**

74. **Kilowatt Hour:** Kilowatt hour is the amount of electric work done when a power of 1000 watts is maintained in a conductor for one hour. It is the commercial unit of electrical energy.
It is also known as Kilo-volt–ampere-hour (KVAH) or Board of trade unit.
1kWh = 3.6MJ

75. Heat is produced in a conductor when electric current flows through it. Total amount of heat produced depends upon resistance, current and time.

76. The effect of electric current due to which heat is produced in a wire when current is passed through it is called **heating effect of current** or **Joule's Law of heating**.

77. **Fuse:** Fuse is a safety device in an electrical circuit. It is the weakest point in an electricity circuit, which melts and breaks the electric circuit.
The circuit gets over loaded -
a) Due to large withdrawal of current.
b) Due to short circuiting in the electric circuit.
c) Due to fluctuation of current in power supply system.

78. **Characteristics of Fuse:**
a) It has high resistance.
b) It has low melting point.
Generally, fuse wire is made from an alloy of 50% lead and 50% tin which melts around 200°C.
Fuse wire must be connected in live wire.

79. **Staircase wiring:** It is a type of electrical wiring used in buildings where there are multiple floors or levels. It gets its name because the wiring is arranged in a way that looks like a staircase, with one switch at each floor controlling the lighting of that floor and the floors above it.

So, for example, if you have a three-story building with a staircase wiring system, there will be three switches - one on each floor - that control the lights on that floor and the floors above it. This way, you can turn on and off the lights for each level of the building independently.

Staircase wiring is a safe and convenient way to wire a building with multiple levels, as it minimizes the risk of electrical shocks and makes it easier to control the lighting of each floor.

80. **Earthing:** Earthing, also known as grounding, is the process of connecting an electrical conductor, such as a wire or a metal rod, to the earth. It is used to provide a reference point for electrical systems and to protect people and equipment from electrical hazards.

81. Electric Current is always distributed in parallel as:
a) It ensures constant E.M.F for each appliance.
b) It reduces the overall resistance of circuit.

82. **Pole Fuse:** Before connecting the electric lines to the meter of a particular house, the electric company places a fuse in the live wire either at pole or before the meter. This fuse is commonly called pole fuse.

83. The electric cable coming to a house consists of three separate and insulated wires, namely, live (phase) wire, neutral wire, and earth wire.

84. **Main Fuse:** The live wire coming out from the output terminals of KWH meter has a fuse in it which is called main fuse.

85. **Main Switch:** Beyond main fuse, the live and neutral wire is connected to a main switch. Main switch consists of double pole and iron clad switch. The switch can cut off the live and neutral wires from household circuit by operating as single lever. The iron body of main switch is locally earthed.

86. Ring system and tree system are two methods employed for the distribution of current in a house.

87. **Ring system of distribution of current is considered superior as:**
  a) Every appliance is connected to separate fuse
  b) A single ring of wires feeds complete house
  c) Is easier to install

88. **Switch:** Switch is a device for making or breaking of an electrical circuit. Switches are always placed in live wires because an appliance is completely cut off from live wire in off position. Thus, a user will not receive any accidental shock.

89. **Plug:** Plug is an electrical fixture that fits in socket. It has three pins of brass, among which earth pin is thicker and longer. The earth pin is on the top of plug, the live pin on right hand side and neutral pin on the left-hand side.

90. **Socket:** It is a device fixed on the wall and connected permanently to the house wiring. In new system brown colour is for live wire, light blue for neutral wire and green or yellow for earth wire.

91. Dual switches are double pole switches. They are used in staircases and long corridors.

92. Appliances like, electric iron, heater, hot plate, room heater, immersion heater, geyser, toaster, oven are based on the heating effects of the current.

93. Appliances like electric bulb and light etc., are based on the heating and lighting effects of the currents.

94. **Nichrome and Manganin are preferred as heating element because:**
  a) They have high electric resistivity.
  b) They do not get oxidized till 1000°C.
  c) They have a high melting point.

95. One gets an electric shock from an electrical appliance if its live wire comes in contact with its metal casing. So, the outer metallic body of all appliances is earthed.

96. **The filament of an electric bulb should have following characteristics:**
  a) Very high melting point.
  b) High electric resistivity.
  c) Should not become brittle at high temperature.
  d) Should not get oxidized on coming in contact with air.

97. **Tungsten filament is used in electric bulbs on account of following reasons:**
  a) It has a very high melting point of 3300°C.
  b) It has a high resistivity.
  c) It is not brittle at high temperature.

d) It can be drawn into very thin wires.

98. Carbon filament is not used for the following reasons:

a) It starts disintegrating above 1600°C.
b) It blackens the bulb.
c) Its electric consumption is very high.

99. Electric bulb is filled with inert gases like Nitrogen or Argon as they -

a) Prevent it from blackening, and
b) Does not allow the filament to get over heated.

100. Disadvantage of filling the electric bulb with inert gas

It does not allow the filament to attain maximum temperature and hence, some amount of heat energy is not converted into light energy.

101. Advantage of coil /coiled Filament

It reduces the area over which filament is spread. As heat is produced over a small area, the temperature of filament rises to a high value. Thus, large amount of heat energy is converted into light energy.

Magnetic Effect of a Current, Electromagnetic Induction

1. In 1820, Oersted discovered that when an electric current is passed through a conductor, a magnetic field is produced around the conductor. i.e., the conductor behaves like a magnet if current flows through it.

2. Any conductor, through which current flows, behaves like a magnet, because it is the magnet which can deflect a magnetic needle.

3. The magnitude of magnetic intensity is directly proportional to the magnitude of current flowing through conductor.
The greater the current, the greater the magnetic intensity.

4. The magnetic field setup by a conductor, acts at right angle to the direction of flow of current.

5. The direction of magnetic field depends upon the direction of flow of current.

6. Ampere's Swimming Rule

Ampere's swimming rule is a principle in physics that states that the force exerted on a wire carrying an electric current by a magnetic field is proportional to the strength of the current in the wire and the strength of the magnetic field. The force is also proportional to the length of the wire and is directed perpendicular to both the direction of the current and the direction of the magnetic field.

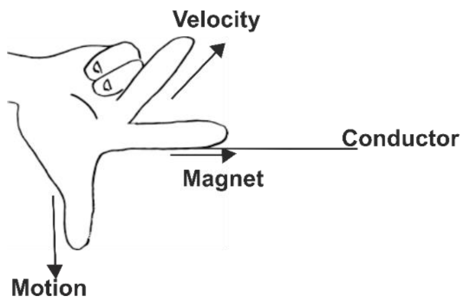
The rule is named after French physicist André-Marie Ampère, who developed the mathematical equations that describe the relationship between electric current and magnetic fields. The principle is commonly used to describe the behavior of electric motors, generators, and other devices that rely on the interaction between currents and magnetic fields. It is also used in the design of electrical circuits and devices, such as transformers and inductors.

7. Properties of magnetic lines of forces around straight conductor

a) They are in the form of concentric circles.

b) The plane of magnetic line of force is at right angle to the direction of current.
c) The direction of magnetic line of force depends upon direction of current.
d) On increasing the magnitude of current the number of magnetic lines of forces increases.

8. Right hand thumb rule or right-hand palm rule:
Imagine you are holding the conductor with the palm of your right hand, such that fingers encircle the conductor and then points in the direction of current. Then the direction of figure encircling conductor, gives the direction of magnetic lines of forces around it.



9. Solenoid: Solenoid is an insulated copper coil wound on a cylindrical cardboard, such that its length is greater than its diameter and behaves like a magnet when current is made to flow through it.

10. Intensity of magnetic field of a solenoid can be increased by:
a) Increasing number of turns in solenoid.
b) Increasing strength of current flowing through solenoid.
c) Placing soft iron core along the axis of solenoid.
d) Laminating soft iron core.

11. Electromagnet: An electromagnet is a type of magnet that is created by running an electric current through a coil of wire. The electric current creates a magnetic field around the wire, which can be used to attract or repel ferromagnetic materials such as iron, steel, and nickel.

12. Use of Electromagnets: Electromagnets can be made in a variety of shapes and sizes, and they are used in many different applications, including electric motors, generators, relays, and MRI machines.

13. A **Galvanometer** is an instrument utilized to detect the presence, direction, and strength of current in a circuit.

14. A pivoted type Galvanometer is used due to its ease of use - it requires no adjustment, uses a pointer for measuring deflection, and its coil returns to the center zero position immediately after the current is stopped.

15. The sensitivity of a Galvanometer refers to the angle through which its coil turns for a small value of current. Sensitivity can be increased by increasing the coil's cross-sectional area, using lighter springs, increasing the number of turns in the coil, and increasing the strength of the magnetic field.

16. An **Ammeter** is an instrument utilized to measure the electrical current flowing through a circuit. In order to be ideal, an Ammeter should possess zero resistance.

To create an Ammeter, a low resistance shunt wire can be connected in parallel to the terminals of a Galvanometer.

17. A **Voltmeter** is an instrument designed to measure the potential difference between two points in an electric field. An ideal Voltmeter would possess infinite resistance.

A Voltmeter can be constructed from a Galvanometer by adding a high resistance in series with one of the terminals. The Voltmeter is a high resistance instrument that is typically connected in parallel within a given electric circuit.

18. An **electric motor** is a device which changes electric energy to mechanical energy.

19. The speed of rotation of electric motor can be increased by -

a) Increasing the number of turns in a coil.
b) Increasing the area of cross section of the coil.
c) Increasing the current flow into coil.
d) Laminating the soft iron core.
e) Increasing the strength of radial magnetic field.

The jerky motion of electric motor is converted into smooth circular motion by winding number of coils on the same soft iron core at an angle of few degrees to each other.

20. Electromagnetic induction is the process by which an electrical current is induced in a conductor that is placed in a changing magnetic field. It is one of the fundamental principles of electromagnetism and is the basis for the operation of many electrical devices, such as generators, transformers, and motors.

21. Induced E.M.F is the potential difference set up in a conductor when magnetic lines of forces are allowed to change around it.

22. Direction of induced current is found by

a) Fleming's right-hand rule
b) Lenz's Law

23. Fleming's right-hand rule: Whenever magnetic flux changes within a closed-circuit coil, an induced e.m.f is set up across the coil which gives rise to induced electric current. The direction of induced e.m.f in an electric generator is found by Fleming's right-hand rule.

24. Lenz's law: In case of electromagnetic induction, the direction of induced current is such that it always opposes the cause which produces it.

25. A **transformer** is an electronic device that can modify the e.m.f of an alternating current to suit specific needs in a given situation.

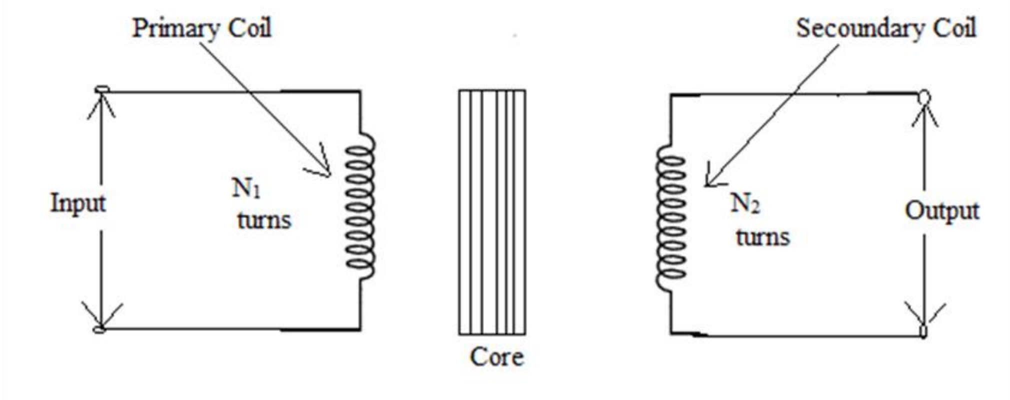
26. A **step-up transformer** is a type of transformer that raises the applied e.m.f of an alternating current.

27. Transformers are utilized in various applications, including but not limited to:
a) Reducing energy losses during long-distance transmission
b) Operating TVs, radios, and discharge tubes
c) Protecting sensitive electrical equipment
d) Charging batteries and powering transistors, radios, etc.

28. There are several causes of energy loss in transformers, including:
a) Energy is lost due to resistance in the primary and secondary coils.

b) Energy is lost due to magnetic hysteresis in the core.
c) Energy is lost due to eddy currents.

29. A **step-down transformer** is a device that lowers the applied e.m.f of an alternating current.



(Step- down transformer)

30. An **electric generator** is a device that converts mechanical energy into electric energy through the principle of electromagnetic induction.

31. Faraday's Laws of Electromagnetic Induction: Whenever magnetic flux changes within a closed-circuit coil, an induced e.m.f is setup across the coil which gives rise to induced electric current.

The magnitude of induced e.m.f is
a) Directly proportional to rate of change of magnetic flux.
b) Directly proportional to number of turns in coil.
c) Directly proportional to area of cross- section of coil.

32. The Snow Rule states that when a wire carrying current flows from south (S) to north (N) and is positioned over a needle, the north pole of the needle will deflect towards the west. The acronym SNOW represents the key elements of this rule: S for South, N for North, O for Over, and W for West.

33. Permanent Magnet
a) It does not exhibit very strong magnetic field.
b) Artificial or natural magnets cannot be readily magnetized.
c) The polarity of an artificial or natural magnet is fixed and cannot be reversed easily.
d) The strength of natural or artificial magnets cannot be changed.

34. Methods of demagnetization -
a) Rough handling of magnet
b) Heating and hammering
c) Demagnetizing with another permanent magnet
d) With the help of alternating current

35. Eddy currents are currents that arise in metallic conductors when there is a change in the surrounding magnetic flux.

Eddy currents have various uses, such as in annealing steel articles, induction furnaces for industrial alloy production, and induction heaters for efficient conversion of electric energy into heat energy.

36. The grid system is a power distribution system that steps up the generated power at the generation station and gradually steps it down until it is consumed at the receiving end with minimal transmission losses.

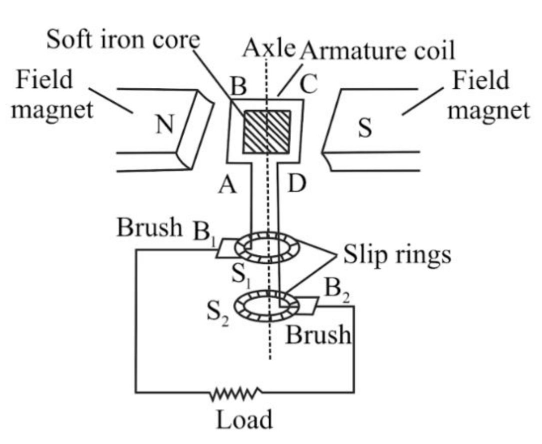
37. An **A.C. generator** converts mechanical energy into electrical energy using the principle of electromagnetic induction.

The induced electromotive force (e.m.f) in an A.C. generator is alternating in nature, with maximum values occurring at 90° and 270° and minimum values occurring at 180° and 360°.

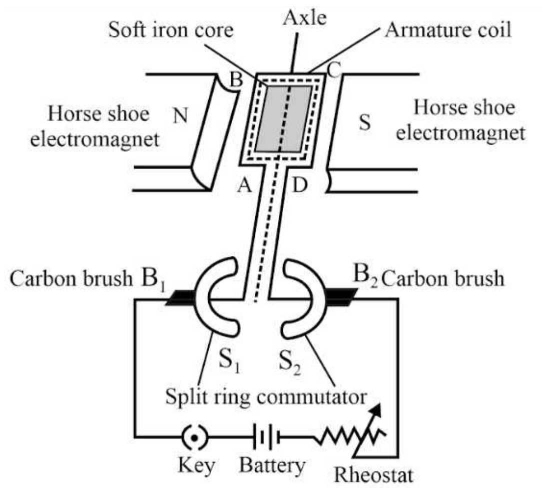
38. A **D.C. motor** converts electrical energy into mechanical energy by utilizing the force acting on a current-carrying conductor placed in a magnetic field.

39. Difference between AC generator and DC electric motor

AC Generator	DC electric motor
Converts mechanical energy into electrical energy	Converts electrical energy into mechanical energy
Uses rotating magnetic fields to induce current in stationary coils	Uses a fixed magnetic field to create motion in rotating coils
Produces alternating current (AC)	Requires direct current (DC) to operate
Typically used in power plants to generate electricity	Used in a wide range of applications, from household appliances to industrial machinery
Voltage output can be easily regulated	Speed can be easily controlled
More efficient for long-distance power transmission	More efficient for low-speed applications
Requires slip rings and brushes for electrical connection	Requires commutator to switch the direction of current flow in the coils
Generally has a higher output power	Generally has a lower output power
More complex in design and construction	Simpler in design and construction



AC generator



DC electric motor

40. The **primary coil** in a transformer is the coil where alternating current is fed from a given source.

41. The **secondary coil** in a transformer is the coil where an induced electromotive force (e.m.f) is generated.

42. Characteristics:

Primary Coil -

a) It is the coil that is connected to the input voltage source, typically the mains electricity supply.
b) It has fewer turns of wire than the secondary coil.
c) It produces a magnetic field that induces a voltage in the secondary coil.
d) The current in the primary coil is typically larger than the current in the secondary coil.
e) The primary coil is typically made of thicker wire than the secondary coil to handle the higher current.

Secondary Coil -

a) It is the coil that is connected to the load, such as an electronic device or an appliance.
b) It has more turns of wire than the primary coil.
c) It receives the magnetic field generated by the primary coil, inducing a voltage in the secondary coil.
d) The voltage in the secondary coil is higher than the voltage in the primary coil.
e) The current in the secondary coil is typically smaller than the current in the primary coil.
f) The secondary coil is typically made of thinner wire than the primary coil to increase its resistance and reduce power losses due to heat.

43. Primary e.m.f: The e.m.f of an alternating current connected to primary coil is called primary e.m.f.

44. Secondary e.m.f: The e.m.f induced in the secondary coil is called secondary e.m.f.

45. $\frac{\text{Primary e.m.f}}{\text{Secondary e.m.f}} = \frac{\text{No.of turns in primary coil}}{\text{No.of turns in secondary coil.}}$ Or $\frac{Vp}{Vs} = \frac{np}{ns}$

46. $\frac{\text{Primary current}}{\text{Secondary current}} = \frac{\text{No.of turns in primary coil}}{\text{No.of turns in secondary coil.}}$ Or $\frac{Ip}{Is} = \frac{np}{ns}$

47. The direction of induced e.m.f in an electric generator is found by Fleming's right-hand rule.

48. The magnitude of induced e.m.f in an electric generator depends upon:

a) Number of turns in coil.
b) Area of cross section of coil.
c) Intensity of radial magnetic field.
d) Rate of rotation of coil in magnetic field.

PART 1

Multiple Choice Questions (MCQs)

1. When the temperature in a metal rise, its electrical resistance

a) Increases
b) Decrease
c) Does not change
d) None of the above

2. Electric current is given by

a) Charge per unit area
b) Charge per unit volume
c) Charge per unit time
d) None of the above

3. Which of the following represent current?

a) ergc^{-1}
b) CS^{-1}
c) Ergs^{-1}
d) Cln^{-1}

4. The unit of specific resistance in S.I is

a) ohm m^{-1}
b) Ohm m
c) ohm cm^{-1}
d) A.m

5. A man has ten $\frac{1}{10}$ ohm resistors. What is the smallest resistance he can make with them?

a) 1/200 ohm
b) 1/250 ohm
c) 1/100 ohm
d) 1/10 ohm

6. A wire of resistance 'r' is doubled by connecting its two ends. The new resistance of the wire is

a) R
b) 4r
c) r/u
d) r/2

7. A cell has e.m.f E volt and its internal resistance is 'r' ohm. This cell is connected to a load of 'r' ohm. What is the potential difference across the terminals of the cell?

a) E/2
b) 2E
c) 4E
d) E/4

8. What happens when a Voltmeter is connected in series and an Ammeter in parallel when the circuit is on?

a) Both Ammeter and Voltmeter will be damaged
b) Neither the Ammeter nor the Voltmeter will be damaged
c) Only the Ammeter will be damaged
d) Only the Voltmeter will be damaged

9. If a wire is stretched to make its length three times, its resistance will become

a) Three times
b) One- third
c) Nine- times
d) One- ninth

10. Ohm's law is applicable to

a) Discharge of electricity through gases
b) Diode valve
c) All metallic conductor
d) Ohmic conductors

11. Potential at the surface of a charged body

a) Is the same all over the surface
b) Depends on the shape of the body
c) Depends on mass of the body
d) None of above

12. For which of the substances, resistance decreases with temperature?

a) Copper
b) Mercury
c) Carbon
d) Platinum

13. Four cells each of emf ε are joined in parallel to form a battery. The equivalent emf of the battery will be

a) 4 ε
b) ε/4
c) ε
d) ZERO

14. An external resistance R is connected to a cell of internal resistance 'r'. The current in the circuit is maximum when ________.

a) R > r
b) R < r
c) R = r
d) R = 2r

15. What is the effect of increasing the resistance in a circuit?

a) The current increases
b) The current decreases
c) The voltage increases
d) The voltage decreases

16. What is the purpose of a conductor in an electrical circuit?

a) To resist the flow of current
b) To increase the resistance in the circuit
c) To decrease the resistance in the circuit
d) To provide a path for the flow of current

17. What is the symbol for a resistor in a circuit diagram?

a) A triangle
b) A circle
c) A square
d) A zigzag line

18. What is the material that is most resistant to the flow of electric current?

a) Copper
b) Aluminum
c) Gold
d) Diamond

19. What is the movement of electrons in a conductor called?

a) Electric current
b) Magnetic field
c) Voltage
d) Resistance

20. What is an electric circuit that is not complete called?

a) Open circuit
b) Short circuit
c) Closed circuit
d) Broken circuit

21. What is the symbol for a battery in a circuit diagram?

a) A triangle
b) A circle
c) A square
d) Two parallel lines with a wavy line between them

22. What is the relationship between the resistance and conductance of a conductor?

a) Conductance is the reciprocal of resistance
b) Conductance is equal to resistance
c) Resistance is equal to conductance
d) There is no relationship between resistance and conductance

23. What is the unit of electrical conductance?

a) Ohm
b) Ampere
c) Volt
d) Siemens

24. What is the formula for calculating electrical power in a circuit?

a) P = V/R
b) P = I/R
c) P = VI
d) P = RI

25. What is the principle that states that the total resistance of a series circuit is equal to the sum of the individual resistances?

a) **Ohm's law**
b) Kirchhoff's first law
c) Kirchhoff's second law
d) The voltage divider rule

26. What is the formula for calculating electrical resistance in a circuit?

a) $R = V/I$
b) $R = I/V$
c) $R = V*I$
d) $R = P/I$

27. What is the formula for calculating electrical potential difference (voltage) in a circuit?

a) $V = P/I$
b) $V = I/R$
c) $V = R*I$
d) $V = W/Q$

28. What is the principle that states that the potential difference (voltage) across a series circuit is equal to the sum of the voltage drops across the individual components in the circuit?

a) Ohm's law
b) Kirchhoff's first law
c) Kirchhoff's second law
d) The voltage divider rule

29. What is the formula for calculating electrical current in a circuit?

a) $I = V/R$
b) $I = P/V$
c) $I = R/V$
d) $I = P/R$

PART 2

Important Questions

I. Answer the following questions

1. What is conventional current? **[2]**
2. Define current and give its SI unit. **[2]**
3. Define electronic current. **[2]**
4. What is current electricity? **[2]**
5. What is current drawn by a lamp that has been rated as 40 W, 250 V? **[2]**
6. What is the unit of electric charge? **[2]**
7. What is electric potential? **[2]**
8. What is potential difference? **[2]**
9. What is an electric cell? **[2]**
10. What is electromotive force (e.m.f)? **[2]**
11. What is electric circuit? **[2]**
12. What is open electric circuit? **[2]**
13. What is closed electric circuit? **[2]**
14. What is electric resistance? **[2]**
15. What is specific resistance? **[2]**
16. What is fixed resistance wire? **[2]**
17. What is variable resistance? **[2]**
18. What is a solenoid or inductor? **[2]**
19. What is (i) Voltmeter, (ii) Ammeter, and (iii) Galvanometer? **[3]**
20. What is electrical conductance? **[2]**

21. Define Electrical Resistance. **[2]**
22. State the greater unit of Resistance. **[2]**
23. Give difference between e.m.f & Potential Difference. **[2]**
24. What is the law of resistance? **[3]**
25. What is a series circuit? **[2]**
26. What is a parallel circuit? **[2]**
27. State two factors which determine internal resistance of cell. **[2]**
28. Why are lead acid accumulators connected in series? **[2]**
29. In what situations are parallel connections most advantageous? **[2]**
30. State two limitations of ohm's law. **[2]**
31. What do you understand by the term 'internal resistance of cell'? **[2]**
32. Plot a graph between potential difference and current. What is your conclusion from the graph? **[2]**
33. What do you understand by non-ohmic resistance? **[2]**
34. Distinguish between the resistors connected in series and in parallel giving circuit diagram. **[3]**
35. Why is an Ammeter likely to be burnt out if you connect it in parallel? **[2]**
36. How do you define 1 ampere? **[2]**
37. a) What is the conductance of a material? **[2]**
b) How is conductance of a material related with its resistance?
38. What is the unit in which the conductance of a conductor is measured? **[2]**
39. What is the relation between resistivity and conductivity of a conductor? **[2]**
40. What is the effect of rise of temperature on the resistance of a conductor? **[2]**
41. A wire having resistance 'R' has its length doubled and diameter halved. What will be its new resistance? **[2]**
42. A wire of resistivity P is broken into two halves. What will be the resistivity of one half of the wire? **[2]**
43. a) What is internal resistance of a cell? **[2]**
b) What is the direction of current through the electrolyte of a cell?
44. What is meant by Board of Trade Unit? **[2]**
45. Why is resistance so named? **[2]**
46. State the factors on which the resistance of a conductor depends? **[2]**
47. What is the unit in which the resistivity of a material is measured? **[2]**
48. What is the relation between resistivity and conductivity of a conductor? **[2]**
49. What is an Ammeter? Why is an Ammeter of low resistance? **[2]**
50. What is a Voltmeter? Why does a Voltmeter have high resistance? **[2]**
51. State the unit of magnetic field in terms of force experienced by a current carrying conductor placed in a magnetic field. **[1]**
52. State the pattern of magnetic field around a straight current carrying conductor. **[1]**
53. When can an electric charge give rise to a magnetic field? **[1]**
54. What is Lenz's Law? **[2]**
55. State Fleming's right-hand rule. **[2]**
56. Do the magnetic lines of force change their direction with the change in direction of current? **[2]**
57. State a law which determines the direction of a magnetic field around a current carrying conductor. **[2]**
58. What were the observations made by Oersted in his experiment? **[2]**
59. What is the shape of magnetic field lines around a straight current carrying conductor? **[1]**
60. What is an electric motor? **[1]**
61. If a magnetic compass is brought near a current-carrying solenoid, what will happen? **[2]**
62. What is an electromagnet? Give its construction. **[2]**
63. Why is soft iron generally used as the core of the electromagnet? **[2]**
64. What is a permanent magnet? Give one use of it. **[2]**
65. What is LORENTZ force? **[3]**
66. State Faraday's Laws of electromagnetic induction. **[2]**
67. Explain the effect of increasing the magnetic field. **[1]**

68. Explain the effect of increasing the speed of rotation of coil. **[1]**
69. Explain the effect of increasing number of turns in the coil. **[1]**
70. In which position of coil is the magnitude of induced e.m.f: **[2]**
a) maximum? b) minimum?
71. Explain the effect of winding more coils at an angle of few degrees on the same soft iron core. **[2]**
72. What is Maxwell's corkscrew rule? **[2]**
73. If a large current is passed, the Galvanometer may be damaged. Why? **[2]**
74. Why is an Ammeter always connected in series in an electrical circuit? **[2]**
75. Why does the coil of Galvanometer rotate on the passage of electric current? **[2]**
76. Why are the pole pieces of permanent magnet 'Concave cylindrical'? **[2]**
77. Why pivoted type moving coil Galvanometer cannot be used in alternating current? **[2]**
78. Why an Ammeter is always connected in series, in an electrical circuit? **[2]**
79. Why is Voltmeter always connected in parallel in an electric circuit? **[2]**
80. Explain why deflection occurs in Galvanometer. **[2]**
81. State the nature of the given physical/quantities. **[4]**
Current, Charge, Potential difference, Electromotive force, Resistance, Internal resistance, Electrical energy, Electric power.
82. What are the factors affecting the internal resistance? **[4]**
83. An experiment is performed to verify ohm's law observations and tabulated as follow: **[3]**

Current (I) **(In Amperes)**	0.1	0.2	0.3	0.4	0.5
Potential difference (V) **(In Volts)**	1.2	2.4	3.6	4.8	6.0

a) From the data, plot a V-I graph
b) Show that the graph confirms the Ohm's law
c) Find the resistance of the resistor used
84. What do you mean by potential? **[2]**
85. What is positive & negative potential? **[2]**
86. Name the material which is used for making wires for heating coils. Explain. **[2]**
87. a) Which will have higher resistivity a conductor or an insulator? **[2]**
b) Why are thick copper wires used as connecting wires? **[2]**
88. When do we connect resistors in parallel? **[2]**
89. When do you connect resistance in series? **[2]**
90. State the order of resistivity of a) a metal b) a semi-conductor and c) an insulator. **[2]**
91. What is the cause of resistance? **[2]**
92. Give a single word for $\frac{1\ joule}{1\ coulomb}$ **[2]**

II. Fill in the blanks (1 Mark each)

1. Combination of cells in series, is most effective when the external resistance is much ______, than the total internal resistance of the combination.
2. Conductance is the reciprocal of ________.
3. Current through a wire flows due to motion of ________.
4. Electric potential is defined as the work done per unit _______.
5. The directions of electronic current and conventional current are _______to each other.
6. In case of a number of resistances connected in series ______current flow through them.

7. In case of a number of unequal resistances connected in parallel _____current flow through them.

8. Potential difference is analogues to _____in heat.

9. Unit of potential difference, in S.I is ____.

10. Resistance of a conductor is measured in _____.

11. Thicker the wire _______is its resistance.

12. Unit of resistivity is ________.

13. Resistivity is the reciprocal of_______.

14. Resistance of a semi-conductor _______with a rise in temperature.

15. Potential difference across the two terminals of a cell in always _____than its e.m.f.

16. The ratio between potential difference to the ______ is a constant quantity and is known as_______.

17. Melting point of tungsten is about _____.

18. Electron volt is the unit for _______.

19. The number of electrons contained in one coulomb of charge is _____.

20. Value of specific charge on an electron is ______.

21. The SI unit for electric intensity is _____.

22. 1 KWh is equivalent to ________.

23. When the temperature of a metal is raised, its conductance______.

24. The SI unit of specific resistance is ______.

25. No current flows between two charged bodies when connected if they have the same_____.

26. The rate of flow of charge is called ______.

27. An Ammeter is a _______________resistance Galvanometer.

28. Voltmeter is a ___________ resistance Galvanometer.

29. A current carrying solenoid behaves like a __________.

30. A Galvanometer is __________ and _______ of current.

31. When current is passed through the conductor, _________ is set up around the conductor.

32. In a moving coil Galvanometer, deflection is proportional to _______.

PART 3

ICSE School Prelim Questions

1.

a) Draw a V-I graph for a conductor obeying Ohm's law.

b) What does the slope of V-I graph for a conductor represent? *(IEM Public School, Kolkata)* **[2]**

2. Two wires of the same material and same length have radii 1 mm and 2 mm respectively. Compare *(IEM Public School, Kolkata)* **[2]**

a) their resistances b) their specific resistance

3. Two lamps, one rated 220 V, 50 W and the other rated 220 V, 100 W, are connected in series with mains of voltage 220 V. Explain why the 50 W lamp consumes more power. *(Pramila Memorial Institute, Kolkata)* **[2]**

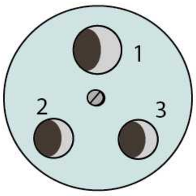
4. A conductor is moved in a varying magnetic field. Name the law which determines the direction of current induced in the conductor. *(IEM Public School, Kolkata)* **[2]**

5. You have three resistors of values 2 Ω, 3 Ω and 5 Ω. How will you join them so that the total resistance is less than 1 Ω? Draw diagram and find the total resistance. *(Pramila Memorial Institute, Kolkata)* **[3]**

6. What is Lenz's law? *(Pramila Memorial Institute, Kolkata)* **[2]**

7. Explain the statement 'the potential difference between two points is 1 volt'. *(IEM Public School)* **[2]**

8. The figure shows a three-pin socket marked as 1, 2 and 3. *(Pramila Memorial Institute, Kolkata)*



a) Identify and write life (L), neutral (N) and Earth (E) against the correct number.

b) To which part of the appliance is the terminal 1 connected?

c) To which wire joined to 2 or 3, is the fuse connected? **[3]**

9.

a) What name is given to a cylindrical coil of diameter less than its length?

b) If a piece of soft iron is placed inside the coil mentioned in part (a) and current is passed in the coil from a battery, what name is then given to the device so obtained?

c) Give one use of the device mentioned in part (b). *(Howard Memorial English School, Kolkata)* **[3]**

10. A fuse is always connected in the live wire of the circuit. Explain with reason. *(Howard Memorial English School, Kolkata)* **[2]**

11. State two differences between an electromagnet and a permanent magnet. *(Howard Memorial English School, Kolkata)* **[2]**

12. What are non-ohmic resistors? Give one example and draw a graph to show its current-voltage relationship. *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)* **[2]**

13. Why is the fuse wire fitted in a porcelain casing? *(Howard Memorial English School, Kolkata)* **[2]**

14. How is the magnetic field due to a straight current-carrying wire affected if current in the wire is *(Seraphim's Assembly School, Kolkata)* **[2]**

a) Decreased b) Reversed

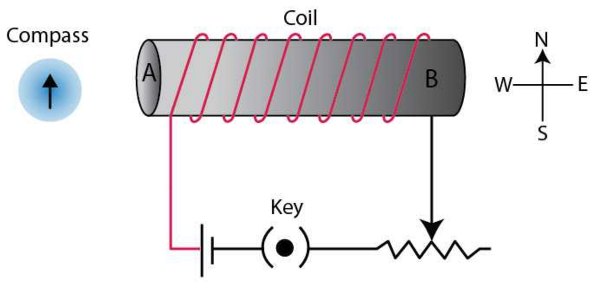
15. It is dangerous to connect the switch in the neutral wire. Explain your answer. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**

16. A fuse is rated 8A. Can it be used with an electrical appliance of rating 5 kW, 200 V? *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)* **[2]**

17. The diagram shows a spiral coil wound on a hollow cardboard tube AB. A magnetic compass is placed close to it. Current is switched on by closing the key. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**

a) What will be the polarity at the ends A and B?

b) How will the compass needle be affected? Give the reason.



18. Two resistors of 2 ohm and 3 ohms are connected (a) in series, (b) in parallel, with a battery of 6.0 V and negligible internal resistance. For each case draw a circuit diagram and calculate the current through the battery. *(Purwanchal Vidyamandir, Kolkata)* **[4]**

19. Name three factors on which the resistance of a wire depends and state how it is affected by the factors stated by you? *(Rishi Aurobindo Memorial Academy, Kolkata)* **[3]**

20. A current of 0.2 A flows through a wire whose ends are at a potential difference of 15 V. Calculate: *(Purwanchal Vidyamandir, Kolkata)* **[2]**

a) The resistance of the wire, and

b) The heat energy produced in 1 minute.

21. An electrical kettle is rated 3 kW, 250 V. Give reason whether this kettle can be used in a circuit which contains a fuse of current rating 13 A. *(Howard Memorial English School, Kolkata)* **[2]**

22.
a) What kind of the energy change takes place when a magnet is moved towards a coil having a galvanometer between its ends?
b) Name the phenomenon. *(Seraphim's Assembly School, Kolkata)* **[2]**

PART 4

Previous Years' Board Questions

1. The graph plotted for potential difference (V) against current (I) for ohmic resistor is: *[ICSE Sem 2, 2022]* **[1]**
a) a curve passing through the origin
b) a straight line not passing through the origin
c) a straight line passing through origin
d) a circle centered at the origin

2. An appliance rated 440 W, 220 V is connected across 220 V supply. *[ICSE Sem 2, 2022]* **[3]**
a) Calculate the maximum current that the appliance can draw.
b) Calculate the resistance of the appliance.

3. An electric bulb is rated '240 V, 100 W'. *[ICSE Specimen Paper Sem 2, 2022]* **[4]**
a) What information can you get from the above statement?
b) What will happen if this bulb is connected across 220 V?
c) Calculate the resistance of the bulb.
d) Also find the energy consumed by the bulb in 10 minutes.

4. A main switch in the main distribution board is present in: *[ICSE Sem 2, 2022]* **[1]**
a) A live wire
b) A neutral wire
c) A live as well as neutral wire
d) Each wire

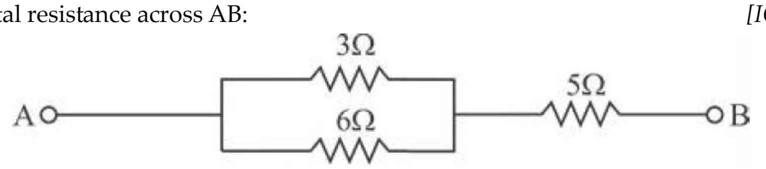
5. Which one of the following statements is correct? *[ICSE Specimen Paper Sem 2, 2022]* **[1]**
a) Live wire has zero potential
b) Fuse is connected in a neutral wire
c) Potential of live and earth wire is always the same
d) Earth wire is used to prevent electric shock

6. *[ICSE Sem 2, 2022]* **[3]**
a) Name two factors on which the force experienced by a conductor carrying current, placed in a magnetic field, depends. Also state how these factors affect the force.
b) With the help of which rule you can determine the direction of force acting on a current carrying conductor placed in a magnetic field?

7. *[ICSE Specimen Paper Sem 2, 2022]* **[3]**
a) State the Faraday's laws of electromagnetic induction.
b) Name one electrical device which works on this principle.

8. Why is it not advisable to use a piece of copper wire as fuse wire in an electric circuit? *[ICSE 2020]* **[2]**

9. Calculate the total resistance across AB: *[ICSE 2020]* **[2]**



10. When a current carrying conductor is placed in a magnetic field, it experiences a mechanical force. What should be the angle between the magnetic field and the length of the conductor so that the force experienced is: *[ICSE 2020]* **[2]**

a) Zero

b) Maximum

11. *[ICSE 2020]* **[3]**

a) What are superconductors?

b) Calculate the current drawn by an appliance rated 110 W, 220 V when connected across 220 V supply.

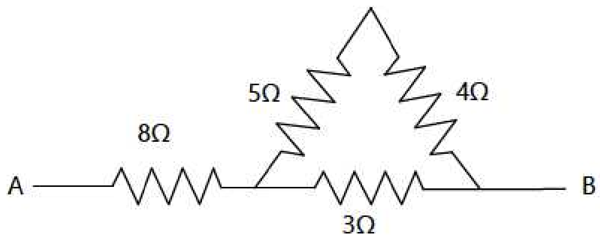
c) Name a substance whose resistance decreases with the increase in temperature.

12. How does an increase in the temperature affect the specific resistance of a: *[ICSE 2019]* **[2]**

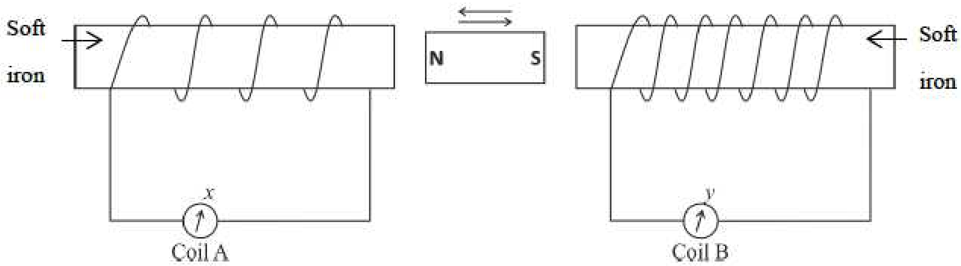
a) Metal and

b) Semiconductor?

13. Calculate the effective resistance across A *[ICSE 2019]* **[2]**



14. A magnet kept at the centre of two coils A and B is moved to and fro as shown in the diagram. The two galvanometers show deflection. *[ICSE 2019]* **[2]**



State with a reason whether:

x > y or x < y. [x and y are magnitudes of deflection.]

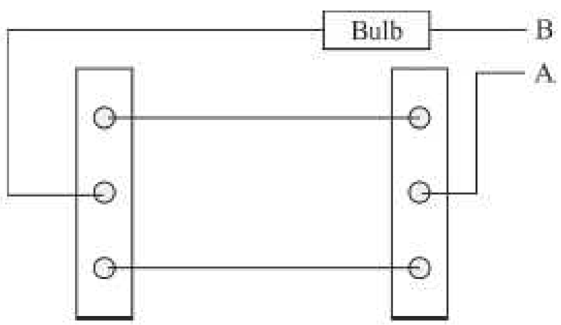
15. *[ICSE 2019]* **[3]**

a) Write one advantage of connecting electrical appliances in parallel combination.

b) What characteristics should a fuse wire have?

c) Which wire in a power circuit is connected to the metallic body of the appliance?

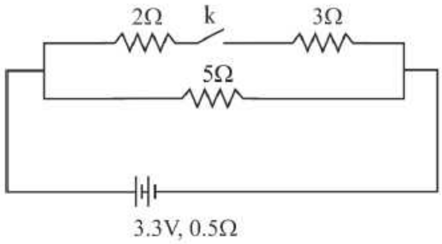
16. The diagram below shows a dual control switch circuit connected to a bulb. *[ICSE 2019]* **[2]**



a) Copy the diagram and complete it so that the bulb is switched ON.

b) Out of A & B which one is the live wire, and which one is the neutral wire?

17. *[ICSE 2019]* **[4]**



The diagram above shows a circuit with the key k open. Calculate:

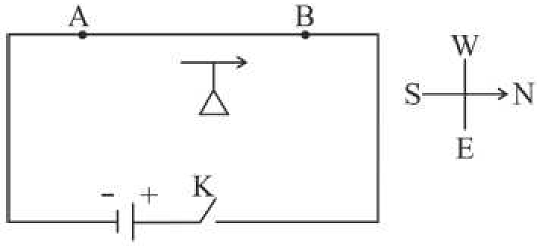
a) the resistance of the circuit when the key k is open.

b) the current drawn from the cell when the key k is open.

c) the resistance of the circuit when the key k is closed.

d) the current drawn from the cell when the key k is closed.

18. The diagram below shows a magnetic needle kept just below the conductor AB which is kept in the North South direction. *[ICSE 2019]* **[2]**



a) In which direction will the needle deflect when the key is closed?

b) Why is the deflection produced?

c) What will be the change in the deflection if the magnetic needle is taken just above the conductor AB?

d) Name one device which works on this principle.

19. *[ICSE 2019]* **[2]**

a) What type of current is transmitted from the power station?

b) At what voltage is this current available to our household?

20. *[ICSE 2018]* **[2]**

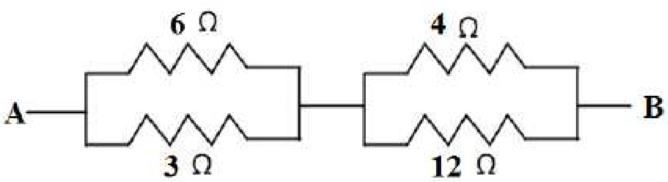
a)

i) A fuse is rated 8A. Can it be used with an electrical appliance rated 5 KW, 200 V? Give a reason.

ii) Name two safety devices which are connected to the live wire of a household electric circuit.

b)

i) Find the equivalent resistance between A and B.



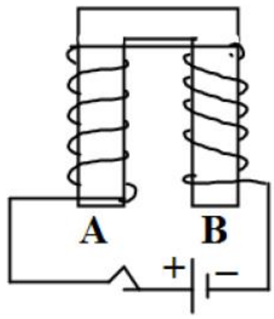
ii) State whether the resistivity of a wire changes with the change in the thickness of the wire.

21. An electric iron is rated 220V, 2kW. *[ICSE 2018]* **[2]**

a) If the iron is used for 2h daily, find the cost of running it for one week if it costs Rs. 4.25 per kWh.

b) Why is the fuse absolutely necessary in a power circuit?

22. *[ICSE 2018]* **[3]**



The diagram shows a coil wound around a U shape soft iron bar AB.

a) What is the polarity induced at the ends A and B when the switch is pressed?

b) Suggest one way to strengthen the magnetic field in the electromagnet.

c) What will be the polarities at A & B if the direction of current is reversed in the circuit?

23. An electric bulb of resistance 500Ω, draws a current of 0.4A. Calculate the power of the bulb and the potential difference at its end. *[ICSE 2017]* **[2]**

24. *[ICSE 2017]* **[2]**

a)

i) Name the colour code of the wire which is connected to the metallic body of an appliance.

ii) Draw the diagram of a dual control switch when the appliance is switched 'ON'.

b)

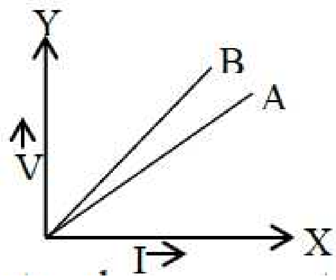
i) Which particles are responsible for current in conductors?

ii) To which wire of a cable in a power circuit should the metal case of a geyser be connected?

iii) To which wire should the fuse be connected?

c) Explain the meaning of the statement 'current rating of a fuse is 5A'.

25. The V-I graph for a series combination and for a parallel combination of two resistors is shown in the figure below. Which of the two A or B, represents the parallel combination? Give a reason for your answer. *[ICSE 2016]* **[2]**



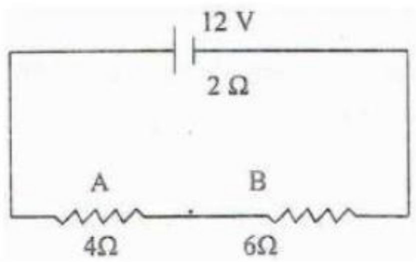
26. A music system draws a current of 400 mA when connected to a 12 V battery. *[ICSE 2016]* **[2]**

a) What is the resistance of the music system?

b) The music system is left playing for several hours and finally the battery voltage drops, and the music system stops playing when the current drops to 320 mA. At what battery voltage does the music system stop playing?

27. Calculate the quantity of heat produced in a 20 Ω resistor carrying 2.5A current in 5 minutes. *[ICSE 2016]* **[2]**

28. A battery of e.m.f. 12V and internal resistance 2 Ω is connected with two resistors A and B of resistance 4 Ω and 6 Ω respectively joined in series. *[ICSE 2016]* **[4]**



Find:

a) Current in the circuit.

b) The terminal voltage of the cell.

c) The potential difference across 6Ω Resistor.

d) Electrical energy spent per minute in 4Ω Resistor.

29. *[ICSE 2015]* **[2]**

a) Why does a current carry, freely suspended solenoid rest along a particular direction?

b) State the direction in which it rests.

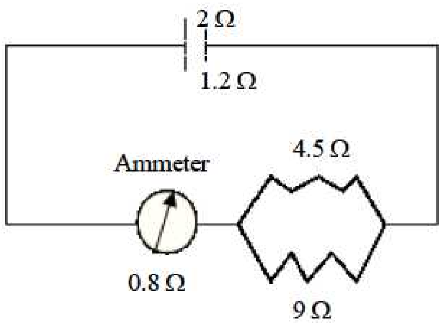
30. The relationship between the potential difference and the current in a conductor is stated in the form of a law. *[ICSE 2015]* **[3]**

a) Name the law.

b) What does the slope of V- I graph for a conductor represent?

c) Name the material used for making the connecting wire.

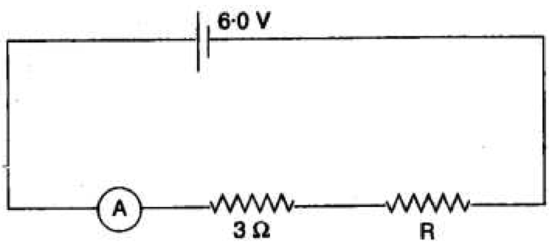
31. A cell of Emf 2V and internal resistance 1.2 Ω is connected with an ammeter of resistance 0.8 Ω and two resistors of 4.5 Ω and 9 Ω as shown in the diagram below: *[ICSE 2015]* **[2]**



a) What would be the reading on the Ammeter?

b) What is the potential difference across the terminals of the cell?

32. The figure shows a circuit *[ICSE 2013]* **[3]**



When the circuit is switched on, the ammeter reads 0.5 A.

a) Calculate the value of the unknown resistor R.

b) Calculate the charge passing through the 3Ω resistor in 120 s.

c) Calculate the power dissipated in the 3Ω resistor.

33. (i) Draw a simple labelled diagram of a d.c. electric motor. *[ICSE 2013]* **[3]**

(ii) What is the function of the split rings in a d.c. motor?

(iii) State one advantage of a.c. over d.c.

34. *[ICSE 2014]* **[2]**

(i) What is an Ohmic resistor?

(ii) Two copper wires are of the same length, but one is thicker than the other.

(1) Which wire will have more resistance?

(2) Which wire will have more specific resistance?

35. *[ICSE 2014]* **[2]**

a) Two sets A and B of the three bulbs each, are glowing in two separate rooms. When one of the bulbs in set A is fused, the other two bulbs also cease to glow. But in set B, when one bulb fuses, the other two bulbs continue to glow. Explain why this phenomenon occurs.

b) Why do we prefer arrangements of Set B for house circuiting?

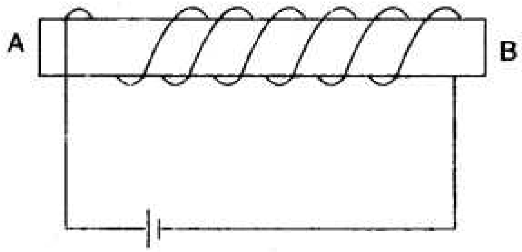
36. Two resistors of 4Ω and 6Ω are connected in parallel to a cell to draw 0.5 A current from the cell.

(i) Draw a labelled circuit diagram showing the above arrangement.

(ii) Calculate the current in each resistor. *[ICSE 2014]* **[2]**

37. *[ICSE 2013]* **[2]**

You have been provided with a solenoid AB.



a) What is the polarity at end A?

b) Give one advantage of an electromagnet over a permanent magnet.

38. *[ICSE 2013]* **[4]**

a) State Ohm's law.

b) A metal wire of resistance 6Ω is stretched so that its length is increased to twice its original length. Calculate its new resistance.

c) An electrical gadget can give an electric shock to its user under certain circumstances. Mention any two of these circumstances.

d) What preventive measure provided in a gadget can protect a person from an electric shock?

39. (i) Draw a neat and labelled diagram to show the structure of an a.c. generator.

(ii) State the energy conversion taking place in the generator when it is working. *[ICSE 2009]* **[4]**

Unit 5

HEAT

REVISION NOTES

1. **Heat** is a form of energy that is transferred from one body to another as a result of a difference in temperature. It is a form of energy that is associated with the motion of particles, particularly the movement and collision of atoms and molecules in a substance.

2. When two objects are in thermal contact, heat will flow from the hotter object to the cooler object until the two reach the same temperature. This transfer of heat is known as **thermal conduction**.

3. Heat can also be transferred by other means, such as radiation or convection. In **radiation**, heat is transferred through electromagnetic waves, such as infrared radiation. In **convection**, heat is transferred by the movement of fluids, such as air or water.

4. Heat is often measured in **units of energy**, such as joules or calories.

5. Heat is an important concept in many fields of physics, including thermodynamics, which is the study of the relationships between heat, work, and energy.

6. **Specific Heat Capacity:** Specific heat capacity, also known as specific heat, is the amount of heat required to raise the temperature of a unit mass of a substance by one degree.

   It is typically denoted by the symbol "c" and is usually expressed in units of joules per kilogram-degree (J/kg-K) or calories per gram-degree (cal/g-°C).

   The specific heat capacity of a substance is a measure of its ability to absorb or release heat. Substances with a high specific heat capacity require more heat to raise their temperature, while substances with a low specific heat capacity require less heat to raise their temperature.

   For example, water has a high specific heat capacity, which means that it requires a lot of heat to raise its temperature. Therefore, water is often used as a coolant in systems that generate a lot of heat, such as car engines or power plants.

7. **Thermal Capacity:** Thermal capacity, also known as heat capacity, is the amount of heat that a substance or system can absorb or release without undergoing a change in temperature. It is typically denoted by the symbol "C" and is usually expressed in units of joules per degree (J/°C) or calories per degree (cal/°C).

   The thermal capacity of a substance or system depends on its mass and specific heat capacity. It is calculated by multiplying the mass of the substance or system by its specific heat capacity. For example, if the mass of a substance is 10 kilograms and its specific heat capacity is 1.0 J/kg K, its thermal capacity would be 10 J/K.

8. **Melting or Fusion:** Melting is the process by which a solid substance changes into a liquid when it is heated to its melting point.

9. **Melting Point:** The melting point of a substance is the temperature at which it transitions from a solid to a liquid. At the melting point, the molecules in a substance have enough energy to break the bonds that hold them in place in a solid state, allowing them to flow and move more freely as a liquid.

10. **Solidification Point:** Solidification is the process by which a liquid substance changes into a solid when it is cooled to its solidification point. The solidification point, also known as the freezing point, is the temperature at which a substance transitions from a liquid to a solid. At the solidification point, the molecules in a substance have lost enough energy that they are no longer able to move freely, and they become arranged in a more ordered structure as a solid.

11. **Regelation**: The phenomenon due to which ice at 0°C melts to form water below 0°C on the application of pressure and the water so formed, refreezes to form ice on the removal of pressure is called regelation. Glaciers found in cold countries are the direct outcome of regelation.

12. **Boiling:** Boiling is the process by which a liquid substance changes into a gas when it is heated to its boiling point.

13. **Boiling point:** The boiling point of a substance is the temperature at which it transitions from a liquid to a gas. At the boiling point, the molecules in a substance have enough energy to escape from the liquid and form a gas.

14. **Evaporation:** Evaporation is the process by which a liquid substance changes into a gas at a temperature below its boiling point. In evaporation, the molecules in a liquid gain enough energy to escape from the liquid and form a gas.

15. **Latent Heat of Fusion:** The latent heat of fusion is the amount of heat that is absorbed or released when a substance changes from a solid to a liquid or from a liquid to a solid. It is typically denoted by the symbol "Lf" and is usually expressed in units of energy per unit mass, such as joules per gram or calories per gram.

16. **Specific Latent Heat of Fusion:** The specific latent heat of fusion is the amount of heat that is absorbed or released when a unit mass of a substance changes from a solid to a liquid or from a liquid to a solid.

17. **Specific Latent Heat of Fusion of Ice**: The specific latent heat of fusion of ice is the amount of heat that is absorbed or released when a unit mass of ice changes from a solid to a liquid or from a liquid to a solid. It is equal to 334 joules per gram or 79.7 calories per gram. This means that it takes 334 joules of energy to melt one gram of ice, and it releases 334 joules of energy when one gram of ice freezes.

18. **Factors affecting Boiling point of a liquid**
    There are several factors that can affect the boiling point of a liquid:
    a) **Pressure:** The boiling point of a liquid increases with an increase in external pressure. This is because the vapor pressure required to boil the liquid must be equal to the external pressure in order for boiling to occur.
    b) **Intermolecular forces:** The strength of the intermolecular forces between the molecules in a liquid can affect its boiling point. Liquids with strong intermolecular forces, such as water, have higher boiling points than those with weaker forces, such as acetone.
    c) **Molecular weight:** The molecular weight of a liquid can also affect its boiling point. In general,

liquids with higher molecular weights have higher boiling points because the molecules have more mass and therefore require more energy to overcome the intermolecular forces and become a gas.

d) **Polarity:** The polarity of a molecule can also affect its boiling point. Polar molecules, which have a positive end and a negative end, have higher boiling points than nonpolar molecules because the polar molecules can form hydrogen bonds, which are strong intermolecular forces.

e) **Impurities:** The presence of impurities in a liquid can lower its boiling point. This is because the impurities disrupt the intermolecular forces between the molecules in the liquid, making it easier for the molecules to escape as a gas.

19. The rate of evaporation

a) Increases with area of exposed surface
b) Increases with rise in temperature of liquid
c) Increases with the increase in movement of air
d) Increases with a rise in temperature of surrounding
e) Increases with a decrease of moisture in air
f) Increases with decrease of atmospheric pressure

20. At constant temperature, boiling or vaporization occurs when a liquid rapidly changes into vapour.

21. Numerical value of melting point or solidification point is same. e.g., if melting point of ice is 0°C, then freezing point of water is 0°C.

22. Numerical value of boiling point or liquefaction point is same. e.g., if boiling point of water is 100°C, then liquefaction point of steam is 100°C.

23. Latent Heat of Vaporization: Latent heat of vaporization is the amount of heat energy that is required to turn a given amount of a substance from a liquid into a vapor or gas at a constant temperature. It is also known as the enthalpy of vaporization or heat of vaporization.

It is an important property of a substance because it determines how much heat energy is required to vaporize the substance and how much heat energy is released when the vapor condenses back into a liquid.

For example, water has a high latent heat of vaporization, so it takes a lot of heat energy to vaporize it, and when it condenses, it releases a large amount of heat energy. This is why sweat is effective at cooling the body - as it evaporates from the skin, it absorbs a large amount of heat energy from the body, helping to cool it down.

24. Specific Latent Heat of Vaporization: It is the amount of heat energy required to vaporize one gram of a substance at a constant temperature. It is also known as the specific enthalpy of vaporization or specific heat of vaporization.

25. Specific Latent Heat of Vaporization of Steam: It is the amount of heat energy required to change 1 kg of water at 100°C, into 1 kg of steam at 100°C, without any rise in temperature. It is 226×10^4 J kg^{-1}. Steam has the highest specific latent heat capacity of vaporization.

26. Calorie: The quantity of heat energy required to raise the temperature of 1 gm of pure water through 1°C is called <u>one calorie.</u>

27. Kilo - Calorie: The quantity of heat energy required to raise the temperature of 1 kg of water through 1°C is called kilocalorie.

1 calorie = 4.2 J   1 Kilocalorie = 4200 J

PART 1

Multiple Choice Questions (MCQs)

1. Specific heat capacity of a body depends on

a) Its volume
b) Its material
c) Heat given to it
d) Its mass

2. The S.I unit of specific heat capacity is

a) J Kg^{-1} ° C^{-1}
b) Calorie g^{-1}
c) Joule °C^{-1}
d) Kilocalorie ° C^{-1}

3. The change from solid to vapour directly is called as

a) Sublimation
b) Condensation
c) Regulation
d) Vaporization

4. When ice at 0°C is converted into water at 273 K

a) Heat is released
b) Heat is absorbed
c) Temperature is increased
d) Temperature is decreased

5. The internal energy of a body is

a) The average energy of a molecule
b) The average kinetic energy of a molecule
c) The total energy of all the molecules due to their random motion and mutual attraction
d) The total kinetic energy of all the molecules

6. An ideal thermometer should have

a) Large heat capacity
b) Medium heat capacity
c) Small heat capacity
d) Variable heat capacity

7. The S.I unit of specific latent heat is

a) Cal Kg^{-1}
b) J Kg^{-1}
c) Cal ° C^{-1}
d) J Kg^{-1} ° C^{-1}

8. The specific heat capacity of copper is 0.1 g^{-1} ° $C.^{-1}$ Its value in J Kg^{-1} ° C^{-1} will be

a) 0.82×10^3
b) 0.42×10^3
c) 0.24×10^3
d) 4.2×10^3

9. Heat is measured in

a) Joules
b) Calorie
c) Kilocalorie
d) Watt

10. The phenomenon due to which ice at 0°C melts to form water at temperature below 0°C, on the application of external pressure and the refreezing of water so formed into ice on the release of pressure is called

a) Regelation
b) Sublimation
c) Liquification
d) Vaporization

PART 2

Important Questions

I. Questions with Short Answers

1. Define heat and state its units. **[2]**

2. Define heat energy based on kinetic model of matter. **[2]**

3. Define calorie. **[2]**

4. Define heat capacity and specific heat capacity. **[2]**

5. Which substance has the highest specific heat capacity? **[1]**

6. State the relation between heat capacity and specific heat capacity. **[2]**

7. Define water equivalent of calorimeter. **[2]**

8. List four precautions in determining the specific heat capacity of a solid experimentally. (By calorimeter) **[2]**

9. What is a calorimeter? Draw a neat, labelled diagram of a calorimeter. **[3]**

10. **[2]**

a) Name the unit of heat in S.I system.
b) Name the substance having the highest specific heat capacity.
c) Name one substance that contracts on melting and expands on solidification.
d) State the approximate temperature at which the water boils in a pressure cooker.
e) Which contains more heat: 1g of water at 100°C or 1 g of steam at 100°C?

11. **[3]**

a) What do you mean by change of phase of a substance?
b) Is there any change in temperature during the change of phase?
c) Is any heat absorbed or liberated by the substance during the change of phase?

12. **[2]**

a) State the effect of impurities on melting point.
b) State the effect of pressure on freezing or melting point. What are the applications of the effect of pressure on freezing point? **[2]**

13. Give difference between boiling and evaporation. **[2]**

14. Give difference between melting (fusion) and regelation. **[2]**

15. a) Give difference between melting point and boiling point. **[2]**
b) Give difference between Specific latent heat of fusion of ice and Specific latent heat of vaporization of steam. **[2]**

16. Explain the formation of (a) Sea breeze and (b) Land breeze **[2]**

17. Answer the following. **[3]**

a) What is a freezing mixture? b) State two uses of freezing mixtures.
c) Name two freezing mixtures which do not use common salt.

18. State three factors on which the rate of evaporation of liquid depends. **[3]**

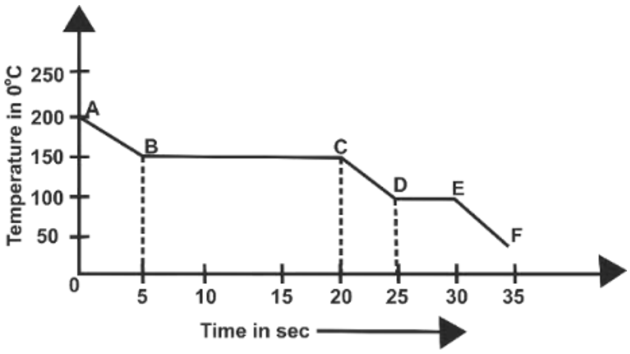
19. What contains more heat: 1 gm of water at 100°C or 1 gm of steam at 100°C?
Give reason for your answer. **[2]**

II. Give reason-based Questions & Answers

1. Doctors advise to put strips of wet cloth on the forehead of a person having high temperature (fever). **[2]**
2. One feels cold after a bath. **[2]**
3. If in a central heating system, steam enters a radiator pipe at 100°C and water leaves the radiator pipe at 100°C, can this radiator pipe heat the room? **[2]**
4. Hot water bottles are very efficient for fomentation. **[2]**
5. One feels ice-cream at 0°C colder than water at 0°C. **[2]**
6. How fast does land cool compared to water? Give one reason for your answer. **[2]**
7. Steam pipes warm a building more effectively than hot water pipes in cold countries. **[2]**
8. Petrol evaporates quickly compared to water. **[2]**
9. Dogs hang out their tongue in summer. **[2]**
10. Water is used as coolant in motor car radiators. **[2]**
11. Human body temperature is maintained at normal value (37°C) when the atmospheric temperature rises as high as 45°. **[2]**
12. Why are press letters cast and not stamped? **[2]**
13. Why a lump of ice at 0°C is more effective in cooling a drink than water at 0°C? **[2]**
14. Will the boiling point of water at Mumbai be the same, less, or greater than that at Shimla? **[2]**
15. Explain why does a wise farmer water his fields if forecast is frost? **[2]**
16. Explain why no tracks are left on the ice during ice skating. **[2]**
17. Why are big tubs of water kept in underground cellars for storing fresh fruit and vegetables in cold countries? **[2]**
18. Soils that are wet do not get heated up as quickly as those that are sandy. **[2]**
19. Atmospheric temperature falls after a hailstorm. **[2]**
20. Explain evaporation based on the kinetic theory. **[2]**
21. Wet khus- khus is used for cooling a room. **[2]**
22. Weather becomes pleasant when it starts freezing in cold countries. **[2]**

III. Figure Based Questions & Answers

1. Draw a neat and labelled diagram of a calorimeter. Why is it made up of copper? **[3]**
2. 1 kg of ice at 0°C is heated at a constant rate and its temperature is recorded after every 30s till steam is formed at 100°C. Draw temperature time graph to represent the change in state. **[3]**
3. The graph represents a cooling curve for a substance being cooled from higher temperature to a lower temperature. **[3]**



a) What is the boiling point of the substance?
b) What happens in the region DE?
c) Why is region DE shorter than the region BC?

4. Draw a well labelled diagram showing the changes taking place while heating and while cooling a substance. **[3]**
5. A piece of ice at 0°C is heated at constant rate and its temperature is recorded at regular intervals till steam is formed at 100°C. Draw a temperature time graph to represent the change in phase. Label the

graph neatly. **[3]**

6. Draw a neat and labelled graph of temperature v/s time, when naphthalene is heated from 0°C to 90°C. Also draw another curve when molten naphthalene cools to room temperature. How will you determine melting point and freezing point from the above graphs? **[3]**

IV. Fill in the Blanks (1 Mark each)

1. Heat is a cause of __________.
2. Temperature is the effect of ___________.
3. Heat is the sum total of _______ and ______ energies of all the molecules of a substance.
4. Temperature is the average ___________ of all molecules of a substance.
5. Evaporation is a ______ process.
6. Specific heat capacity of water is ____ J Kg^{-1} K^{-1}
7. Specific heat capacity of ice and stream is _____ J Kg^{-1} K^{-1}
8. Specific latent heat of fusion of ice is _____ J Kg^{-1}
9. Specific latent heat of vaporization of steam is ________.
10. 1 calorie is equal to _____ joules.
11. Increase in pressure _______ the boiling point of water.
12. When ice melts, there is a _______ in volume.
13. A pressure cooker is based on the principle of _________.
14. During fusion and boiling, the temperature is not raised even by _____ of heat.
15. _______ is used as coolant in car radiators.
16. Boiling is a ______ and evaporation is a ______ process.
17. _______ in general, tends to reduce the melting point of solids.
18. _____ has the highest Specific Latent heat of vaporization.
19. Specific Latent heat of fusion of ice is the amount of heat energy required to melt ________ to form _______ without any rise in temperature.
20. The phenomenon due to which ice at ______ melts to form water below _______, on the application of pressure and the water so formed refreezes to form ice on the removal of pressure is called ________.

PART 3

ICSE School Prelim Questions

1. Name three factors on which the heat energy absorbed by a body depends on and state how does it depend on them. *(IEM Public School Kolkata)* **[3]**
2. Same amount of heat is supplied to two liquids A and B. The liquid A shows a greater rise in temperature. What can you say about the heat capacity of A as compared to that of B? *(IEM Public School, Kolkata)* **[2]**
3. What is the principle of the method of mixture? What another name is given to it? Name the law on which this principle is based. *(Pramila Memorial Institute, Kolkata)* **[2]**
4. Calculate the amount of heat energy required to raise the temperature of 100 g of copper from 20°C to 70°C. Specific heat of capacity of copper =390 J kg^{-1} K^{-1}. *(Pramila Memorial Institute, Kolkata)* **[2]**
5. A piece of ice of mass 40 g is added to 200 g of water at 50°C. Calculate the final temperature of the water when all the ice has melted. Specific heat capacity of water = 4200 J kg^{-1} K^{-1} and specific latent heat of fusion of ice = 336 x 10^3 J kg^{-1}. *(Howard Memorial English School, Kolkata)* **[3]**
6. 1.0 kg of water is contained in a 1.25 kW kettle. Calculate the time taken for the temperature of water to rise from 25°C to its boiling point 100°C. Specific heat capacity of water = 4.2 J g^{-1} K^{-1}. *(Howard Memorial English School, Kolkata)* **[2]**

7. Calculate the total amount of heat energy required to convert 100 g of ice at -10°C completely into water at 100°C. Specific heat capacity of ice = 2.1 J g^{-1} K^{-1}, specific heat capacity of water = 4.2 J g^{-1} K^{-1}, specific latent heat of fusion of ice = 336 J g^{-1}. *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)* **[3]**

8. Ice cream appears colder to the mouth than water at 0°C. Give reasons. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**

9. 250 g of water at 30°C is contained in a copper vessel of mass 50 g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to 5°C. Given specific latent heat of fusion of ice = 336 x 10^3 J kg^{-1}, specific heat capacity of copper = 400 J kg^{-1} K^{-1}, the specific heat capacity of water is 4200 J kg^{-1} K^{-1}. *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)* **[4]**

10. Find the time taken by a 500 W heater to raise the temperature of 50 kg of material of specific heat capacity 960 J kg^{-1} K^{-1}, from 18°C to 38°C. Assume that all the heat energy supplied by heater is given to the material. *(Purwanchal Vidyamandir, Kolkata)* **[3]**

11. The temperature of 600 g of cold water rises by 15°C when 300 g of hot water at 50° C is added to it. What was the initial temperature of the cold water? *(Pramila Memorial Institute, Kolkata)* **[3]**

12. Discuss the role of high specific heat capacity of water with reference to climate in coastal areas. *(Purwanchal Vidyamandir, Kolkata)* **[2]**

13. A substance on heating undergoes (i) A rise in its temperature, (ii) A change in its phase without change in its temperature. In each case, state the change in energy of molecules of the substance. *(IEM Public School)* **[2]**

14. 200 g of ice at 0 °C converts into water at 0°C in 1 minute when heat is supplied to it at a constant rate. In how much time, 200 g of water at 0°C will change to 20°C? Take specific latent heat of ice = 336 J g^{-1}. *(Purwanchal Vidyamandir, Kolkata)* **[3]**

15. Why do the farmers fill their fields with water on a cold winter night? *(Howard Memorial English School, Kolkata)* **[2]**

16. It is difficult to cook vegetables on hills and mountains. Explain. *(Pramila Memorial Institute, Kolkata)* **[2]**

17. Water is used in hot water bottles for fomentation. Give reason. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**

18. 2 kg of ice melts when water at 100°C is poured in a hole drilled in a block of ice. What mass of water was used? Given: Specific heat capacity of water = 4200 J kg^{-1} K^{-1}, specific latent heat of ice = 336 × 10^3 J Kg^{-1}. *(IEM Public School, Kolkata)* **[3]**

19. Which has more heat: 1 g of ice at 0°C or 1 g of water at 0°C? Give reasons. *(Howard Memorial English School, Kolkata)* **[2]**

20. A mass m_1 of a substance of specific heat capacity c_1 at temperature T_1 is mixed with a mass m_2 of other substance of specific heat capacity c_2 at a lower temperature T_2. Deduce the expression for the temperature t of the mixture. State the assumption made, if any. *(Rishi Aurobindo Memorial Academy, Kolkata)* **[3]**

PART 4

Previous Years' Board Questions

1. 200 g of ice at $0^{\circ}C$ needs .... heat to melt. [Specific latent heat of ice = 336000 J kg^{-1}]

[ICSE Specimen Paper Sem 2, 2022] **[1]**

a) 6720 J b) 67200 J c) 672000 J d) 67.2 J

2. If water absorbs 4000 joules heat to increase the temperature of 1 kg water through $1^{\circ}C$ then the specific heat capacity of water is: *[ICSE Sem 2, 2022]* **[1]**

a) 4 J kg^{-1} $°C^{-1}$ b) 400 J g^{-1} $°C^{-1}$ c) 4 J g^{-1} $°C^{-1}$ d) 4.2 J g^{-1} $°C^{-1}$

3. Water is used in car radiators because: *[ICSE Sem 2, 2022]* **[1]**

a) It is a good conductor of heat.

b) It conducts heat faster as compared to the other substances and cools the engine quickly.

c) Its specific heat capacity is very low.

d) Its specific heat capacity is very high so it can cool the engine without greater increase in its own temperature.

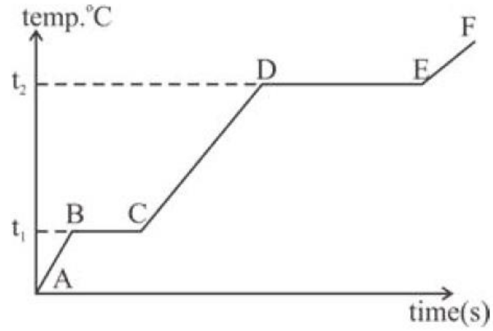
4. A metal piece of mass 420g present at 80°C is dropped in 80g of water present at 20°C in a calorimeter of mass 84g. If the final temperature of the mixture is 30°C then calculate the specific heat capacity of the metal piece. [Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$. Specific heat capacity of calorimeter = 200J kg^{-1} $°C^{-1}$] *[ICSE Sem 2, 2022]* **[4]**

5. Why does stone lying in the sun get heated up much more than water lying for the same duration of time? *[ICSE 2020]* **[2]**

6. Two metallic blocks P and Q having masses in ratio 2:1 is supplied with the same amount of heat. If their temperatures rise by the same degree, compare their Specific Heat Capacities. *[ICSE 2020]* **[2]**

7. Define heat capacity of a substance. Write the S.I unit of heat capacity. *[ICSE 2020] [ICSE 2017]* **[2]**

8. The diagram below shows the change of phases of a substance on a temperature v/s time graph on heating the substance at a constant rate. *[ICSE 2020]* **[2]**



i) Why is the slope of CD less than the slope of AB?

ii) What is the boiling and melting point of the substance?

9. A piece of ice of mass 60 g is dropped into 140 g of water at 50°C. Calculate the final temperature of water when all the ice has melted. *[ICSE 2020]* **[2]**

(Assume no heat is lost to the surrounding)

Specific heat capacity of water = 4.2 $Jg^{-1}k^{-1}$

Specific latent heat of fusion of ice = 336 Jg^{-1}

10. The specific heat capacity of a substance A is 3800 $Jkg^{-1}K^{-1}$ and that of a substance B is 400 $Jkg^{-1}K^{-1}$. Which of the two substances is a good conductor of heat? Give a reason for your answer. *[ICSE 2019]* **[2]**

11. *[ICSE 2019]* **[2]**

a) State whether the specific heat capacity of a substance remains the same when its state changes from solid to liquid.

b) Give one example to support your answer.

12. *[ICSE 2019]* **[3]**

a) Answer the following questions.

i) Define Calorimetry.

ii) Name the material used for making a Calorimeter.

iii) Why is a Calorimeter made up of thin sheets of the above material answered in (ii)?

b) The melting point of naphthalene is 80°C and the room temperature is 30°C. A sample of liquid naphthalene at 100°C is cooled down to room temperature. Draw a temperature time graph to represent this cooling. In the graph, mark the region which corresponds to the freezing process.

c) 104 g of water at 30°C is taken in a calorimeter made of copper of mass 42 g. When a certain mass of ice at 0°C is added to it, the final steady temperature of the mixture after the ice has melted was found to be 10°C. Find the mass of ice added. [Specific heat capacity of water = 4.2 $Jg^{-1}°C^{-1}$, Specific latent heat of fusion of ice = 336 Jg^{-1}, Specific heat capacity of copper = 0.4 $Jg^{-1}°C^{-1}$]

13. *[ICSE 2019]* **[2]**

a) Name the physical quantity which is measured in calories.

b) How is calorie related to the S.I unit of that quantity?

14. *[ICSE 2018]* **[2]**

a) How can a temperature in degree Celsius be converted into S.I. unit of temperature?

b) A liquid X has the maximum specific heat capacity and is used as a coolant in Car radiators. Name the liquid X.

15. *[ICSE 2018]* **[3]**

a)

i) Heat supplied to a solid change it into liquid. What is this change in phase called?

ii) Do the average kinetic energies of the molecules increase during the phase change?

iii) What is the energy absorbed during the phase change called?

b)

i) State two differences between 'Heat Capacity' and 'Specific Heat Capacity'.

ii) Give a mathematical relation between Heat Capacity and Specific Heat Capacity.

c) The temperature of 170g of water at 50°C is lowered to 5°C by adding a certain amount of ice to it. Find the mass of ice added. Given: Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$ and Specific latent heat of ice = 336000 J kg^{-1}

16. A solid metal weighing 150 g melts at its melting point of 800°C by providing heat at the rate of 100 W. The time taken for it to completely melt at the same temperature is 4 min. What is the specific latent heat of fusion of the metal? *[ICSE 2018]* **[2]**

17. *[ICSE 2017]* **[2]**

a)

i) How is the transference of heat energy by radiation prevented in a calorimeter?

ii) You have a choice of three metals A, B and C, of specific heat capacities 900 $Jkg^{-1}°C^{-1}$, 380 $Jkg^{-1}°C^{-1}$ and 460 $Jkg^{-1}°C^{-1}$ respectively, to make a calorimeter. Which material will you select? Justify your answer.

b) Calculate the mass of ice needed to cool 150g of water contained in a calorimeter of mass 50g at 32°C such that the final temperature is 5°C.
Specific heat capacity of calorimeter = 0.4 J/g°C
Specific heat capacity of water = 4.2 J/g°C
Latent heat capacity of ice = 330 J/g

18. Name two factors on which the heat energy liberated by a body depends. *[ICSE 2017]* **[2]**

19. Calculate the mass of ice required to lower the temperature of 300g of water at 40°C to water at 0°C. *[ICSE 2016]* **[2]**

(Specific latent heat of ice = 336 J/g, Specific heat capacity of water = 4.2 J/g °C)

20. What do you understand by the following statements: *[ICSE 2016]* **[2]**

i) The heat capacity of the body is 60 JK^{-1}.

ii) The specific heat capacity of lead is 130 $Jkg^{-1}K^{-1}$.

21. State two factors upon which the heat absorbed by a body depends. *[ICSE 2016]* **[2]**

22. *[ICSE 2016]* **[3]**

a)

i) What is the principle of method of mixtures? ii) What is the other name given to it?

iii) Name the law on which the principle is based.

b) Some ice is heated at a constant rate, and its temperature is recorded after every few seconds, till steam is formed at 100°C. Draw a temperature time graph to represent the change. Label the two-phase changes in your graph.

c) A copper vessel of mass 100 g contains 150 g of water at 50°C. How much ice is needed to cool it to 5°C? Given: Specific heat capacity of copper = 0.4 J g^{-1} $°C^{-1}$ Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$ Specific latent heat of fusion of ice = 336 J g^{-1}

23. Rishi is surprised when he sees water boiling at 115°C in a container. Give reasons as to why water can boil at the above temperature. *[ICSE 2015]* **[2]**

24. Which property of water makes it an effective coolant? *[ICSE 2015]* **[2]**

25. *[ICSE 2014]* **[4]**

a)

i) Water in lakes and ponds do not freeze at once in cold countries. Give a reason in support of your answer.

ii) What is the principle of Calorimetry?

iii) Name the law on which this principle is based.

iv) State the effect of an increase of impurities on the melting point of ice.

b) A refrigerator converts 100 g of water at 20°C to ice at -10°C in 35 minutes. Calculate the average rate of heat extraction in terms of watts. Given: Specific heat capacity of ice = 2.1 J g^{-1} $°C^{-1}$; Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$; Specific Latent heat of fusion of ice = 336 J g^{-1}

26. *[ICSE 2014]* **[2]**

a) Heat energy is supplied at a constant rate to 100g of ice at 0°C. The ice is converted into water at 0°C in 2 minutes. How much time will be required to raise the temperature of water from 0 °C to 20 °C? [Given: sp. heat capacity of water = 4.2 Jg^{-1} $°C^{-1}$, sp. latent heat of ice = 336 Jg^{-1}].

b) Specific heat capacity of substance A is 3.8 Jg^{-1} $°K^{-1}$ whereas the Specific heat capacity of substance B is 0.4 Jg^{-1} $°K^{-1}$.

i) Which of the two is a good conductor of heat?

ii) How is one led to the above conclusion?

27. How much heat energy is released when 5g of water at 20°C changes to ice at 0°C? [Specific heat capacity of water = 4.2 Jg^{-1} $°C^{-1}$; Specific latent heat of fusion of ice = 336 Jg^{-1}] *[ICSE 2013]* **[2]**

28. *[ICSE 2013]* **[2]**

a) It is observed that the temperature of the surroundings starts falling when the ice in a frozen lake starts melting. Give a reason for the observation.

b) How is the heat capacity of the body related to its specific heat capacity?

29. *[ICSE 2013]* **[2]**

a) Why does a bottle of soft drink cool faster when surrounded by ice cubes than by ice cold water, both at 0°C?

b) A certain amount of heat Q will warm l g of material X by 3°C and 1 g of material Y by 4°C. Which material has a higher specific heat capacity?

30. A calorimeter of mass 50g and specific heat capacity 0.42 Jg^{-1} $°C^{-1}$ contains some mass of water at 20°C. A metal piece of mass 20g at 100°C is dropped into the calorimeter. After stirring, the final temperature of the mixture is found to be 22°C. Find the mass of water used in the calorimeter. [specific heat capacity of the metal piece = 0.3 Jg^{-1} $°C^{-1}$ specific heat capacity of water = 4.2 Jg^{-1} $°C^{-1}$] *[ICSE 2012]* **[4]**

31. A hot solid of mass 60g at 100°C is placed in 150 g of water at 20°C. The final steady temperature recorded is 25°C. Calculate the specific heat capacity of the solid. [Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$] *[ICSE 2012]* **[2]**

32. *[ICSE 2012]* **[3]**

a)

i) Write an expression for the heat energy liberated by a hot body.

ii) Some heat is provided to a body to raise its temperature by 25°C. What will be the corresponding rise in temperature of the body as shown on the kelvin scale?

iii) What happens to the average kinetic energy of the molecules as ice melts at 0°C?

b) A piece of ice at 0°C is heated at a constant rate and its temperature recorded at regular intervals till steam is formed at 100°C. Draw a temperature – time graph to represent the change in phase. Label the different parts of your graph.

c) 40g of ice at 0°C is used to bring down the temperature of a certain mass of water at 60°C to 10°C. Find the mass of water used.

[Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$; [Specific latent heat of fusion of ice – 336 x 103 J kg^{-1}.]

33. Differentiate between heat and temperature. *[ICSE 2011]* **[2]**

34. 200 g of hot water at 80°C is added to 300 g of cold water at 10°C. Calculate the final temperature of the mixture of water. Consider the heat taken by the container to be negligible. [Specific heat capacity of water is 4200 J kg^{-1} $°C^{-1}$] *[ICSE 2011]* **[2]**

35. *[ICSE 2011]* **[3]**

a)

i) Explain why the weather becomes very cold after a hailstorm.

ii) What happens to the heat supplied to a substance when the heat supplied causes no change in the temperature of the substance?

b)

i) When 1 g of ice at 0°C melts to form lg of water at 0 °C then, is the latent heat absorbed by the ice or given out by it?

ii) Give one example where a high specific heat capacity of water is used as a heat reservoir.

iii) Give one example where a high specific heat capacity of water is used for cooling purposes.

c) 250 g of water at 30°C is present in a copper vessel of mass 50 g. Calculate the mass of ice required to bring down the temperature of the vessel and its contents to 5°C.

Specific latent heat of fusion of ice = 336 x 10^3 J kg^{-1}.

Specific heat capacity of copper vessel = 400 J kg^{-1} $°C^{-1}$.

Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$.

36. *[ICSE 2010]* **[3]**

a)

i) Define the term 'specific latent heat of fusion' of a substance.

ii) Name the liquid which has the highest specific heat capacity.

iii) Name two factors on which the heat absorbed or given out by a body depends.

b)

i) An equal quantity of heat is supplied to two substances A and B. Substance A shows a greater rise in temperature. What can you say about the heat capacity of A as compared to that of B?

ii) What energy change would you expect to take place in the molecules of a substance when it undergoes:

1) a change in its temperature?

2) a change in its state without any change in its temperature?

c) 50 g of ice at 0°C is added to 300 g of liquid at 30°C. What will be the final temperature of the mixture when all the ice has melted? The specific heat capacity of the liquid is 2.65 Jg^{-1} $°C^{-1}$ while that of water is 4.2 Jg^{-1} $°C^{-1}$. Specific latent heat of fusion of ice = 336 Jg^{-1}.

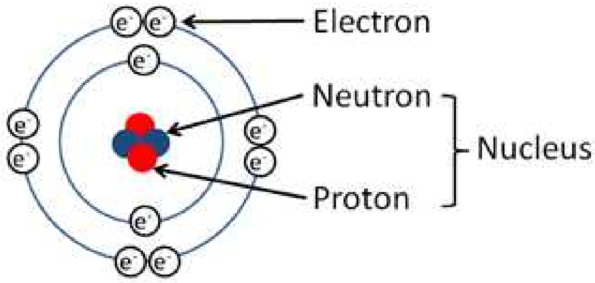
Unit 6 MODERN PHYSICS

REVISION NOTES

Radioactivity

1. **Atom**: Atom is the smallest unit of an element, which may or may not exist independently, but always takes part in a chemical reaction.

2. **Structure of an atom**: An atom consists of electrons, protons, and neutrons. Atoms are made up of a nucleus, where protons and neutrons reside, while the electrons revolve around the nucleus in some specific orbits without radiating any energy outside.



3. **Nucleus**: The central core of the atom is called nucleus.

4. **Structure of Nucleus**: The nucleus is at the centre of atom whose size is of the order of 10^{-15} m to 10^{-14} m (i.e., 10^{-5} to 10^{-4} times the size of the atom). It consists of protons and neutrons.

5. **Protons**: Protons are positively charged particles, having a charge equal to 1.6×10^{-19} C and mass equal to 3.32×10^{-27} kg.

6. **Neutrons**: A neutron is an electrically neutral particle (i.e., change = 0)

7. **Nucleons**: The protons and neutrons which are the main constituents of the nucleus, are called the nucleons.

8. **Electron**: Electrons are negatively charged particles, revolving around nucleus. Their mass is equal to 9.106×10^{-31} kg and charge is equal to -1.6×10^{-19} C.

9. **Comparison of Proton, Neutron and Electron:**

Particle	Symbol	Mass (amu)	Charge	Location
Proton	p+	1	+1	Nucleus
Neutron	n	1	0	Nucleus
Electron	e-	0.0005486	-1	Orbit

- Note that the mass of the proton and neutron is given in atomic mass units (amu).

- The electron has a much smaller mass than either the proton or neutron, and its mass is given in kilograms.
- The charge of the proton and electron are given in units of the elementary charge (e), which is the charge of the electron.
- The charge of the neutron is zero.
- The location of the particles refers to where they are typically found in an atom. The protons and neutrons are found in the nucleus of the atom, while the electrons are found in the outermost energy level, or orbit, around the nucleus.

10. **Atomic Number**: The atomic number of an atom is equal to the number of protons in its nucleus (which is same as the number of electrons in a neutral atom). i.e.
Z = number of protons in the nucleus of an atom.

11. **Mass Number**: The mass number of an atom is equal to the total number of nucleons (i.e., number if protons and neutrons combined) in its nucleus. i.e.,
A = number of protons + number of neutrons in the nucleus of an atom.

12. **J.J. Thomson** was a physicist who is credited for the discovery of electron. He used his research on cathode ray tube technology in this discovery.

13. **Atomic Model:** An atom is electrically neutral, therefore the number of protons in the nucleus of an atom is equal to the number of electrons revolving around the nucleus of the atom.
If Z is the atomic number and A is the mass number of an atom, then the atom contains
Number of electrons = Z
Number of protons = Z
Number of neutrons = A – Z
The atom is specified by the symbol ${}_{Z}^{A}X$ where X is the chemical symbol for the element.

14. **Isotopes**: In nuclear physics, isotopes are atoms of the same element that have the same number of protons in their nucleus, but a different number of neutrons. This means that isotopes of a given element have the same atomic number (number of protons), but a different atomic mass (number of protons plus neutrons).

Isotopes can be either *stable* or *radioactive*.
   a. **Stable isotopes** are those that are not radioactive and do not decay over time.
   b. **Radioactive isotopes**, on the other hand, are unstable and will eventually decay into other elements through the emission of particles such as alpha or beta particles.

Isotopes have a wide range of applications, including use in medicine, agriculture, and industry. In medicine, isotopes can be used in imaging techniques such as PET scans to help visualize the inside of the body. In agriculture, isotopes are used to study plant growth and soil chemistry. In industry, isotopes are used in a variety of applications, including the production of electricity in nuclear power plants and the sterilization of medical equipment.

15. **Isobars**: Isobars are nuclides (atoms) that have the same atomic mass number but different atomic numbers (number of protons). This means that they have the same number of neutrons, but different numbers of protons. Isobars are therefore isotopes of different elements.

Isobars can be useful in understanding the properties and behavior of different nuclides, because they have the same number of neutrons and therefore similar nuclear properties, but they have different numbers of protons and therefore different chemical properties.

16. **Isotones**: In nuclear physics, isotones are nuclides that have the same number of neutrons but different numbers of protons. This means that isotones have the same atomic mass, but different atomic numbers.

Isotones are important in nuclear physics because they can help to understand the properties of nuclei and the forces that hold them together. They can also be used in various applications, such as medical imaging and radiation therapy.

17. **Henry Becquerel** discovered the phenomenon of radioactivity in 1896.

18. **Radioactivity** is a nuclear phenomenon. It is the process of spontaneous emission of α or β and Υ radiations from the nucleus of atoms during their decay.

19. **Types of Radiation**: Radiations are of three types (1) positively charged (2) negatively charged and (3) uncharged which are named as alpha, beta, and gamma radiations respectively.

20. **Radioactive Substances**: Substances that disintegrate (or decay) by the spontaneous emission of radiations, are called the radioactive substances. e.g., uranium, radium, thorium, polonium, actinium, etc.

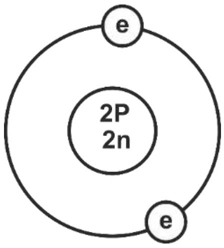
21. **Natural Radioactive Substances**: Natural radioactive substances are materials that contain naturally occurring radioactive isotopes. These isotopes are atoms that have an unstable nucleus and emit radiation in the process of radioactive decay. Some common natural radioactive substances include: Uranium, Thorium, Carbon-14.

22. **Ernest Rutherford**: In 1903, Rutherford experimentally studied the nature of radiations emitted by the radioactive substances.

23. Symbol, Charge and mass of electron, proton, and neutron.

	Electron	**Proton**	**Neutron**
Symbol	e	p	N
Charge	-1.6×10^{-19} C	$+1.6 \times 10^{-19}$ C	Zero
Mass	9.1×1.6^{-31} kg	1.67×10^{-27} kg	1.67×10^{-27} kg

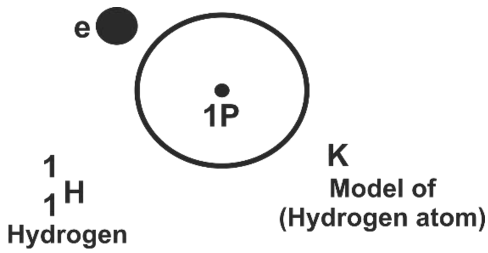
24. The Helium atom has the mass number A = 4 and the atomic number Z = 2. It is represented as ${}_{2}^{4}He$



(Model of Helium atom)

The helium atom has 2 neutrons and 2 protons inside the nucleus and 2 electrons in the K shell.

25. Hydrogen Atom -



The lightest atom is hydrogen whose mass number A is 1 and atomic number Z is also 1. It is represented by $_{1}^{1}H$ and it has one proton in the nucleus and one electron in the K shell as shown above.

26. Sodium Atom: The sodium atom has atomic number Z = 11 and mass number A = 23. It will have Z = 11 protons and A – Z = 23 – 11 = 12 neutrons inside the nucleus and Z = 11 electrons distributed as 2 in K shell, 8 in L shell, and 1 in M shell.
It is represented as $_{11}^{23}Na$.

27. Alpha (α) Particles - Alpha particles also called alpha rays or alpha radiation, consisting of two protons and two neutrons bounding together into a particle identical to helium – 4 nucleuses.

They are generally produced in the process of alpha decay.

- α – particles are stream of positively charged particles
- Speed – Nearly 10^{7} ms^{-1}
- Mass – Four times the mass of protons i.e. 6.68 x 10^{-27} kg
- Charge – Positive charge (2 times of proton) = +3.2 × 10^{-19} C (or +2e)
- Specific charge = 4.79 × 10^{7} c kg^{-1}
- Penetration - Small
- Power – 3 to 8 cm in air
- Biological damage – Less damage
- Effect of electrical and magnetic fields – Less deflected

28. Beta (β) Particles - β particles are the first moving electrons emitted from the nucleus of an atom.

- It is represented as $_{-1}^{0}\beta$ or $_{l}^{o}e$
- The rest mass of β particle is 9.1 × 10^{-31} kg (= m_e) and its change is –1.6 × 10^{-19} C (or –e).
- Thus, specific change (in $\frac{\Upsilon}{m}$ value) of β – particles is 1.76 ×10^{11} C kg^{-1}.
- Speed – 27 × 20^{8} ms^{-1}
- Ionizing power – 100 times of ϒ.
- Penetrating power – large
- Stopping substance – lead (1 mm thick)
- Aluminum (5mm thick)
- Biological damage – More damage

29. Gamma (ϒ) Radiation - Gamma radiations are the electromagnetic waves like X rays and light. They are highly energetic.

- Speed – 3 x 10^{8} ms^{-1} (in vacuum) (same as speed of light)
- Rest mass – No mass
- Change – No change
- Wavelength – 10^{-4} mm (or 10^{-13} m)
- Penetrating power – Very large up to a few hundred meter in air
- Stopping substance – Iron (30 cm thick)

- Concrete (Few meters thick)
- Biological damage – Cause immense biological damage as it can pass through human body easily.
- Effect of electric and magnetic field – Unaffected

30. Sources of Harmful Radiations

The main sources of harmful radiations are:

a. Radioactive fallout from the nuclear plants and other similar sources
b. Nuclear waste
c. Laboratories and medical diagnostic centers
d. Other sources e.g., cosmic radiation and X-ray

31. **Harmful Effect of Radiation** - The biological effects of nuclear radiations are of three types: (1) Genetic effects (2) Leukemia and cancer (3) Diarrhea, sore throat, loss of hair, nausea etc. The exposure to radiations can be acute if there is an accidental burst of radiations from an unshielded source.

32. **Nuclear fission** is the phenomenon in which a large nucleus is divided into two smaller nuclei of roughly equal size through the bombardment of slow neutrons. A vast amount of energy (approximately ≈190 MeV) is generated in each fission reaction.

33. **Nuclear fusion** involves the merging of two light nuclei to form a heavier nucleus, resulting in the release of an enormous amount of energy.

PART 1

Multiple Choice Questions (MCQs)

1. The atomic number (Z) of any element means

a) The total number of protons
b) The total number of electrons
c) The total number of neutrons
d) Any of (a) and (b)

2. Which of the following decay emits electromagnetic radiation?

a) Alpha decay
b) Beta plus decay
c) Beta minus decay
d) Gamma decay

3. The number of protons or atomic number is reduced to 2 by which form of radioactive decay?

a) Beta-decay
b) Gamma decay
c) Alpha decay
d) None of the above

4. A radioactive element undergoes gamma decay. Then the atomic number of the daughter nucleus____.

a) decreases by 2
b) increases by 1
c) decreases by 1
d) remains same

5. Isotopes of an element have a different number of

a) Proton
b) Neutron
c) Electron
d) Atom

6. $_{7}N^{14}$ and $_{7}N^{15}$ represents ____.

a) isotopes
b) isotones
c) isobars
d) isoneurons

7. The atomic number is not changed by which type of radioactive decay

a) Beta
b) Gamma
c) Alpha
d) The atomic number is affected by all forms of radioactive decay

8. When a radioactive element undergoes a beta-plus decay, the atomic number of daughter nucleus ____.

a) increases by one
b) decreases by one
c) decreases by two
d) remains same

9. An isotope of ____ is used in the treatment of cancer.

a) uranium
b) cobalt
c) iron
d) iodine

10. Three types of radioactive elements are emitted when unstable nuclei undergo radioactive decay. Which of the following is not one of them?

a) Beta
b) Gamma
c) Alpha
d) Delta

PART 2

Important Questions

1. Name the three constituents of an atom and state their mass and charge. How are they distributed in an atom? **[3]**

2. Define the following terms: **[2]**
   a) Atomic number
   b) Mass number

3. What is nucleus of an atom? Compare its size with that of the atom. How is the number of these constituents determined by the atomic number and mass number of the atom? **[2]**

4. What are isotopes? Give an example. **[2]**

5. What are the isobars? Give one example. **[2]**

6. Name the atoms of a substance having same atomic number, but different mass numbers. Give one example of such substance. How do the structures of such atoms differ? **[2]**

7. What is meant by radioactivity? Name two radioactive substances. **[2]**

8. Is radioactivity a nuclear phenomenon? Comment. **[2]**

9. A radioactive source emits three types of radiations. **[3]**
   a) Name the three radiations.
   b) Name the radiations which are deflected by the electric field.
   c) Name the radiation which is most penetrating.
   d) Name the radiation which travels with the speed of light.
   e) Name the radiation which has the highest ionizing power.

f) Name the radiation consisting of the same kind of particles as the cathode rays.

10. Compare the ionizing power of α, β and ϒ – radiations. **[2]**

11. State the penetrating range in air for the α, β and ϒ radiations. **[2]**

12. State two differences between a chemical change and a nuclear change. **[2]**

13. How is the radioactivity of an element affected when it undergoes a chemical change to form a chemical compound? Give reason for your answer. **[2]**

14. A radioactive source emits three types of radiations. **[3]**

a) Name the radiation of zero mass.

b) Name the radiation which has the lowest ionizing power.

c) Name the radiation that has the lowest penetrating power.

d) Give the charge and mass of particles composing the radiation in part (c).

e) From which part of the atom does this radiation come from?

f) When the particle referred to in part (c) becomes neutral, it is found to be the atom of a rare gas. Name this rare gas and draw a model of its neutral atom.

15. Explain why alpha and beta particles are deflected in an electric or a magnetic field, but gamma rays are not deflected in such a field. **[2]**

16. What are radio isotopes? What is their use? **[2]**

17. What are the harmful effects of radio isotopes? **[2]**

18. State the precaution that must be taken while handling a radioactive source. **[2]**

19. Answer the following questions. **[2]**

a) What is Becquerel ray?

b) Give four properties of Becquerel rays.

20. Who discovered the phenomenon of radioactivity? **[1]**

21. Which radioactive substance was discovered first? **[2]**

22. What part of the atom is responsible for radioactivity? **[2]**

23. What happens to the atomic number of an element when an α – particle is emitted? **[2]**

24. Arrange the α, β and ϒ radiations in ascending order of their (a) ionizing power, and (b) penetrating power. **[2]**

25. State the speed of each of α, β and ϒ radiations. **[2]**

26. An α – particle captures **[2]**

a) One electron b) Two electrons

In each case, what does it change to?

27. Answer the following questions. **[2]**

a) What is the composition of α, β and ϒ radiations?

b) Which one has the least penetrating power?

28. A certain radioactive nucleus emits a particle that leaves its mass unchanged but increases its atomic number by one. Identify the particle and write its symbol. **[2]**

29. What happens to the (a) atomic number, (b) mass number of an element when **[6]**

(i) an α – particle, is emitted

(ii) a β – particle, is emitted

(iii) a ϒ – radiation is emitted

30. What changes occur in the nucleus of a radioactive element when it emits (a) an alpha particle, (b) a beta particle, (c) gamma radiation. Give one example in each case to support your answer. **[3]**

31.

a) An atomic nucleus A is composed of 84 protons and 128 neutrons. The nucleus A emits an α – particle and is transformed into nucleus B. What is the composition of B?

b) Does the composition of nucleus C change if it emits ϒ radiation? **[2]**

32. Complete the following nuclear changes: **[4]**

a) $_{n}^{a}P \rightarrow Q + _{-1}^{0}\beta$

b) $^{238}_{92}P \xrightarrow{\alpha} Q \xrightarrow{\beta} R \xrightarrow{\beta} S$

c) $^{238}_{92}P \xrightarrow{\alpha} Q \xrightarrow{\beta} R \xrightarrow{\beta} S$

d) $^{A}_{z}X \xrightarrow{\alpha} X_1 \xrightarrow{\Upsilon} X_2 \xrightarrow{2\beta} X_3$

e) $X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} {}^{172}_{69}X_3$

33. Why are the alpha particles not used in radio therapy? **[2]**

34. Why do you usually use isotopes emitting gamma radiations as radioactive tracers in medical science? **[2]**

35. Find the radio isotope in each pair (a), (b), and (c). Give reason. **[2]**

a) $^{12}_{6}C$, $^{14}_{6}C$ b) $^{30}_{15}P$, $^{32}_{15}P$ c) $^{39}_{19}K$, $^{40}_{19}K$

36. Arrange the α, β and ϒ radiation in ascending order of their biological damage. Give reason. **[2]**

37. When does the nucleus of an atom become radioactive? **[2]**

38. Why should a radioactive substance not be touched by hand? **[2]**

39. State the medical use of radioactivity. **[2]**

40. Why do isotopes have the same chemical properties? **[2]**

41. Why do isobars have different chemical properties? **[2]**

42. Explain why α – particles cannot travel through a long distance in air? **[2]**

43. Explain why ϒ – radiation can travel through a long distance in air? **[2]**

44. **[2]**

a) A thorium isotope $^{233}_{90}Th$ undergoes an α – decay and changes to radium. What is the atomic number and mass number of the radium produced?

b) If radium undergoes a further disintegration and emits two β – particles, represent the reaction in the form of an equation.

45. Complete the equations to show the effect of the emission of an α – particle from a radioactive atom. Write down the atomic and mass numbers of X and Y. **[2]**

a) $^{218}_{84}Po \longrightarrow X + {}^{4}_{2}He$

b) $^{230}_{90}Th \longrightarrow Y + {}^{4}_{2}He$

46. **[2]**

a) What is thermionic emission?

b) Name two factors on which the rate of emission of thermions depends.

47. $^{27}_{12}Mg \xrightarrow{\beta} Al \xrightarrow{\Upsilon}$ **[2]**

In the above nuclear reaction,

$^{27}_{12}Mg$ emits a β – particle and is transformed to aluminum. Write the mass number and the atomic number of aluminum.

48. What happens to the position of the element in the Periodic table when the following are emitted? **[2]**

a) An α – particle

b) A β – particle

49. A mixture of radioactive substances gives off three types of radiations. **[2]**

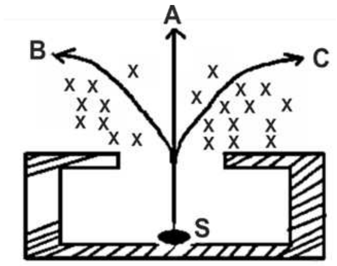
a) Name the three types.

b) Name the type of radiation consisting of the same kind of particles as cathode rays.

c) One of these radiations is like X – rays. Name the radiation.

d) When the particle referred to in becomes neutral, it is found to be the atom of a rare gas. Name this rare gas.

50. The diagram below shows a radioactive source S placed in a thick lead walled container. The radiations given out are allowed to pass through a magnetic field. The magnetic field (shown as X) acts perpendicular to the plane of paper inwards. Arrows shows the path of the radiations A, B and C. **[2]**



a) Name the radiations labelled A, B and C.

b) Explain clearly how you used the diagram to arrive at the answer in part (a).

51. How are ϒ radiations produced? List two common properties of gamma radiations and visible light. **[2]**

52. What do you mean by background radiations? Name its two sources. Is it possible for us to keep ourselves away from it? **[2]**

53. What is Einstein's mass energy relation? **[1]**

54. Mention safety measures to be taken while establishing a nuclear power plant. **[2]**

55. What is meant by nuclear waste? State one way for the safe disposal of nuclear waste. **[2]**

56. What do you mean by nuclear energy? What is responsible for its release? **[2]**

57. Write down the Einstein's mass – energy equivalence relation, explaining the meaning of each symbol used in it. **[2]**

58. Answer the following questions. **[2]**

a) What is a.m.u? Express 1 a.m.u in MeV.

b) Write the approximate mass of a proton, neutron, and electron in a.m.u.

59. State the scientific use of radio isotopes. **[2]**

60. State the industrial use of radio isotopes. **[2]**

61. Complete the following fusion reactions: **[2]**

a) $^{3}_{2}He + ^{2}_{1}H \longrightarrow$ $_{2}$He + energy

$^{3}_{2}He + ^{2}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{1}H$ + energy

b) $^{2}_{1}H + ^{2}_{1}H \longrightarrow$ $_{2}$He + ^{1}n + energy

$^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n$ + energy

PART 3

ICSE School Prelim Questions

1. $^{23}_{11}Na$ State the atomic and mass number and draw its atomic model. *(Pramila Memorial Institute, Kolkata)* **[2]**

2. A radioactive source emits three types of radiations. *(IEM Public School, Kolkata)* **[3]**

a) Name the radiation of zero mass.

b) Name the radiation which has the lowest ionizing power.

c) Name the radiation which has the lowest penetrating power.

d) Give the charge and mass of particles composing the radiation in part (c).

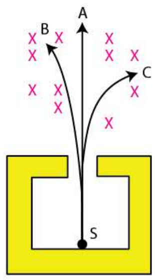
e) When the particle referred to in part (c) becomes neutral, it is found to be the atom of model of its neutral atom.

f) From which part of the atom do these radiations come?

3. 'Radioactivity is a nuclear phenomenon.' Comment on this statement. *(Pramila Memorial Institute, Kolkata)* **[2]**

4. A certain radioactive nucleus emits a particle that leaves its mass number unchanged but increases its atomic number by one. Identify the particle and write its symbol. *(Howard Memorial English School, Kolkata)* **[2]**

5. The diagram in the figure shows a radioactive source S placed in a thick lead walled container. The radiations given out are allowed to pass through a magnetic field. The magnetic field (shown as x) acts perpendicular to the plane of paper inwards. Arrows shows the paths of the radiation A, B and C. *(Howard Memorial English School, Kolkata)* **[2]**



a) Name the radiations labelled A, B and C.

b) Explain clearly how you used the diagram to arrive at the answer in part (a).

6. What are radio isotopes? Give one example of a radio isotope. State one use of radio isotopes. *(St. Mary's Orphanage School, Kolkata)* **[2]**

7. Name the atoms of a substance having the same atomic number, but different mass numbers. Give one example of such a substance. How do the structures of such atoms differ? *(IEM Public School, Kolkata)* **[2]**

8. Define the following terms: *(Aryans School, Kolkata)*

a) Atomic number   b) Mass number

9. From which part of the atom do the radiations come? *(Aryans School, Kolkata)* **[2]**

10. Complete the following reactions: *(Rishi Aurobindo Memorial Academy, Kolkata) (St. Stephen's School, Habra)*

$$^{238}_{92}P \xrightarrow{\alpha} Q \xrightarrow{\beta} R \xrightarrow{\beta} S$$

[2]

11. Give two characteristics of radioactive decay. *(Aryans School, Kolkata)* **[2]**

12. Why are the alpha particles not used in radio therapy? *(Aryans School, Kolkata)* **[2]**

13. What is the composition of α, β and γ radiations? *(Rishi Aurobindo Memorial Academy, Kolkata)* **[2]**

14. How are γ radiations produced? Mention two common properties of gamma radiations and visible light. *(Purwanchal Vidyamandir, Kolkata)* **[2]**

15. An α particle captures (i) one electron, (ii) two electrons. In each case, what does it change to? *(Purwanchal Vidyamandir, Kolkata)* **[2]**

16. What happens to the (i) atomic number, (ii) mass number of the nucleus of an element when (a) an α particle, (b) a β particle, and (c) γ radiation, is emitted? *(Purwanchal Vidyamandir, Kolkata)* **[2]**

17. State the speed of each of α, β, and γ radiations. *(Seraphim's Assembly School, Kolkata)* **[2]**

18. A certain nucleus A (mass number 238 and atomic number 92) is radioactive and becomes a nucleus B (mass number 234 and atomic number 90) by the emission of a particle.

a) Name the particle emitted.

b) Explain how you arrived at your answer.

c) State the change in the form of a reaction.

(North Point High School, Mumbai) **[3]**

19. What is meant by nuclear waste? *Seraphims Assembly school, Kolkata)* **[2]**

20. State whether the following nuclear disintegrations are allowed or not (star indicate an excited state). Give reason if it is not allowed. *(Seraphims Assembly school, Kolkata)* **[2]**

a)

$$\frac{A}{Z}X^{X} \rightarrow \frac{A}{Z}X + y$$

b)

$$\frac{A}{Z}X \rightarrow {}^{A}_{z-2}X + {}^{4}_{2}He$$

PART 4

Previous Years' Board Questions

1. The heaviest nuclear radiation is: *[ICSE Sem 2, 2022]* **[1]**
   a) X-radiation
   b) α-radiation
   c) γ-radiation
   d) β-radiation

2. To study the age of excavated material of archaeological significance we study the rate of decay of an isotope of: *[ICSE Sem 2, 2022]* **[1]**
   a) Carbon
   b) Cobalt
   c) Carbon
   d) Chlorine

3. The radiation with maximum penetrating power is: *[ICSE Specimen Paper Sem 2, 2022]* **[1]**
   a) γ
   b) β
   c) X-radiation
   d) α

4. The nuclear radiation which gets deflected towards negatively charged plate in an electric field is: *[ICSE Specimen Paper Sem 2, 2022]* **[1]**
   a) Gamma
   b) Ultraviolet
   c) Beta
   d) Alpha

5. A beam of α, β and γ rays is travelling through a certain region in space.
   a) Arrange them in ascending order of ionizing power.
   b) Which of the above will pass undeviated if subjected to an electric field?
   c) With respect to your answer to part (b) above, what will be the change in the nucleus of an atom after such a ray is emitted. *[ICSE Specimen Paper Sem 2, 2022]* **[3]**

6. An atomic nucleus A is composed of 84 protons and 128 neutrons. The nucleus A emits an alpha particle and is transformed into a nucleus B. *[ICSE 2020]* **[2]**
   i) What is the composition of B?
   ii) The nucleus B emits a beta particle and is transformed into a nucleus C. What is the composition of C?
   iii) What is the mass number of the nucleus A?
   iv) Does the composition of C change if it emits gamma radiations?

7. State one safety precaution in the disposal of nuclear waste. *[ICSE 2020]* **[2]**

8. (i) Differentiate between nuclear fusion and nuclear fission. *[ICSE 2020]* **[2]**
(ii) State one safety precaution in the disposal of nuclear waste.

9. Is it possible for a hydrogen ($^{1}_{1}H$) nucleus to emit an alpha particle? Give a reason for your answer. *[ICSE 2019]* **[2]**

10. *[ICSE 2018]* **[2]**
   i) What are isobars?
   ii) Give one example of isobars.

11. When does the nucleus of an atom tend to be radioactive? *[ICSE 2017]* **[2]**

12. An element $^{Z}S_{A}$ decays to $^{85}R_{222}$ after emitting 2 α particles and 1 β particle. Find the atomic number and atomic mass of the element S. *[ICSE 2016]* **[2]**

13. A radioactive substance is oxidized. Will there be any change in the nature of its radioactivity? Give a reason for your answer. *[ICSE 2016]* **[2]**

14. Arrange α, β and γ rays in ascending order with respect to their *[ICSE 2016]* **[2]**
   i) Penetrating power

ii) Ionizing power
iii) Biological effect

15. *[ICSE 2016]* **[3]**
i) Represent the change in the nucleus of a radioactive element when a β particle is emitted.
ii) What is the name given to elements with the same mass number and different atomic number?
iii) Under which conditions does the nucleus of an atom tend to be radioactive?

16. State any two precautions to be taken while handling radioactive substances. *[ICSE 2015]* **[2]**

17. A nucleus $_{11}Na^{24}$ emits a beta particle to change into Magnesium (Mg) *[ICSE 2014]* **[3]**
i) Write the symbolic equation for the process.
ii) What are numbers 24 and 11 called?
iii) What is the general name of $_{12}Mg^{24}$ with respect to $_{11}Na^{24}$?

18. A radioactive nucleus undergoes a series of decays according to the sequence: *[ICSE 2013]* **[2]**

$$X \xrightarrow{\beta} X_1 \xrightarrow{\alpha} X_2 \xrightarrow{\alpha} X_3$$

If the mass number and atomic number of X_3 are 172 and 69 respectively, what is the mass number and atomic number of X?

19. Which of the radioactive radiations: *[ICSE 2013]* **[2]**
i) Can cause severe genetical disorders
ii) Are deflected by an electric field

20. Give any two important sources of background radiation. *[ICSE 2012]* **[2]**

21. A certain nucleus X has a mass number 14 and atomic number 6. The nucleus X changes to $_7Y^{14}$ after the loss of a particle. *[ICSE 2012]* **[2]**
(i) Name the particle emitted.
(ii) Represent this change in the form of an equation.

22. Mention one use and one harmful effect of radioactivity. *[ICSE 2008]* **[2]**

23. An element P disintegrates by α -emission and the new element suffers two further disintegrations, both by β -emission, to form an element Q. Explain the fact that P and Q are the isotopes. *[ICSE 2008]* **[2]**

24. What will an alpha particle change into when it absorbs: *[ICSE 2007]* **[2]**
i) One electron ii) Two electrons

25. Which of the following is the radio isotope in each pair? *[ICSE 2007]* **[2]**
a) $^{12}_{6}C$, $^{14}_{6}C$
b) $^{30}_{15}P$, $^{32}_{15}P$
c) $^{39}_{19}K$, $^{40}_{19}K$
Give reason for your answer.

26. *[ICSE 2007]* **[2]**
a) What happens to the atomic number of an element when it emits:
i) an alpha particle
ii) a beta particle
b) Explain why alpha and beta particles are deflected in an electric or a magnetic field but gamma rays are not deflected in such a field.

ANSWERS

Chapter 1 – Work, Force, Power & Energy

PART 1

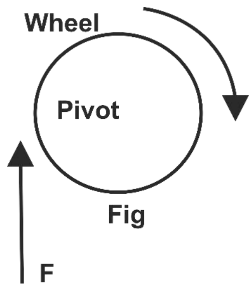
1. a) Potential Energy
2. c) both Kinetic and Potential energy
3. b) 746 W
4. b) Electric Energy
5. a) Force and Velocity
6. b) Nm
7. a) both Kinetic and Potential energy
8. b) Positive
9. b) Loudspeaker
10. c) Instantly transforms into light energy
11. b) Speed
12. c) A fictitious force

PART 2

1. A rigid body when acted upon by a force, can have two kinds of motion:
   i) Linear or translational motion
   ii) Rotational motion
   Tip: *A rigid body is any object that does not deform when forced is applied to it. For example, when you push a car (a rigid object), it does not deform, but tends to move.*

2. When a force acts on a stationary rigid body which is free to move, the body starts moving in a straight path in the direction of force. This is called the linear or translational motion.
   Example: On pushing a ball lying on a floor, it begins to move.

3. If the body is pivoted at a point and the force is applied on the body at a suitable point, it rotates the body about the axis passing through the pivoted point. This is the turning effect of the force and the motion of body is called rotational motion.



   Example: If a wheel is pivoted at its centre and a force is applied tangentially on its rim, the wheel rotates about its centre.
   Similarly, when a force is applied normally on the handle of a door, the door begins to rotate about axis passing through the hinges on which the door rests.

4.
   a) **The translational motion -** When the body is free to move.
   b) **The rotational motion -** When the body is pivoted at a point.

5. The turning effect on a body by a force depends on the following 2 factors:

i) The magnitude of the force
ii) The distance of line of action of the force from the axis of rotation (or pivoted point)

6. The moment of a force (or torque) is equal to the product of the magnitude of the force and the perpendicular distance of the line of action of force from the axis of rotation. The S.I unit of moment of force is Newton metre (Nm)

7. Vector quantity

8. In translational motion, the body moves in a straight line, whereas in a rotational motion the body rotates about a fixed point.

9. Turning force, also known as torque, is a measure of the ability of a force to cause rotational motion about an axis. It is defined as the product of the force applied and the lever arm, which is the distance between the point of application of the force and the axis of rotation. The unit of torque is the newton meter (Nm).

10. If the turning effect on a body is clockwise, the moment of force is called the clockwise moment and it is taken *negative*. If it is anticlockwise, the moment of force is called anticlockwise moment and is taken *positive*.

11. When body is pivoted at a point, the force applied on the body at suitable point rotates the body about the axis passing through the pivoted point. The direction of rotation can be changed by changing the point of application of force.

12. Moment of force about a given axis = Force × Perpendicular distance of force from the axis of rotation.

13. To obtain a greater moment of a force about a given axis of rotation, force applied must be increased and the distance between the line of action and the axis of rotation must be maximum.

14. Moment of a force depends on the distance of line of action of the force from the axis of rotation. So, by decreasing the perpendicular distance from the axis reduces the moment of a given force.

15. It is easier to open a door by applying the force at the free end of it because larger the perpendicular distance, less is the force required to turn the body.

16. The handle on a hand flour grinder is located near the rim of the stone to make it easier to grip, balance the weight of the stone, and apply more leverage while grinding. This helps to make the grinding process more efficient and easier on the user.

17. The larger diameter steering wheel has a longer lever arm, which means that the force applied to the wheel is multiplied more, resulting in less overall force being required to turn the wheel. It may also have a more comfortable grip and higher torque, which can also make it easier to turn.

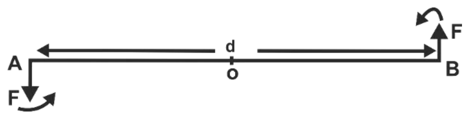
18. A spanner is a type of hand tool that is used for tightening and loosening bolts and nuts. The handle of a spanner is typically longer than the head, which allows the user to apply more torque to the bolt or nut being tightened or loosened. This makes it easier to loosen stubborn bolts or nuts, and also allows the user to apply more force without straining their hand or wrist. The longer handle also gives the user more leverage, which can make it easier to turn the spanner when applying pressure. In addition, the longer handle can also provide better reach in tight or hard-to-reach spaces.

19.

a) Resultant force acting on the body
 $F - F = 0$
 i.e., No motion of the body.
b) The forces tend to rotate the body about the mid-point between two forces,
 Moment of force = Fr

20. Turning effect will be maximum as the free end of the of the tree has maximum distance from the fixed point, i.e., the tree.

21.



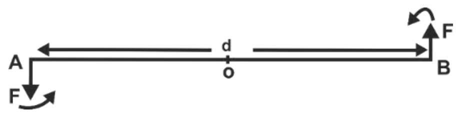
At A and B, two equal and opposite forces each of magnitude F are applied. The two forces rotate the bar in anticlockwise.

22. Two equal and opposite parallel forces not acting along the same line, form a couple. A couple is always needed to produce the rotation.

Examples:

i) Turning a water tap
ii) Tightening the cap of a bottle
ii) Turning a steering wheel

23.



AB is a bar which is pivoted at a point O. At the end A and B, two equal and opposite forces, each of magnitude F, are applied. The two forces rotate the bar in anticlockwise direction. The perpendicular distance between these two forces is AB which is called the couple arm.

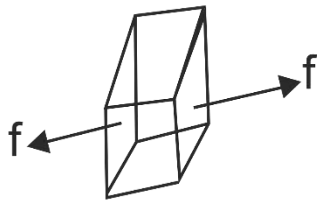
Moment of force F at the end A
= F × OA (anticlockwise)
Moment of force F at the end B
= F × OB (anticlockwise)

Total moment of couple = F × OA + F × OB
= F (OA + OB) = F×AB
= F × d (anticlockwise)
= Either force × perpendicular distance between the two forces (or couple arm)
∴ Moment of couple = Force × Couple arm

24. When a number of forces acting on a body produce no change in its state of rest or of linear or rotational motion, the body is said to be in equilibrium.

25.

a) When a body remains in the state of rest under the influence of the applied forces, the body is in static equilibrium.
For example, a book lying on a table is in static equilibrium.



(A body is in static equilibrium)

b) When a body remains in the same state of motion (translational or rotational), under the influence of the several applied forces, the body is said to be in dynamic equilibrium.
Example: An Airplane moves at a constant height when upward lift on it balances its weight downwards.

26. Two conditions must be satisfied for a baby body to be in equilibrium.

i) The resultant of all the forces acting on the body should be equal to zero.
ii) The sum of the anticlockwise moments of the axis of rotation must be equal to the sum of the clockwise moments about the same axis.

27. The blades of a running fan and the motion of a potter's wheel.

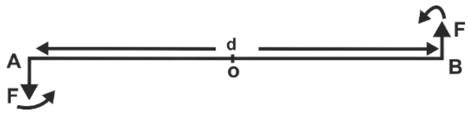
28. Wheels of a moving vehicle have both these motions.

29.

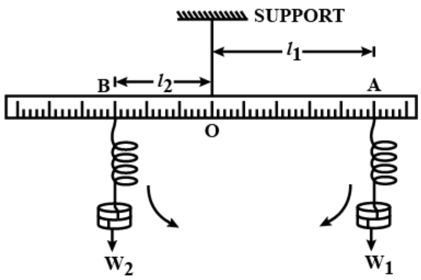
i) Opening or closing of a water tap
ii) Tightening the cap of a bottle
iii) Turning the key in a lock
iv) Steering wheel of motor car
v) Driving the pedal of a bicycle

30. The perpendicular distance between two equal and unlike forces acting on a rigid body such that the body turns around a fixed point is called arm of couple or couple arm.

31. The required diagram is shown below.



32. Verification of the principle of moments:
Suspend a metre rule horizontally from a fixed support by mean of a strong thread at 'O' as shown in the figure.
Now suspend two spring balances A and B on the metre rule with some slotted weights W_1 and W_2 on them on either side of the thread. The metre rule may tilt to one side. Now adjust either the slotted weighs on the spring balances or the position of the spring balance on either side thread in such a way that the metre rule again becomes horizontal.



(Verification of principle moments)

Let the weight suspended on the right side of suspended spring balance A be W_1 at a distance OA = L_1 while the weight suspended on the left side of the thread from the spring balance B be W_2 at a distance OB = L_2.
The weight W_1 tend to turn the metre rule clockwise, while the weight W_2 tend to turn the metre rule anticlockwise.

Clockwise moment of weight W_1 about the point O = $W_1 \times L_1$.
Anticlockwise moment of weight W_2 about the point O = $W_2 \times L_2$.

In equilibrium, when the metre rule is horizontal, it is found that $W_1L_1 = W_2L_2$
Example: clockwise moment = anticlockwise moment
This verifies the principle of moments.

33. The centre of gravity (CG) of a body is the point at which the body can be balanced, regardless of its orientation. It is the average location of the weight of the body, or the point around which the body's mass is evenly distributed. The centre of gravity is an important concept in mechanics and engineering, as it determines the stability and balance of a body.

34. The centre of gravity of a body is the point through which the whole weight of the body acts irrespective of its position.

35. Not necessary, the centre of gravity of a ring lies at its centre where there is no material.

36. The position of the centre of gravity of a body of given mass depends on its shape i.e., on the distribution of mass in it.
Example: The centre of gravity of a given wire is at the middle of its length. But if the same wire is bent into the form of a circle, its centre of gravity will then be at the centre of the circle.

37.
a) At the point of intersection of its diagonal.
b) At the midpoint on the axis of cylinder.

38.
a) At the point of intersection of its medians
b) At the centre of circular lamina

39. The center of gravity of a uniform ring is located at its geometrical center. This is because a uniform ring has a symmetrical distribution of mass, which means that each part of the ring has an equal contribution to its total weight.

40.
a) True
Explanation: The position of the centre of gravity (also known as the centre of mass) of a body remains unchanged as long as the body is in a state of equilibrium, even if the body is deformed. This is because the centre of gravity is a property of a body that is determined by the distribution of

mass within the body, and the position of the centre of gravity is independent of the shape or size of the body.

For example, if you take a long, thin rod and bend it into a circular shape, the position of the centre of gravity will not change. Similarly, if you take a block of wood and cut it into a different shape, the position of the centre of gravity will not change as long as the total mass of the body remains the same.

However, if you add or remove mass from a body, the position of the centre of gravity will change. For example, if you attach a weight to one end of a rod, the centre of gravity will shift towards the weight.

b) True
Explanation: The centre of gravity of a freely suspended body is the point at which the body's weight is evenly distributed.

When a body is suspended, the force of gravity is pulling it downward, and the point of suspension is supporting it by applying an equal and opposite force (called the reaction force) in the opposite direction.

If the body is symmetrical and has a uniform mass distribution, the centre of gravity will be directly below the point of suspension. This is because the forces acting on the body will be balanced, and the body will be in equilibrium.

41. Uniform circular motion refers to the motion of an object moving in a circle at a constant speed. This means that the object's velocity, or the rate at which it is moving, is not changing as it travels in a circular path.

An example of uniform circular motion is the motion of the earth around the sun. The earth's speed as it orbits the sun is constant, and the force of gravity provided by the sun keeps the earth moving in a circular path around it.

42. Motion of a cyclist on a circular track is an example of motion in which speed remains uniform, but the velocity changes.

43. Yes, it is possible to have an accelerated motion with a constant speed. This type of motion is called uniform acceleration.

Uniform acceleration is defined as a change in velocity that occurs at a constant rate over a given time period. This means that the speed of an object remains constant while the object's velocity (which includes both the speed and direction of motion) changes.

For example, consider a car traveling at a constant speed of 60 miles per hour (mph) on a straight road. If the car's speed increases to 80 mph over a period of 20 seconds, it is experiencing uniform acceleration. The car's speed remains constant at 60 mph during this time, but its velocity increases because it is moving faster in the same direction.

44. A **uniform linear motion** is a motion in which an object moves in a straight line at a constant speed. In other words, the object's position changes by the same amount over a given time period, regardless of its starting position. This type of motion is often referred to as rectilinear motion.

On the other hand, a **uniform circular motion** is a motion in which an object moves in a circular path at a constant speed. In this case, the object's position is constantly changing, as it moves around the circumference of the circle. The object's speed is constant, but its velocity (which is a vector quantity that includes both speed and direction) is constantly changing, as it moves in different directions around the circle.

45. Centripetal force is required for circular motion. It is always directed towards the centre of circle.

46. Force acting on a body which is in circular motion is called centripetal force. It acts towards the centre of circular path.

47. A force acting on a body away from the centre of circular path is called the centrifugal force.

Centrifugal force is in a direction opposite to the direction of centripetal force. Its magnitude is same as that of the centripetal force.

48. Centrifugal force is a fictitious force that is often used to describe the behaviour of objects moving in a circular path. It is not a real force in the sense that it is not a fundamental force of nature like gravity or electromagnetism. Instead, it is a mathematical construct that is used to describe the effects of an object moving in a circular path and is often used to make calculations and predictions about the motion of objects in circular motion.

49. A planet moves around the sun in a nearly circular path for which the gravitational force of attraction on the planet by the sun provides the necessary centripetal force required for circular motion.

50.

a) False
b) True
c) True
d) False

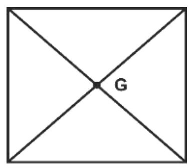
51.

Centripetal Force	Centrifugal Force
The force that keeps an object moving with a uniform speed along a circular path is called centripetal force.	A force acting or a body away from the centre of circular path is called the centrifugal force.
At each point of circular path this force is directed towards the centre of the circle.	Centrifugal force is in a direction opposite to the direction of centripetal force.

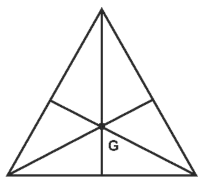
52.

Object	Position of Centre of Gravity
Rod	Mid-point of rod
Circular disc	Geometric centre
Circular ring	Centre of ring
Solid or hollow sphere	Geometric centre of the sphere
Solid or hollow cylinder	Mid-point on the axis of cylinder
Solid cone	At a height of h/4 from the base, on its axis. (h = height of cone)
Hollow cone	At a height of h/4 from the base, on its axis. (h = height of cone)
Triangular lamina or scalene triangle	The point of intersection of medians
Parallelogram, rectangular lamina, square or rhombus	The point of intersection of the diagonals.

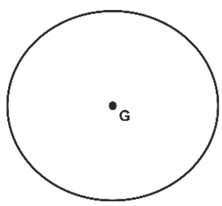
53. The position of centre of gravity is shown by the point G.



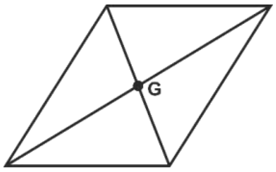
(SQUARE)



(TRIANGULAR LAMINA)



(CIRCULAR RING)



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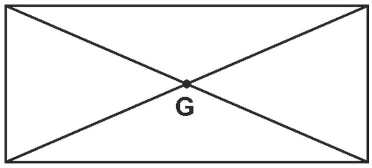

(RECTANGLE)

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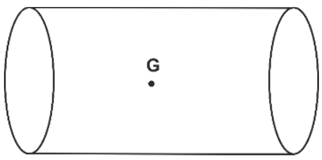


(CYLINDER)

54.

a)

i) **Positive Moments:** If the force produces anti clockwise motion in the rigid body about turning point, it is positive moment.

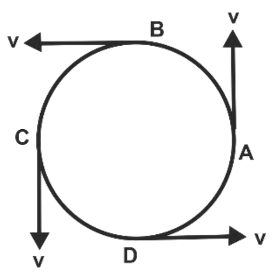
ii) **Negative Moment**: If the force produces clockwise motion in the body about turning point, it is negative moment.

b) Absolute unit moment of force in

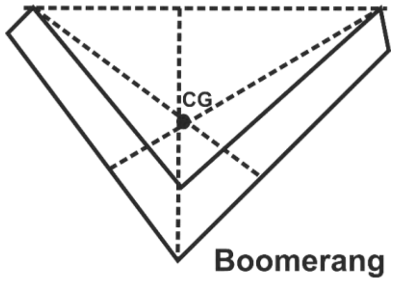
i) C.G.S. system in dyne-cm.

ii) S.I. system is newton-meter (Nm)

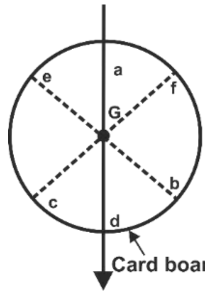
c)



55. Yes, the body with L shape or a Boomerang has its centre of gravity outside the body.



56.



(Centre of gravity of cardboard or lamina)

Make three fire holes at a, b and c near the edge of the lamina. Now suspend the given lamina along with a plumb line from the hole 'a' using a pin clamped horizontally on a retort stand. Check that the lamina is free to oscillate on the nail about the point of suspension. When lamina has come to rest, draw a straight line 'ad' along the plumb line. Repeat the procedure by suspending the lamina through the hole 'b' and then through the hole 'c' for which we get straight lines be and cf respectively. It is noticed that the lines ad, be and cf intersect each other at a common point G which is the position of centre of gravity of the lamina.

57. a) The stone is moving with uniform speed.

b) The stone is moving in a circular path at a constant speed, but its direction is constantly changing. This means that the stone is experiencing uniform acceleration, with the direction of the acceleration pointing towards the centre of the circle.

c) The force which acts on the hand is the centripetal force. It is directed towards the hand along the string.

58. Work is defined as the transfer of energy from one body or system to another, or the application of a force over a distance. Work is said to be done by a force when the force causes an object to move in the direction of the force.

For example, if you push a book across a table, the force of your push is doing work on the book, causing it to move. The work done by a force is equal to the product of the force and the displacement of the object, or W = Fd.

59. a) When force is in direction of displacement, then work done,
W = F x S
b) When force is at an angle θ to the direction of displacement, then work done. W = FS cosθ

60. Two conditions when the work, done is zero are:
i) When there is no displacement (S = 0)
ii) When the displacement is normal to the direction of the force (O = 90°)

61. a) When force is at an angle θ to the direction of displacement, then work done, W = FS cosθ.
b)
i) For zero work done, the angle between force and displacement should be 90° as cos 90° = 0. W = FS cos 90° = FS x O = 0 (zero).
ii) For maximum work done the angle between force and displacement should be 0° as cos 0°= 1. Hence, W = FS cos 0° = FS x 1 = FS

62. If the displacement of the body is in the direction of force, then work done is positive. Hence, W = F x S.
Example:
a) A porter does work on the load when he raises it up against the force of gravity. The force exerted by porter (= mg) and displacement both are in upward direction.
b) If the displacement of the body is in the direction opposite to the force, then work done is negative. Hence, W = F × S
Example: When a body moves on a surface, the frictional forces between the body and the surface is in direction opposite to the motion of the body and so the work done by the force of friction is negative.

63. Work done by the force of gravity (which provides the centripetal force) is zero as the force of gravity acting on the satellite is normal to the displacement of the satellite.

64.
a) No
Explanation: A man pushing a wall will not result in any work being done, because a wall is an object that is stationary and does not move. The man may be expending effort, but this effort will not result in any displacement of the wall or transfer of energy to the wall.

b) Yes
Explanation: A coolie standing with a box on his head for 15 minutes will result in work being done, because the coolie is supporting the weight of the box and holding it in place. This requires the coolie to exert a force on the box and to resist the force of gravity acting on the box, which results in work being done.

c) Yes
Explanation: A boy climbing up 20 stairs will result in work being done, because the boy is lifting his own body weight against the force of gravity and moving upward. This requires the boy to exert a force on his own body and to overcome the force of gravity acting on him, which results in work being done.

65.
a) C.G.S unit of work is erg or gcm^2s^2
S.I unit of work is joule or kgm^2s^2
b) 1 J = 10^7 ergs or 1 erg = 10^{-7}g

66. Rate of doing work is called power. Two mathematical expressions for power are:
i) $P = \frac{W}{t}$
ii) $P = \frac{F \, x \, S}{t} = F \, x \, \frac{s}{t} = F \, x \, v$
(Here, P – Power, W – Work done
T – Time taken, F – Force
S – Distance, V – average speed

67.

a) Absolute unit of power is watt.
b) Horsepower is unit of power used in engineering. 1 H.P. = 746 W

68.

a) Capacity of doing work is called energy. S.I. unit of energy is Joule.
b) Energy possessed by a body by virtue of its changed position or configuration is called the potential energy.

Example:

i) A stone kept at a height when, drop can break a plate of glass because of potential energy possessed by it.
ii) A stretched rubber string has the potential energy.

69. There are two kinds of potential energy
i) Gravitational potential energy and
ii) Elastic potential energy
Gravitational Potential Energy - The potential energy possesses by a body due to force of attraction of earth on it, is called its gravitational potential energy.
Elastic Potential Energy - The potential energy possessed by a body in the deformed state due to change in its configuration is called the elastic potential energy.

70. For a body placed at a height above the ground, the gravitational potential energy is measured by the amount of work done in lifting it up to that height against the force of gravity.
Let a body of mass 'm' be lifted from the ground to a vertical height 'h'. The least upward force 'F' required to lift the body (without acceleration) must be equal to the force of gravity (= mg) on the body acting vertically downwards. The work done W on the body in lifting it to a height 'h' is
W = force of gravity (mg) x displacement (h) = mgh
This work is stored in the body when it is at a height 'h' in the form of its gravitational potential energy.
Gravitational potential energy,
U = mgh

71. $\frac{2K}{v^2} = \frac{2 \times \frac{1}{2}mv^2}{v^2} = m$
Hence, the physical quantity obtained is mass and its unit are kilogram (kg).

72. The energy possessed by a body by virtue of its state of motion is called the kinetic energy. Put simply, kinetic energy of an object is the energy it has because of its motion.
Examples:

i) A collision of pool balls is an example of kinetic energy being transferred from one object to another.
ii) A bullet though of very small mass but moving with high speed and hence kinetic energy can penetrate a body.
iii) Running water of the river due to its kinetic energy can rotate a turbine to produce electricity.
iv) A shooting arrow possesses kinetic energy.
v) Blowing wind possesses K.E.
vi) A truck running at high speed possesses kinetic energy and when hits a body can damage it.

73. Because all forms of energy on earth depend directly or indirectly on the sun's energy. For example:

i) Plants use the light and heat energy of the sun to make their food.
ii) Animals and human beings depend on plants for their food.

74.

a) Potential Energy
b) Kinetic Energy
c) Potential Energy
d) Potential Energy
e) Kinetic Energy
f) Kinetic Energy

75. According to the Law (or principle) of conservation of energy, energy can neither be created nor can it be destroyed. It can only be changed from one form to another.

76. According to the law of conservation of mechanical energy, whenever there is an interchange between the potential energy and kinetic energy, the total mechanical energy (i.e., the sum of kinetic energy K and potential energy U) remains constant i.e., K + U = constant when there are no frictional forces. Mechanical energy is conserved only when there no frictional forces for a given system (i.e., between body and air). Thus, conservation of mechanical energy is strictly valid in vacuum, where friction due to air is absent.

77.

i) Motion of a simple pendulum and
ii) Motion of a freely falling body

78.

a) Potential Energy
b) Potential Energy and Kinetic Energy
c) Kinetic Energy

79. As a body is thrown vertically upwards, its velocity will decrease due to the force of gravity pulling it downward. As the velocity of the body decreases, its kinetic energy will also decrease. When the velocity of the body becomes zero at the highest point of its trajectory, its kinetic energy will also be zero.

After reaching the highest point, the body will start to fall back down towards the ground. As it falls, its velocity will increase, and its kinetic energy will also increase. This increase in kinetic energy is due to the conversion of gravitational potential energy, which the body possesses due to its position above the ground, into kinetic energy as it falls.

80.

a) Potential Energy
b) Kinetic Energy
c) Both Kinetic and Potential Energy

81. Degradation of energy refers to the loss of usable energy as it is transferred or converted from one form to another.

An example of energy degradation in daily life is the **process of driving a car**. When a car is fuelled with petrol, the chemical energy stored in the petrol is converted into mechanical energy to power the car's engine. However, not all of the energy stored in the petrol is converted into usable mechanical energy. Some of the energy is lost as heat due to friction and other inefficiencies in the engine. This loss of energy is an example of energy degradation.

82. The amount of work done on a body moving in a circular path depends on the forces acting on the body and the displacement of the body.

If *there is* a net force acting on the body that is not parallel to the displacement of the body, work is done on the body.

If *there is no* net force acting on the body, or if the net force is parallel to the displacement of the body, no work is done on the body.

83.

a) Increases
Explanation: When a spring is compressed, the spring becomes more compressed, and the spring force becomes stronger. This increase in spring force results in an increase in the potential energy stored in the spring.

b) Increases
Explanation: When a spring is stretched, the spring becomes longer, and the spring force becomes stronger. This increase in spring force also results in an increase in the potential energy stored in the spring.

c) Decreases
Explanation: When a body is taken away against the force of gravity, it is being moved against the direction of the gravitational field, which is downward. This means that the body's potential energy decreases as it is moved against the force of gravity.

d) Increases
Explanation: An air bubble in water has buoyancy, which is the upward force exerted on the bubble by the surrounding water. As the air bubble rises in water, it moves against the downward force of gravity and its potential energy increases.

84. The major changes that take place are:
Chemical energy $\rightarrow$ Heat energy $\rightarrow$ Mechanical energy

85. The kinetic energy will increase because chemical potential energy of the explosives in the shot will be converted into the kinetic energy.

86.

a) At a hydroelectric power station, the potential energy of water is changed into kinetic energy and then into electrical energy.

b) In a geothermal power plant, hydrothermal energy changes to electrical energy.

c) At a thermal power station chemical energy of coal is changed into heat energy which is further changed into electrical energy.

d) At start – Potential energy to kinetic energy
When stops – Kinetic energy to Potential energy.

87. The potential energy of a body of mass 'm' placed at a height 'h' above the earth surface can be expressed as:
Potential Energy (PE) = mgh
where 'g' is the acceleration due to gravity and is equal to 9.8 m/s^2 on the surface of the earth.
Assumptions:

i) The body is at rest.
ii) The earth is a point mass, meaning that it is a single point in space with all its mass concentrated at its centre.
iii) The gravitational force between the earth and the body is the only force acting on the body.
iv) The acceleration due to gravity is constant and does not vary with altitude or position.

88. Kinetic energy $= \frac{1}{2}$ x mass x (velocity)^2
$= \frac{1}{2}mv^2$

89. The work done by a force is given by the product of the force and the displacement of the object in the direction of the force. The displacement of the object in this case is the change in its velocity, or v - u. Therefore, the work done by the force is given by the following equation:

Work = force * (v - u)

90. The relationship between kinetic energy and momentum is given by the equation:

KE = $(p^2)/(2*m)$

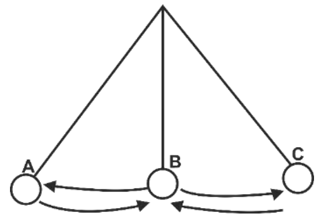
where KE is the kinetic energy, p is the momentum, and m is the mass of the object.

This equation shows that the kinetic energy of an object is directly proportional to the square of its momentum.

This means that if the momentum of an object increases, its kinetic energy will also increase.

The units of kinetic energy are typically joules (J), while the units of momentum are typically kilogram meters per second (kg*m/s).

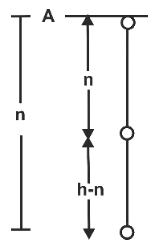
91. Diagram shows a freely oscillating pendulum.



In position A, it has maximum potential energy and zero kinetic energy.

In position B, it has zero P.E and maximum kinetic energy.
In position C, it has maximum potential energy and zero kinetic energy.
Thus, experiment clearly proves that sum of total of energy is conserved, but it can change its form.

92.



At point A
PE = mgh
KE = 0 (zero)
E = PE + KE = mgh

At point B
PE = mg (h – n)
= mgh – mgx
KE = $\frac{1}{2}mv^2$
⇒ $v^2 - u^2 = 2gn$, (u = 0)
⇒ $v^2 = 2gn$
K.E. = $\frac{1}{2}m(2gn)$ = mgn
E = P.E. + K. E
= mgh – mgn + mgn = mgh
At point C
PE = 0
KE = $\frac{1}{2}mv^2$
$v^2 - u^2 = 2gh$ (∴ u = 0)
$v^2 = 2gh$
So KE = $\frac{1}{2}m2gh = mgh$
Now E = PE + KE = 0 + mgh = mgh
At all points total energy is constant.

93.

Work	**Power**
Work done by a force is equal to the product of force and the displacement in the direction of force	Power of a source is the rate of doing work by it.
Work done does not depend on time.	Power spent depends on the time in which work is done.
S.I. unit of work is Joule (J)	S.I. unit of power is watt (W)

94.

Energy	**Power**
Energy of a body is its capacity to do work.	Power of a source is the rate at which energy is supplied by it.
Energy spent does not depend on time.	Power depends on the time in which energy is spent.
S.I. unit of energy is joule (J).	S.I. unit of power is watt (W).

95.

Potential Energy	**Kinetic Energy**
It is the energy possessed by a body due to its changed position or configuration.	It is the energy possessed by a body due to its state of motion.
It is equal to the work done in bringing the body to its changed state.	It is equal to the work that a moving body can do before coming to rest.
It can change only in form of kinetic energy.	It can change into any other form.
It does not depend on the speed of the body.	It depends on the speed of the body.

96. Tidal energy is generated by the movement of tides caused by the gravitational pull of the moon and sun. It is harnessed through the use of tidal turbines, which generate electricity as the tides move in and out.

Ocean thermal energy is generated by the temperature difference between the warmer surface waters of the ocean and the colder deep waters. It is harnessed through the use of an ocean thermal energy conversion (OTEC) system, which uses the temperature difference to power a heat engine and generate electricity.

97. Tidal energy is a form of renewable energy that is generated from the movement of tides, while geothermal energy is a form of renewable energy that is generated from the heat of the earth's interior.

98. The main differences between nuclear energy and chemical energy are:

i) Nuclear energy is produced by splitting atomic nuclei, while chemical energy is stored in the bonds between atoms.
ii) Nuclear reactions release more energy than chemical reactions.

99. A machine is a device that is designed to perform one or more tasks, often using mechanical or electrical energy. Machines can be simple, such as a lever, or complex, such as a computer. Machines can be used to perform a wide variety of tasks, including manufacturing, transportation, communication, and entertainment.

Some common examples of machines include automobiles, airplanes, computers, smartphones, and washing machines.

100.

i) A machine can multiply force, such as pulley system, lever etc.

ii) A machine can increase speed such as in levers, wheel and axle etc.

iii) A machine can change the direction of effort applied.

iv) A machine can shift the point of application to a convenient place.

101.

Ideal Machine	Practical Machine
Efficiency is 100%	Efficiency is lesser than 100%
Parts are weight less, elastic and perfectly smooth	Parts are not weightless, elastic and perfectly smooth
No loss of energy due to friction	Always some loss of energy due to friction
Work output of such a machine is equal to the work input	Work output is always less than the work input

102. (a) Simple machines are:
(1) Lever, (2) Pulley, (3) Wedge, (4) Inclined plane, (5) Wheel and axle, (6) Screw

(b) Practical examples:
(1) Lever: handle of common water pump helps in multiplying effort.
(2) Pulley: gears used for changing the direction of the effort.
(3) Wedge: Axe, Knife are the example.
(4) Inclined plane: Ramp or staircase or screw jack.
(5) Wheel and axle: Free wheel or crank of bicycle.
(6) Screw: Screw bolt

103. The formula used to calculate the resistance offered by the nut is given as follows.
$E_a \times E = L_a \times L$

From the given diagram, the data derived is as follows.
The effort required to crack the nut,
E = 50N
The effort arm, $E_a = 18 + 2 = 20$cm
$E_a = 0.2$m
The load offered by the nut, L
The load arm, $L_a = 2$cm
$L_a = 0.02$m
Now substitute these values in the above formula provided.
Thus, we get, $20 \times 50 = 2 \times L$

$\Rightarrow L = (20 \times 50) / 2 \Rightarrow L = 500$N

Therefore, the resistance offered by the nut for the effort required to crack the nut by 50 N is 500 N.

104.

a) **Total load** is the total amount of force that a machine is subjected to during operation. This includes both the useful load, which is the load that the machine is designed to handle, as well as any additional or external forces that may act on the machine.

b) **Useful load** is the load that a machine is designed to handle or support during operation. It is the load that the machine is intended to lift, move, or transmit, and it is typically measured in units of force such as kgs, pounds or newtons.

c) **Effort** is the force that is applied to a machine to operate it. It is the force that is used to lift, move, or transmit the load, and it is typically measured in units of force such as pounds or newtons.

d) An **ideal machine** is a hypothetical machine that operates with 100% efficiency and has no losses due to friction or other sources of resistance. An ideal machine is used as a benchmark against which the performance of real-world machines can be compared.

e) **Ideal mechanical advantage** is the ratio of the load that a machine can lift or transmit to the effort required to lift or transmit it.

f) **Actual mechanical advantage** is the ratio of the load that a machine can lift or transmit to the effort required to lift or transmit it, taking into account the losses due to friction and other sources of resistance.

g) **Velocity ratio** is the ratio of the speed of the effort applied to a machine to the speed of the load that the machine can lift or transmit.

h) **Efficiency** of a machine is a measure of the effectiveness of the machine in converting input energy into useful output work. It is typically expressed as a percentage, and it is calculated by dividing the useful work done by the machine by the input energy applied to the machine and multiplying the result by 100%.

105. There are several reasons why a machine cannot be 100% efficient:

i) Friction between moving parts can cause energy to be lost as heat.

ii) Thermal effects can cause materials to expand and become less efficient.

106. Suppose a machine overcomes a Load(L) by the application of an effort (E), in Time(T). Let the displacement of effort be d_E and the displacement of load be d_L

$Work\ input = effort \times displacement\ of\ effort$

= E × d_E …………………….. a)

Work output = Load × displacement of load

L × d_L ……………………. b)

By definition,

$Efficiency\ n = \frac{Work\ output}{Work\ input}$

From a) and b)

$n = \frac{L \times d_L}{E \times d_E} = \frac{L}{E} \times \frac{d_L}{d_E}$

$= \frac{L}{E} \times \frac{1}{d_E/d_L}$

But $\frac{L}{E} = M.A$ and $\frac{d_E}{d_L} = V.R$

$\therefore$ $Efficiency\ n = \frac{M.A}{V.R}$

OR

M.A = V.R × n

Thus, the mechanical advantage of a machine is equal to the product of its efficiency and velocity ratio.

107. A lever is a simple machine that is used to amplify force or movement. It consists of a rigid bar that pivots on a fixed point called a fulcrum. When a force is applied to one end of the lever, it can be used to lift a heavy object at the other end.

108. Depending upon the relative position of fulcrum, load and effort, levers are classified into three classes or three orders.

i) Lever of first order or Class I lever example - screw, a scissor, a crowbar, claw hammer and handle of common water pump.

ii) Lever of second order or Class II lever example - Nutcracker, wheelbarrow, oar of boat.

iii) Lever of third order or Class III levers example - Fire tong, Bread knife, spade used to lift coal or soil, fishing rod, the human forearm.

109. Out of Effort(E), Load(L), and fulcrum(F), the one which is in between the other two determines the order of lever.

i) If F is in between L and E – Class I Lever

ii) If L is in between F and E – Class II Lever

iii) If E is in between L and F – Class III Lever

110.

(a) $n = \frac{M.A}{V.R}$

$\therefore MA = n.V.R = \frac{60}{100} \times 4 = 2.4$

(b) M.A = $\frac{l}{E}$

$\therefore$ E = $\frac{l}{MA} = \frac{1000}{2.4}$ =416.67N

111.

a) A railway signal – lever of 1st order as F is in between load and effort.

b) A nutcracker is II order lever as load is in between effort and fulcrum.

c) Cutting a bread with knife is III order

d) A boy writing a piece of paper - III order lever as effort is in between load and fulcrum.

e) Handle of a water pump- 1st order lever as fulcrum is in between effort and load.

f) see-saw: Lever of 1st order as fulcrum is in between load and effort.

g) Forceps: III order lever as effort is in between fulcrum and load.

h) A man rowing a boat: 2nd order of lever as load is in between effort and fulcrum.

i) Lock and key: lever of II order.

j) Soda water opener: 2nd order lever as load is in between fulcrum and effort.

k) A door: II order lever as load is in between effort and fulcrum.

l) Motorcar foot break: 3rd order lever as effort is in between load and fulcrum

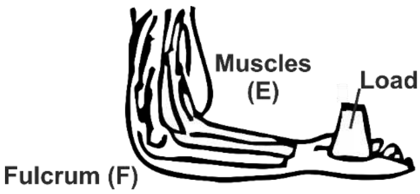
m) Fishing rod: 3rd order lever as effort is in between fulcrum and load.

n) Lemon squeezer: 2nd class lever as load is in between fulcrum and effort.

112. Mechanical advantage of third order lever is always less than 1 as effort arm is less than load arm
M.A = Effort arm/Load arm

113. Pliers are designed for gripping and cutting small, hard objects, while scissors are designed for cutting a wider range of materials. The smaller cutting edges of pliers allow them to better grip and cut small objects, while the larger cutting edges of scissors allow them to cut a wider range of materials more easily.

114.



Human arm carrying weight (Class III lever)

115. An inclined plane is a sloping surface (like ramps or bridge over the railway tracks at a railway station) that behaves like a simple machine whose M.A is always less than.

116. Inclined plane acts as machine since less effort is needed in lifting a load to a higher lever by moving over an inclined plane as compared to that in lifting the load directly.

117. Four examples of inclined plane acting as machine: (1) Ramp, (2) Railway bridge, (3) Staircase, (4) Mountainous foot path or roads.

118. The ratio between the vertical distance moved by a body the horizontal distance travelled along the inclined plane is called grade of inclination or gradient of inclined plane.
e.g. If a body rises by 10m vertically when it moves along the inclined plane by 200m or $\sin\theta = 10 / 200 = 1/20$. Then inclination grade is said to be 1 in 20.
Higher is the magnitude of gradient the more difficult is the slope to climb and vice versa.

While laying hill roads, the gradient is kept as low as possible. This helps in using lesser effort while going up the hill road.

119. a) **Gear**: A gear is a wheel with teeth around its rim or is a precise device to transfer the rotatory motion from one point to the other.
b) **Driven wheel**: A wheel which receives motion from driver wheel and is connected to the load and rotates in opposite direction to driver wheel.
c) **Gear wheel**: A gear wheel which is closer to the source of power and effort is applied to this wheel is called driving wheel.

120. If a driven wheel rotates faster than the driving wheel that is turning it, the driven wheel will have a higher speed. However, the increased speed may come at the cost of reduced load capacity, because the driven wheel will have to work harder and may be more likely to fail if it is carrying a heavy load. It is important to consider both speed and load capacity when designing mechanical systems.

121. Pulley is a flat circular dice having a groove in its edge and capable of rotating about a fixed point passing through its centre commonly called axle.

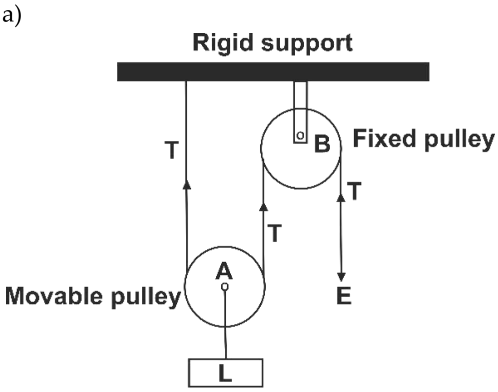
122. A pulley which has its axis of rotation fixed in a position, is called a fixed pulley. It's ideal mechanical advantage is 1 and velocity ratio is 1. This type of pulley is used for lifting a small load (such as a water bucket or a basket).

123. Despite having a mechanical advantage less than 1, the pulley is still a useful and widely used simple machine. It allows for a change in the direction of the applied force, which can be useful in a variety of situations.

For example, a pulley can be used to lift a heavy object by attaching a rope to the object and pulling down on the rope. The pulley will change the direction of the force applied to the rope, allowing the object to be lifted upward.

124. A pulley whose axis of rotation is movable (i.e., not fixed in position) is called a movable pulley. It's ideal mechanical advantage is 2. Its velocity ratio is 2. It is used as a force multiplier. The load moves in the direction of the effort.

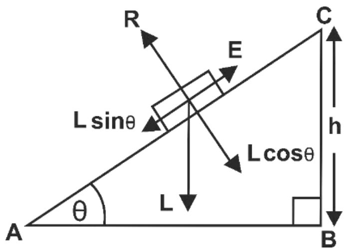
125. a)



b) To increase the mechanical advantage of the system: weight of the pulley and the string should be made negligible (as less as possible)

126. Class II Lever has a mechanical advantage always greater than 1. To increase mechanical advantage effort arm must be increased and load arm must be decreased.

127. Mechanical advantage (M.A) = $\frac{Load}{Effort}$



For inclined plane

M.A = $\frac{Load(L)}{Effort(E)} = \frac{L}{L\sin\theta} = \frac{l}{sin\theta}$

For right angled triangle ABC

Sinθ = $\frac{Perpendicular}{Hypoteneus} = \frac{l}{h}$

Hence, M.A = $\frac{l}{sin\theta} = \frac{\frac{l}{h}}{L} = \frac{L}{h}$

PART 3

1. a) When a body moves in a circular path, no work is done since the force on the body is directed towards the centre of circular path (the body is acted upon by the centripetal force), while the displacement at all instants is along the tangent to the circular path, i.e., normal to the direction of force.
b) It doesn't matter that if the object does a half rotation or completes one full rotation, the work done remains zero.

2. Power = work/time
Work = F × S
Power = F × S/t
Power = F × v where v is the velocity as it is rate of change of displacement
60000 = 20000 × v
v = 60000/20000
v = 3m/s.

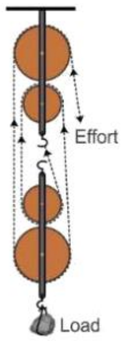
3. A hydroelectric power station takes its water from a lake whose water level is 100 m above the turbine.
Therefore, h = 50m
Overall Efficiency provided here is 80% i.e., 0.8
P.E = mgh
P.E = m × 10 × 100 = 1000 × mJ
80% of this is equal to (0.8)1000 × m
= 800 × m
Power = work/time
1 × 10^6 = 800 × m/1sec
m = 10^6/800 = 1250kg

4. When the fulcrum is situated at a location that is closer to the load, the amount of effort required to transfer the load across a shorter distance is reduced. If the fulcrum is located further away from the effort, then less effort will be required to move the load a shorter distance. Such levers are classified as Class I lever.
Example of Class I lever where mechanical advantage is
a) more than one – Shears used for cutting thin metal sheets
b) Less than one – Scissors with its blades longer than its handles

5. a) M.A = length/ height = $\frac{2}{0.8}$ = 2.5

b) Efforts = $\frac{load}{M.A} = \frac{600}{2.5}$ = 240 N

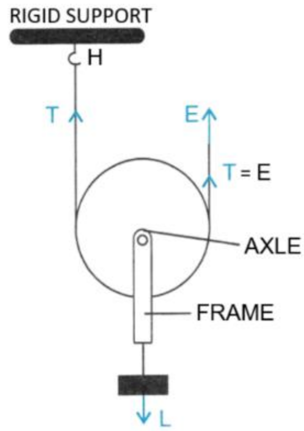
6. a)



b) As efficiency is determined by the mass of the lower block, the weight of the lower block reduces efficiency. Thus, the lower block of this pulley system should be of negligible weight.

7. a) The stone is moving with a **uniform acceleration**. Uniform acceleration refers to a change in velocity that occurs at a constant rate.
In the case of the stone being whirled by the boy in a circular path, the velocity of the stone is constantly changing as it moves in a circle. This means that the stone is experiencing uniform acceleration, also known as centripetal acceleration.
b) The force acting on the stone is the **centripetal force**, which is provided by the hand of the boy. The hand of the boy is providing the force that is causing the stone to move in a circular path. This force is directed towards the centre of the circle and is necessary to keep the stone moving in a circular path at a constant speed.

8. a) The single movable pulley functions as a force multiplier and has a mechanical advantage that is equal to 2.
b)



9. Both ice and water at 0°C have potential energy due to the chemical bonds that hold the molecules together.

However, **water at 0°C has a higher potential energy than ice at 0°C** because the molecules in water are able to move and rotate more freely than the molecules in ice, which are arranged in a fixed pattern.

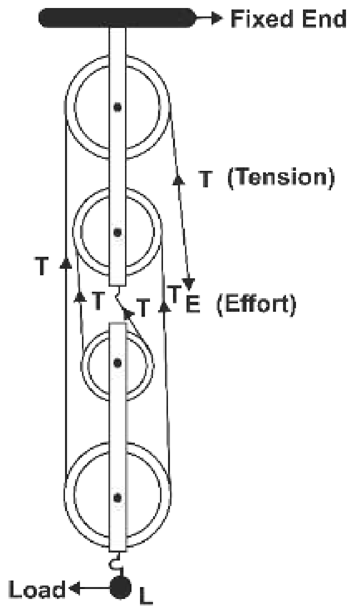
10. Let, Initial velocity = u and initial mass = m
Final velocity = v and final mass = 4 × m
K.E remains the same.
$K.E_{initial} = K.E_{final}$
$\frac{1}{2}mu^2 = \frac{1}{2}(4\times m)\, v^2$
$u^2 = 4 \times v^2$
$v^2 = \frac{u^2}{4}$
$v = \frac{u}{2}$

∴ The velocity of a body should be halved if its mass is increased by four times for the same K.E of the body.

11.
a) Work done by its weight when a body is displaced along a horizontal surface is generally considered to be zero work. This is because the force of gravity (the weight of the body) is acting perpendicular to the displacement of the body, so the dot product of the force and displacement is zero.
b) When a ball falls freely under the action of gravity, work is being done on the ball by the force of gravity. This work is negative, because the force of gravity is acting in the opposite direction of the displacement of the ball.

c) When two similar charges are brought closer to each other, they repel each other due to the electrostatic force between them. If work is done to bring the charges closer together, it is positive work, because the force is acting in the same direction as the displacement. If work is done to separate the charges, it is negative work, because the force is acting in the opposite direction of the displacement.

12. $M.A = \frac{Load}{Effort}$
$= \frac{nT}{T}$
= n = 4
Load = 4 × Effort
(n = no. of pulleys)
Here n = 4



Labelled diagram of system of pulleys

13. Power of the electric motor (P) = 150 W
Time (t) = 2 minutes 40 seconds = 160 seconds
65% of energy of the motor is useful.
$g = 10\ m/s^2$
a) We know that,
Energy (E) = Power (P) × Time (t)
Energy (E) = 150 × 160 J
Energy (E) = 24000 J
Energy (E) = 24×10^3 J
65% of energy = 65/100 × 24000 J
Useful energy = 15600 J
So, the useful work done by the motor is 15600 J.
b) Let the load be m kg.
Height (h) = 4 m
According to the question,
mgh = 15600
m × 10 × 4 = 15600
40m = 15600
m = 15600/40
m = 390
Hence, the load lifted by it through vertical hei ght of 4 m is 390 kg.

14.
a) An energy source is generally considered to be renewable if it can be replenished within a relatively short period of time, such as within a human lifetime. Renewable energy sources include solar, wind, hydroelectric, geothermal, and tidal power, as well as biofuels made from crops and other organic materials.
b) Tidal Energy:
Advantage
Predictable and reliable: Tidal energy is a predictable and reliable energy source, as the tides are driven by the gravitational pull of the Moon and the Sun, which are both very predictable and stable.

Disadvantage
High upfront costs: Tidal energy projects can be expensive to build, as they often require the construction of large infrastructure such as dams or barrages.

15. Given Force F = 100N and
velocity v = 40m/s
Power, $P = \frac{work\ done}{time}$
Also, we know, work done W = F × s where s= displacement and velocity, $v = \frac{s}{t}$
Thus, power $P = \frac{F \times s}{t} = F \times v$
P = 100 × 40 = 4000W

16. The conversion of energy that occurs:
a) A battery being charged – It converts electrical energy into chemical energy.
b) A microphone - It converts sound energy into electrical energy.

17. **Moment of Couple**: The moment of couple is the turning effect of a couple around a given point or axis. It is calculated as the product of either force or the perpendicular distance between the line of action of both the forces. The S.I unit of moment of couple is Nm.

18.

Work	Power
Work can be described as the process of transferring energy from the motion of an item to the motion of another object by applying force to the object.	Power can be thought of as the amount of energy that is transferred in a specific amount of time.
The SI unit of work is Joule (J).	The SI unit of power is Watt (W).
Work = Force × Displacement	**Power** = Work/Time
Work can also be measured in units like electron volt (eV), kWh, MWh, and GWh.	Power is also measured in units like kW, MW and GW.

19. Effort arm = 2cm
Load arm = 8.0cm
Given effort = 10kgf
i) Mechanical advantage M.A. = $\frac{Effort\ arm}{Load\ arm} = \frac{2}{8}$
= 0.25
ii) Load = M.A. × effort = 0.25 × 10 = 2.5kgf

20. a)

Uniform Circular Motion	Uniform Linear Motion
When a body moves in a circular path with uniform speed (constant speed).	When a body travels an equal distance in equal intervals of time no matter how small the intervals maybe.
It goes in a path that has been planned and is consistent direction.	The path that the motion takes is not always the same direction.
Example: A car running at a constant speed 10 km/h.	Example: A stone tied to a thread.

b) The diagram represents the forces acting on a body in circular motion. 'A' represents the force pointing towards the centre of a circle that keeps an object moving in a circular path.' B 'represents the centrifugal force i.e., the apparent force that is felt by an object moving in a circular path that acts outwardly away from the centre of rotation. Centrifugal force is fictious force.

21. Given,
Mass m = 500g = 0.5kg
Height h″ = 5cm = 0.05m
Assuming there is no loss in energy due to air friction,
a) Total energy of simple pendulum
= potential energy at its extreme position
= mgh = 0.5 × 10 × 0.05 = 0.25J
b) Kinetic energy at a mean position change in PE = change in KE
= $\frac{1}{2}mv^2$ = mgh
or v = √2gh = √2 × 10 × 0.05 = √1
= 1 ms^{-1}

22. Kilowatt hour is the commercial unit of electrical energy. It is the amount of electric work done when a power of 1000 watts is maintained in a conductor for one hour.
The Commercial unit of energy is kilowatt hour (kWh)
The SI unit of energy is joule(J)
1kWh = 1000 $\frac{J}{s}$ × 3600s
1kWh = 3.6 × 10^6J

23.
a) Different forms of kinetic energy are as follows:
i) **Translation kinetic energy**: This is the kinetic energy associated with an object moving through space. For example, a car moving down the road has translation kinetic energy.
ii) **Rotational kinetic energy**: This is the kinetic energy associated with an object rotating around an axis. For example, a spinning top has rotational kinetic energy.
iii) **Vibrational kinetic energy:** This is the kinetic energy associated with the movement of atoms or molecules within a substance. For example, a gas has vibrational kinetic energy due to the movement of its atoms or molecules.
iv) **Gravitational potential energy:** This is the kinetic energy associated with an object falling

under the influence of gravity. For example, a rock rolling down a hill has gravitational potential energy that is converted into kinetic energy as it falls.

v) **Elastic potential energy:** This is the kinetic energy stored in an object that has been deformed or stretched. For example, a rubber band has elastic potential energy when it is stretched.

b) Yes, it is possible for a body to have more than one form of kinetic energy simultaneously. Kinetic energy is the energy possessed by an object due to its motion, and it can take different forms depending on the type of motion involved.

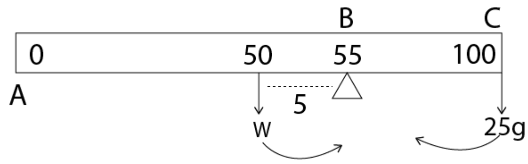
For example, consider a baseball being thrown through the air. The baseball has **translational** kinetic energy, which is the energy associated with the movement of the object from one point to another.

It also has **rotational** kinetic energy, which is the energy associated with the object's rotation about its axis of symmetry.

Additionally, the baseball may also have **vibrational** kinetic energy, which is the energy associated with the object's vibrations or oscillations. For example, if the baseball is thrown with a spin, it will experience some amount of vibration due to the spin.

24. The S.I. unit of work is the joule. 1 Joule of work is produced when a body is moved by a force of 1 N over a distance of 1 m in the force's direction.
S.I unit of work is Joule.
C.G.S unit of stork is erg.
Relation between joule and erg:
1 joule = 1N ×1m
But 1N = 10^5 dyne
And 1m = 100cm = 10^2cm
Hence, 1 joule= 10^5 dyne × 10^2cm
= 10^7 dyne × cm = 10^2 erg
Thus, 1 joule = 10^7erg

25.



As the meter scale is balanced at 55cm mark i.e. large arm is balanced by arm BC and 25g is suspended at one end i.e. at 100cm mark

∴ Anticlockwise moment= clockwise moment

w× (55 – 50) = (100 – 55) W =
25 × 45/5 = 225g

26.

a) One suitable reason for using a secondary cell, also known as a storage battery, in a solar panel system is to store excess energy that is generated during periods of high solar irradiance. This allows the energy to be used later, when the solar panel is not generating as much power, such as at night or on cloudy days. By storing excess energy in a secondary cell, the solar panel system can provide a more consistent and reliable source of power.

b) In uniform circular motion, an object moves in a circle at a constant speed. However, the direction of the object's velocity is constantly changing as it moves in the circle. This means that the object is accelerating, because acceleration is a change in velocity (speed or direction).
For example, consider a car driving around a circular track at a constant speed. The car is always turning as it goes around the track, so its direction of motion is constantly changing. This means that the car is accelerating, even though its speed is not changing.

27.

a) T The work done by a man in lifting a bucket out of a well is **positive** because he is applying a force to lift the bucket, which increases its potential energy.

b) The work done by friction on a body sliding down an inclined plane is **negative**. This is because the direction of the friction force is opposite to the displacement of the body. When a body slides down an inclined plane, it moves in the direction of the slope, and the friction force acts in the opposite direction, opposing the motion of the body.

Since work is defined as the product of force and displacement, and the force and displacement are in opposite directions in this case, the work done by friction is negative.

28. Volume of water V = 30000L
$= 30000 \times 10^{-3}\ m^3 = 30\ m^3$
Density of water $\rho = 1000$ kg m^3
Mass of water m = $\rho \times$ V
= 1000 × 30 = 30000kg
Work done W = mgh
$= 30000 \times 10 \times 45 = 1.35 \times 10^7$ J
Time t = 10min = 10 × 60 = 600s
Power p $= \frac{W}{t} = \frac{1.35 \times 10^7}{600} = 22500$W

29. i) The resulting force will be zero because two forces of equal magnitude operating on the same body at the same location but are in opposing directions.

ii) The moment of force will be F x r when two forces of equal magnitude act on a body at two different points separated by r and in opposite directions.

30. Watt (W) is a unit of power, while watt-hour (Wh) is a unit of energy. Power is the rate at which energy is generated or consumed, and it is typically measured in watts. Energy is the capacity to do work, and it is typically measured in watt-hours.
For example, a light bulb that consumes 100 watts of power will use 100 watt-hours of energy in one hour. If the light bulb is turned on for two hours, it will use 200 watt-hours of energy.

31.

a) Since it is in a compressed condition, the spring possesses elastic potential energy.

b) The spring stores potential energy, which is transformed into kinetic energy upon release. When the ball is released, its potential energy is converted into kinetic energy by the force of motion, and the ball flies away.

32. The velocity ratio of a single fixed pulley is 1, meaning that the force applied to one end of the rope is transmitted to the other end of the rope at the same velocity.

Friction in the pulley bearing can slightly reduce the velocity ratio if it is significant enough, but this is generally not the case.

33. **Step 1**
Let mass of body A be m_1 and mass of body B be m_2
Step 2
Given, Ratio of the mass of the body = 5:1
Ratio of the Kinetic energy of the body
= 125:9
Step 3
Since, K.E $= \frac{1}{2} mv^2$
Therefore, ratio of kinetic energy
$\frac{K.E_1}{K.E_2} = \frac{m_1 v_1^1}{m_2 v_2^2}$
Step 4
Then ratio of velocity
$\frac{v_1}{v_2} = \sqrt{\frac{K.E_1 \times m_2}{K.E_2 \times m_1}}$
$\frac{v_1}{v_2} = \sqrt{\frac{125 \times 1}{9 \times 5}}$
$\frac{v_1}{v_2} = \sqrt{\frac{25}{9}}$
$\frac{v_1}{v_2} = \frac{5}{3}$

PART 4

1. (c) Negative work
Explanation:
If the force applied by the coolie is in the opposite direction of the displacement of the load, then the work done by the coolie is negative. This is because the angle between the force applied by the coolie and the displacement of the load is 180 degrees, which means that the force and displacement are acting in opposite directions.

2. (b) light to chemical energy
Explanation:

In green plants, CO_2 and H_2O react in presence of sun light and product obtained is glucose and O_2. So light energy from sun gets converted to chemical energy of glucose.

3. (d) Power = Force x Velocity

Explanation:

Work done = Force x displacement

Power = $\frac{Work\ done}{time}$

Power = Force x $\frac{displacement}{time}$

Power = Force x Velocity

[As $\frac{displacement}{time}$ = Velocity]

4. (b) 10^7

5. (b) Kinetic Energy

6. (d) 746 Watt

7. (d) 5:3

Explanation:

Power = $\frac{Work\ done}{Time}$

As A and B have some mass and climb to some height, their work done is same.

$P_A = \frac{W_A}{t_A}$ and $P_B = \frac{W_B}{t_B}$

$$\frac{P_A}{P_B} = \frac{W_A}{t_A} \div \frac{W_B}{t_B}$$

$$\frac{P_A}{P_B} = \frac{W_A}{t_A} \times \frac{t_B}{W_B} \quad ....[As\ W_A = W_B]$$

$$\frac{P_A}{P_B} = \frac{t_B}{t_A} = \frac{5}{3}$$

8. (b) displacement is perpendicular to the centripetal force

Explanation:

Work done = FS cos θ

As $\theta = 90^\circ$

$\Longrightarrow$ cos 90° = 0

$\therefore$ Work done = 0

9. (b) chemical to electrical energy

10. (A) (d) 20 J

Explanation:

Potential energy

P.E. = mgh

Where m = $\frac{200}{100}$ kg = 0.2 kg

g = 10 ms^{-2}, h = 10 m

$\therefore$ P.E. = mgh

= 0.2 x 10 x 10 joules = 20 J

(B) (b) 10 J

Explanation:

According to law of conservation of energy, loss in P.E. = gain in K.E.

Body falls through a height of 5 m (from 15 m to 10 m)

$\therefore$ loss in P.E. = mgh

= 0.2 x 10 x 5 = 10 J

$\therefore$ Gain in K.E. = 10 J

(C) (b) 30 J

Explanation:

Total mechanical energy of a freely falling body remains constant P.E. at height 15 m is

P.E. = mgh

= 0.2 x 10 x 15 joules = 30 joules

$\therefore$ Total mechanical energy just before striking ground is 30 J.

(D) (c) $10\sqrt{3}$

Explanation:

Total P.E. at height 15 m = 30 J

$\therefore$ Total K.E., just before striking the ground is also 30 J.

11. d) 0.5

Explanation:

Mass of water and bucket

m = 10 kg

$\therefore$ Load = mg

= 10 x 10 N = 100 N

Effort = 200 N

Mechanical advantage

(M.A.) = $\frac{Load}{Effort}$

M.A. = $\frac{100}{200} = \frac{1}{2}$ = 0.5

12. a) It changes the direction of applied effort conveniently.

13. b) 2

14. c) M.A. x E = L

Explanation:

Mechanical advantage = $\frac{Load}{Effort}$

$\therefore$ M.A. = $\frac{L}{E}$

M.A. x E = L

15. d) For a given design of a machine, even if the mechanical advantage increases, the velocity ratio remains the same

16. d) is 3

Explanation:

In a block and tackle system the velocity ratio is always equal to the number of movable pulleys.

17. b) 75 m

Explanation:

V.R. = $\frac{d_E}{d_L}$

$5 = \frac{d_E}{15}$

d_E = 75 m

Explanation:

This is the case of single movable pulley in which the distance travelled by effort is twice the distance travelled by load as load is supported by two strings.

V.R. = $\frac{d_l}{d_l}$

$= \frac{2d}{d} = 2$

18.

a) The turning effect on the body about an axis is due to the moment of force applied on the body and is equal to the product of the magnitude of the force and the perpendicular distance of the line of action of the force from the axis of rotation.

b) 1 Nm = 10^7 dyne cm

According to Board Examiners

a) Majority of the candidates were able to answer this question correctly. Some errors which were observed are as follows: - Instead of writing 'line' of action, they wrote 'point' of application. In many cases, candidates did not mention perpendicular distance. Some even mentioned displacement. - Some merely wrote turning effect and did not mention the axis of rotation or fulcrum. Instead of turning effect of force, many wrote turning effect of a body. b) Most of the candidates answered it correctly. But some made following errors: A few candidates wrote 1 N m= 10^7 erg instead of dyn-cm. Some wrote 1 J=10^7 dyn. Some related the SI and CGS unit of force, instead of relating the SI and CGS unit of moment of force.

19.

a) Centripetal force acts in a direction towards the centre of circular path whereas centrifugal force acts in a direction away from the centre of circular path.

b) No, centrifugal force is not the force of reaction of centripetal force because action and reaction do not act on the same body.

c) Magnitudes of centripetal and centrifugal forces are in the ratio 1:1.

According to Board Examiners

a) Almost all candidates answered correctly. However, some only wrote inside or outside instead of writing radially inside or radially outside the circular path.
b) Barring a few, most candidates answered this part correctly.
c) Most candidates answered this part correctly. However, a few candidates wrote vague answers. They explained centrifugal and centripetal forces but did not compare their magnitudes. Some wrote that centripetal force is greater /more than centrifugal force.

20. One kilowatt hour (kWh) is the energy spent or work done by a source of power 1 kW in 1 hour.

$1\ kWh - 3.6 \times 10^6 J$

According to Board Examiners

Most candidates could establish the relation between kW h and J. Some errors were as follows:
- Several candidates did not mention that it is the energy consumed / required; in some cases, they mentioned power.
- Some comprehended 1kW h as 1watt energy consumed in 1 hour.
- Some candidates used the concept of kilo and multiplied by 10^3 for writing the relation between kilowatt hour and joule.
- A few candidates committed errors in converting 1kW h to J, or while converting into MJ.

21. The work done by the satellite at any instant is zero because the force required (centripetal force) to go around the planet is perpendicular to the displacement at any instant of its motion.

According to Board Examiners

Most candidates answered correctly. However, some candidates could not give a satisfactory reason for their answer. The mistake which they made was common i.e., they wrote displacement as zero. Candidates overlooked the words work at any instant.

22.

a) Class III lever

b) Without increasing the length of the lever, its mechanical advantage can be increased by shifting the effort (E) towards the load (L), i.e., by increasing the effort arm.

According to Board Examiners

a) Some candidates did not identify the class of lever correctly.
b) This part of the question was not answered by most candidates. Many candidates expressed the answer learnt by rote, i.e., "By increasing effort arm". They did not pay attention to the statement without increasing the length of the lever. The following errors were also observed.
- Some candidates wrote by increasing load or by decreasing effort without realising that as load changes, effort also changes proportionately.
- A few candidates wrote - change the position of load and effort without realising that the class of lever would change.

23.

a) A dry cell in use

b) Loudspeaker

According to Board Examiners

a) Most of the candidates answered it correctly. Many candidates were confused between 'cell in use' and 'charging of a cell'. A few candidates wrote vague answers.
b) A number of candidates answered this part correctly but following errors were also observed:
- Many of them wrote microphone instead of loudspeaker.
- Some gave technically incorrect answers such as, bell instead of an electric bell.

24. Let the work done in both case be x joule.

Crane A	Crane B
$W_1 = x\ Joule$	$W_2 = x\ Joule$
$t_1 = 55\ s$	$t_2 = 2\ s$
$P_A \frac{W_1}{t_1} = \frac{x}{5} W$	$P_B \frac{W_2}{t_2} = \frac{x}{2} W$

$\therefore = \frac{P_A}{P_B} = \frac{\frac{x}{5}}{\frac{x}{2}}$ $\quad \frac{x}{5} \times \frac{2}{x} = \frac{2}{5}$

$\therefore$ Power of Crane A : Power of Crane B = 2:5

According to Board Examiners

This part was well attempted by a number of candidates. Some did not express their answers in ratio form and left it in fractional form. A few did not get the inverse proportion between power and time for same work. Some candidates wrote their answer in the form of > and < and not in ratio form.

25.

a) m = 200 g = 0.2 kg = 10 ms^{-2}, h = 5 m
$\therefore$Potential energy (U) = mgh
at position $B = 0.2 \times 10 \times 5 = 10\ J$

b) 10 J ($\because K + U = constant$)

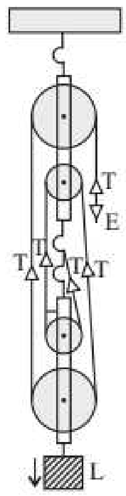
c) At position A, kinetic energy (K) = 10 J
$\frac{1}{2} mv^2 = 10$
$\Rightarrow \frac{1}{2} \times 0.2 \times v^2 = 10$
$\Rightarrow v^2 = \frac{10 \times 2}{0.2} = 100$
$\therefore v = \sqrt{100} = 10\ ms^{-1}$

According to Board Examiners

a) Several candidates did not convert mass from g to kg, hence the answer was incorrect.
b) Many candidates did not realize the principle of conservation of energy involved in the process. Some got this incorrect because of errors made in the first part. Many candidates simply wrote total mechanical energy = P.E. + K.E. but did not write the exact value.
c) Many candidates wrote the unit of acceleration instead of writing the unit of velocity. A large number of candidates could not apply the principle of conservation of mechanical energy and thus, could not arrive at the correct answer. Some wrote v^2 = 10 m/s. In this subpart, some candidates did not convert mass into the SI unit 'kg', however in the comparison of kinetic energy and potential energy, that is ½ mv^2 = m g h, as m was cancelled, they got the correct velocity, as the error got nullified.

26.

a) Diagram of a block and tackle system having velocity ratio = 4



b) If weight of movable pulley is doubled there will be no change in the velocity ratio.

According to Board Examiners

a) Following errors were observed:
– No fixed support was shown.
– Strands drawn were loose.
– Connections shown were incorrect.
– Directions of either/both load and effort were not marked.
– Rough sketches of pulleys were drawn.
b) Most candidates wrote that V.R. becomes half/double.

27.

a) Two equal and opposite parallel forces, not acting along the same line forms a couple. A couple is always needed to produce rotation.

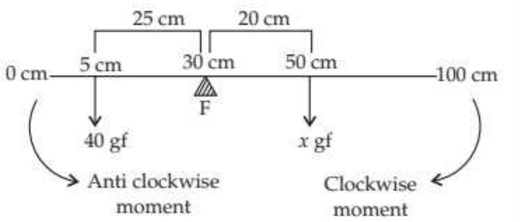
b) S.I. unit of moment of couple is Newton x metre (Nm).

According to Board Examiners

a) In many answer scripts key words/terms such as two, equal, parallel, opposite, not acting along the same line etc. were missing which made the definition incomplete or meaningless. Some of them defined moment of couple or torque instead of couple. b) Many candidates wrote the SI. unit of moment of couple correctly, but some candidates wrote joule in place of Nm or N or dyn or N/m or N m^{-1}

28.

a) Let the weight of the meter scale be x gf and it acts at the centre of gravity (i.e., 50 cm mark)



Anticlockwise moment = $40 \times 25\ gf\ cm$

Clockwise moment = $x \times 20 gf\ cm$

When the meter scale is balanced,

Clockwise moment = Anticlockwise moment

$x \times 20 = 40 \times 25$

$x = \frac{40 \times 25}{20}$ gf

= 50 gf

∴ Weight of meter scale is 50 gf.

b) F is shifted towards 0 cm.

According to Board Examiners

a) Many candidates used 100 cm in place of 50 cm for the calculation of the torque on the other side. Some candidates got confused between the unit of mass and weight that is g and gf.
b) Some candidates wrote that F is shifted towards 100 cm. They failed to understand that since the forces are same, the moment can be equalised by adjusting their torque arms.

29.

a) Class I lever
b) Pliers

30. Let mass, kinetic energy and velocity of bodies A and B be $(m_A, m_B), (k_A, k_B) and\ (v_{A,} v_B)$ respectively.

Given: $\frac{m_A}{m_B} = \frac{5}{1}$

and $\frac{k_A}{k_B} = \frac{125}{9}$

$\Rightarrow \frac{\frac{1}{2} m_A (v_A)^2}{\frac{1}{2} m_B (v_B)^2} = \frac{125}{9}$ $\quad [\because k = \frac{1}{2} mv^2]$

$\Rightarrow \frac{m_A}{m_B} \times \left(\frac{v_A}{v_B}\right)^2 = \frac{125}{9}$

$\Rightarrow \frac{5}{1} \times \left(\frac{v_A}{v_B}\right)^2 = \frac{125}{9}$

$\Rightarrow \left(\frac{v_A}{v_B}\right)^2 = \frac{125}{9} \times \frac{1}{5} = \frac{25}{9}$

$\Rightarrow \frac{v_A}{v_B} = \sqrt{\frac{25}{9}} = \frac{5}{3}$

$\therefore v_A : v_B = 5:3$

According to Board Examiners

Many candidates could not do substitution in the ratio form. Some candidates did not express the final answer in the ratio form with lowest term.

31. Given: Mass (m) = 10 kg, height (h) = 5 m, g = 10 ms^{-2}, Potential energy (U) = mgh
$= 10 \times 10 \times 51 - 500\ J$

a) According to the law of conservation of energy, the sum of kinetic energy (k) and potential energy (U) remains constant when there are no frictional forces.
∴ Total mechanical energy at height of 2 m = Initial potential energy = 500 J

b) Similarly, according to the law of conservation of energy, the kinetic energy possessed by the body just before touching the ground = 500 J

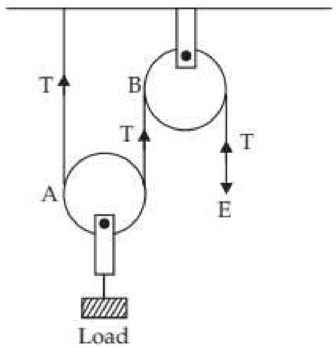
According to Board Examiners

a) A large number of candidates answered correctly. However, in some scripts the following mistakes were observed:
• For calculation of potential energy height was taken as 2 m in place of 5 m.
• Did not mention about the use of principle of conservation of energy.
• Calculated kinetic energy and potential energy separately but for finding velocity they took the

distance travelled to be 2 m in place of 3 m. They added this to get the total mechanical energy which was asked in the second part and therefore, even the second answer went incorrect.
b) Some candidates made mistakes due to improper conversion of units. i.e. mass was taken in gram in place of kg.
Some adopted the longer way by calculating the velocity at the bottom and then calculating the kinetic energy.
Some candidates calculated 200 J in subpart a), by applying the principle of conservation of energy, and stated the same answer in subpart b).
Some candidates substituted 5 metre in place of velocity and calculated kinetic energy using $\frac{1}{2}.mv^2$

32.

a) The diagram with direction of tension on each strand is shown below.



b) Velocity ratio = 2

c) E = T

d) Load is raised by a distance $\frac{x}{2}$.

According to Board Examiners

a) Most of them marked arrows correctly but some of them marked the arrows in two different directions on the two strands.
b) Majority of the candidates answered correctly. Some of them derived and obtained the answer.
c) Most of them answered it as E = T but some of them due to lack of clarity answered it as E = 2T. Some even answered using inequality.
(iv) Many candidates answered correctly as $\frac{x}{2}$ but some of them wrote it as 2x. Some wrote in terms of L. The concept that the velocity ratio depends upon the number of strands supporting the load was missing.

33.

a) The motion of a body moving with a constant speed around a circular path is accelerated due to the continuous change in its direction at each point of circular path. Hence the velocity of the body changes continuously.

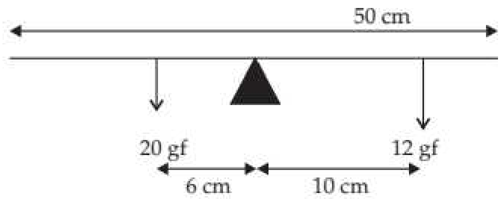
b) $\frac{2K}{v^2} = \frac{2\times\frac{1}{2}mv^2}{v^2} = m$
Hence, the physical quantity obtained is mass and its unit is kilogram (kg)/g/any unit of mass.

According to Board Examiners

a) Several candidates explained the centripetal and centrifugal forces. Some candidates diagrammatically showed that motion is tangential to the curved path but were unable to make it clear that the motion of a body moving with a constant speed around a circular path, would be accelerated. b) Most of the candidates could name the unit of physical quantity obtained by the given formula correctly, however, a few candidates were unable to name the unit.

34.

a) The force of 12 gf causes a clockwise moment.



b) Clockwise moment
= 12 × 10 gf cm = 120 gf cm
Anti-clockwise moment
= 20 × 6 = 120 gf cm
∵ Clockwise moment = Anti-clockwise moment
∴ Yes, the rod is in equilibrium.

c) If the direction of 20 gf force is reversed, it will also create a clockwise moment.
∴ Resultant moment
= (120 + 120) gf cm (clockwise)
= 240 gf cm

According to Board Examiners

a) Majority of the candidates were able to answer this question. However, some candidates were confused and wrote both 20 gf and 12 gf. b) This part of the question was attempted well by most candidates. However, some candidates arrived at the conclusion after long, elaborate, and unnecessary calculations. A few candidates guessed the answer to be either a yes or no. c) This question was performed well by most candidates.

35.

a) The load 'L' is in between effort 'E' and fulcrum 'F', so it is a class II lever.

b) If load is shifted towards the fulcrum, keeping the dimensions of the lever same, the load arm decreases,
Since, Mechanical advantage of a lever
$= \frac{Effect\ arm}{Load\ arm}$
Hence, the mechanical advantage increases.

According to Board Examiners

a) Most of the candidates wrote second class lever but a few candidates did write Class I or Class III lever. b) Majority of the candidates were unable to answer what happens to the mechanical advantage of the lever if the load is shifted towards the fulcrum without changing the dimensions of the lever. They just mentioned mechanical advantage is greater than one without realizing that the mechanical advantage of lever is already > 1 which increases further.

36.

a) The S.I. unit of power is watt (W).
If 1 joule of work is done in 1 second, the power spent is said to be 1 watt.

b) 1 H.P. = 746 W

According to Board Examiners

a) Majority of the candidates were able to answer this question. However, some candidates either did not define the unit or defined an incorrect unit. A few candidates made spelling errors while stating and defining the unit watt. b) Most candidates answered this sub-part correctly. Some candidates, however, wrote either 1 H.P. = 0.746 watt or 1 watt = 746 H.P. Some candidates were unsure about the exact value of H.P. in watt. A few candidates did not write the unit.

37.

a) Electrical energy changes to heat energy

b) Electrical energy changes to mechanical energy

According to Board Examiners

a) Some candidates stated the energy change in case of an electric iron electrical to mechanical or vice versa. A few candidates gave irrelevant answers. b) Majority of the candidates answered this sub-part correctly. However, some candidates stated the energy change in case of a ceiling fan, mechanical to wind energy instead of electrical to kinetic energy.

38.

a) The S.I. unit of work is joule (J) and C.G.S. unit is erg.
1 joule = 1 newton × 1 metre
$= 10^5$ dyne × 100 cm $= 10^7$ dyne cm
(∵ 1 dyne cm= 1 erg) $= 10^7$ erg
Or 1 J $= 10^7$erg

b) We know that,
$W = FS\cos\theta$
For maximum positive work, $\cos\theta$ should be maximum.
Maximum value of $\cos\theta = 1$
$\therefore \theta = 0°$.

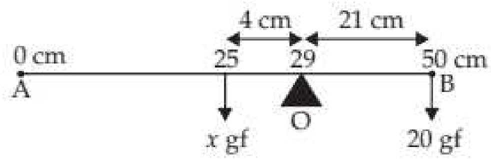
According to Board Examiners

a) Some candidates, instead of deriving the relation between S.I. and C.G.S. unit of work wrote the relation. Some candidates showed the derivation between newton and dyne. The derivations done by a few candidates were the substitution on R.H.S of equation making it meaningless. b) Several candidates wrote $\theta = 90^0$ or 180^0 or $\cos 90^0 = 1$. Some candidates identified the angle correctly but made contradictory statements like $\cos 0 = 0$.

39. A jack screw is provided with a long arm to increase the perpendicular distance of the point of application of force from the axis of rotation, so that we can apply a small force to rotate the jack to lift the heavy load.

40.

a) Let the weight of the half metre rule be x gf and it acts at the 25 cm mark (centre of gravity)



b) Anti-clockwise moment (ACWM)
$= x \times 4\ gf\ cm$
Clockwise moment (CWM)
= 20 × 21 gf cm
In equilibrium,
ACWM = CWM or
$x \times 4 = 20 \times 21$
$\therefore x = \frac{20 \times 21}{4}\ gf = 105 gf$
The weight of the half metre rule is 105 gf.

41.

a) Load to be lifted F_{load} = 50Kgf

i) Fixed pulley is used

MA for single fixed pulley = 1
Thus, effort applied by the boy F_{effort} = MAF_{load}
= 150 = 50Kgf

ii) Movable pulley is used.
MA for movable pulley = 2
Thus, effort applied by the boy F_{effort} = MAF_{load}
= 250 = 25Kgf
So, effort to be applied by the boy is less in case when he used a movable pulley because MA for a movable pulley is greater than 1.

b) In uniform linear motion, the speed and velocity are constant, and acceleration is zero, whereas in a uniform circular motion, the velocity is variable (even though speed is uniform), so, it is an accelerated motion.

c) Nuclear fission is the process by which electricity is generated from nuclear energy; nuclear energy is created by the fission of uranium atoms. In turn, this produces steam, which is then used to power a turbine generator.

42. Given: Power = $100\,kW = 100 \times 10^3$ W = 10^5 W
Force (Weight) = 50,000 N = 5×10^4N
Since, Power = Force × Average speed
$\therefore$ Average speed $= \frac{\text{Power}}{\text{Force}}$
$= \frac{10^5}{5\times10^4}\text{ms}^{-1} = \frac{10\times10^4}{5\times10^4}\text{ms}^{-1} = 2\text{ ms}^{-1}$
Therefore, at a speed of 2 ms^{-1} the motor can raise a load of 50,000 N.

43. A class II lever will always have M.A. > 1, because the load lies between the fulcrum and the effort. Hence, the effort arm is always longer than the load arm.
Since, $M.A. = \frac{Effort\ arm}{Load\ arm}$
$and\ Effort\ arm >$ Load arm
$\therefore M.A. > 1$

44. For single fixed pulley,
Load (L) = 50 kgf
Mechanical Advantage (M.A.) = 1
Since, M.A. $= \frac{Load}{Effort}$
$\therefore$ Effort (E_1) applied.
$= \frac{Load}{M.A.} = \frac{50}{1} = 50\ kgf$
For a single movable pulley,
L = 50 kgf M.A. = 2
$\therefore Efforts\ (E_2)\ applied,$
$= \frac{Load}{M.A.} = \frac{50}{2} = 25\ kgf$
Ratio of effort applied,
$E_1 : E_2 = 50 : 25 = 2 : 1$

45. Given: Velocity Ratio (V.R.) = 4
Load (L) = 175 kgf
= 175 x 10 N = 1750 N
Displacement of load (d_2) = 15 m
Effort (E) = 50 kgf = 50 x 10 N = 500 N
g = 10 N kg^{-1}.

a) $V.R. = \frac{\text{Distance moved by effort } d_E}{\text{Distance moved by load } d_L}$
$Or\ 4 = \frac{d_E}{15}$
$\therefore$ Distance moved by effort (d_E)
$= 4 \times 15\,m = 60\,m$

b) Work done by the effort
$= E \times d_E$
$= 500 \times 60\,J = 30000\,J$

c) $M.A. = \frac{L}{A} = \frac{1750}{500} = 3.5$

d) Efficiency (η) $= \frac{M.A.}{V.R.} \times 100\%$
$= \frac{3.5}{4} \times 100\% = 87.5\%$

46.

a) The stone is moving with a uniform speed.

b) Yes, the stone is moving with a uniform acceleration, acting radially inward.

c) The force which acts on the hand is the centrifugal force. Its direction is opposite to the centripetal force i.e., away from the centre.

47.

a) Weight of a boy (F_1) = 40 kgf
Distance covered (d) = $30 \times \frac{20}{100} = 6\,m$
Work done by boy (W_1) = F_1d
= 40 x 9.8 x 6 = 2352 J ($\because$ 1 kgf = g = 9.8 N)
Weight of a girl (F_2) = 30 kgf
Work done by girl (W_2) = F_2d = 30 x 9.8 x 6
= 1764 J
On comparing work done by them, we get
$\frac{W_1}{W_2} = \frac{2352\text{ J}}{1764\text{ J}} = \frac{4}{3}$

b) Time taken by a boy (t_1) = 4 min
$= 4 \times 60 = 240\ sec$
Power developed by boy (P_1)
$= \frac{W_1}{t_1} = \frac{2352}{240} = 9.8$ W
Time taken by a girl (t_2) = 3 min
$= 3 \times 60 = 180\ sec$
Power developed by girl (P_2)
$= \frac{W_2}{t_2} = \frac{1764}{180} = 9.8$ W
On comparing power developed by them, we get $\frac{P_1}{P_2} = \frac{9.8\,W}{9.8\,W} = 1:1.$

48. Velocity ratio will not change for a machine of a given design and it can be defined as the ratio of the displacement of the effort to the displacement of the load (in the same given time).

49.

a) A is a single movable pulley
B is a single fixed pulley

b) It is quite difficult to apply effort in the upward direction, if no fixed pulley B is used. The fixed pulley changes the direction of effort from upwards to downwards, making the application of the effort more convenient and easier.

c) Given, L = 20 kgf
Effort = ?
In equilibrium,
L = 2T
At C, Effort (E) = T
Effort needed = $\frac{L}{2} = \frac{20}{2} = 10$ kgf

50. Mechanical advantage (M.A.)
$= \frac{\text{Lord}}{\text{Effort}} = \frac{120}{30} = 2.4$
Efficiency (η) $- \frac{\text{M.A.}}{\text{V.R.}} \times 100\%$
Since, Velocity ratio (V.R.)
= Number of pulleys = 3
$\therefore$ Efficiency $= \frac{2.4}{3} \times 100 = 80\%$

51.

a) The position of the centre of gravity of a body depends on the distribution of mass within the body. If the mass is evenly distributed throughout the body, the centre of gravity will be located at the geometric centre of the body. If the mass is concentrated in certain areas or if there are unevenly distributed masses within the body, the centre of gravity will be located accordingly.

b) The S.I. unit of moment of force is newton metre (Nm).

52. The factors affecting the turning effects of a body are:
i) The magnitude of force applied.
ii) The perpendicular distance of the line of action of force from the axis of rotation.

53.

a) When several forces acting on a body produce no change in its state of rest or of motion, then the body is said to be in equilibrium.

b) Static

54. The motion of a planet around the sun in a circular path is due to the centripetal force which is provided by the gravitational force of attraction on the planet by the sun.

55.

a) Work done is given by the product of the force (F) and the displacement (d) in the direction of the force.
i.e., Work done = F × d

b) Work done is measured by the product of the force (F) and the component of displacement (d) in the direction of the force.
i.e., Work done = $F \times d \cos\theta$
where is the angle which the displacement makes with the direction of the force.

56.

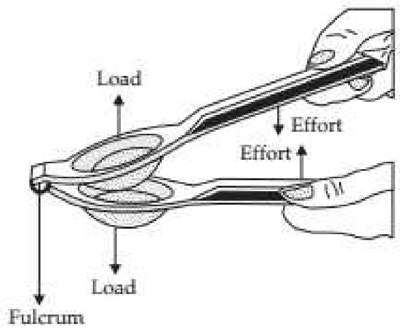
a) Chemical energy to the light and heat energy

b) Chemical to heat energy to mechanical energy

57. Force

58. Power exerted = Force × Average speed
= 150 × 10 = 1500 W

59.



60.

a) The physical quantity is power.
1 H.P. = 746 W

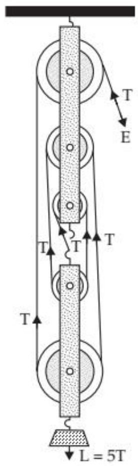
b) Given: Distance = 20 cm
$= \frac{20}{100} = 0.2\ m$
Force = 2 N
Moment of the force

= Force × Distance = 2 x 0.2 Nm = 0.4 Nm

c) Here, the fielder uses a force to oppose the motion of the ball.
Thus, $\theta = 180°$
We know, work done = force (F) × displacement (d) × cos 180°
$= -F \times d$
($\because \cos 180° = -1$)
Thus, work done is negative.

61.

a)



b) Efficiency = 75%
V.R. - 5
$Efficiency - \frac{\text{M.A.}}{V.R.}$
$Thus, \frac{75}{100} = \frac{M.A}{5}.$
Or M.A. = 3.75
Now, $M.A. \frac{\text{Load}}{\text{Effort}}$
$3.75 = \frac{Load}{150}$
Thus, Load = $3.75 \times 150 = 562.5\ kgf.$

62. The weight of a body placed at the centre of the earth is zero as
g = 0 W = mg = 0

63. Yes, it is possible to have accelerated motion with constant speed.
For example, in uniform circular motion, the magnitude of speed is constant but direction of motion changes so that acceleration is produced.

64.

a) Work is said to be done when the applied force produces displacement in the direction of the force.
Work done = Force × Displacement

b) Work done is zero by the moon, as there is no displacement since it is moving in a circular path.

65. An ideal machine works on the principle that work input = work output and has 100% efficiency as there is no energy loss.

OR

Work done by the machine = Work done on the machine.

66. Dissipation of energy

67. Let a body of mass $'m' kg$ is moving with velocity $\frac{v' m}{s}$. The initial kinetic energy is given by
$K.E_i = \frac{1}{2} mv^2$
Now, the velocity is reduced to $\frac{1}{3\text{rd}}$ of the initial velocity. The final kinetic energy is given by
$K.E_f = \frac{1}{2} m \left(\frac{v}{3}\right)^2$
$= \frac{1}{9}\left(\frac{1}{2} mv^2\right) = \frac{1}{9}\ K.E_i$
So, K.E. becomes $\frac{1}{9th}$ of its initial K.E.

68.

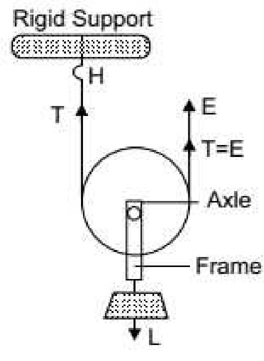
a) Loudspeaker: Electrical energy to sound energy.

b) Glowing electric bulb: Electrical energy to heat and light energy

69.

a) K.E. completely changes to P.E. (K.E. becomes zero).

b) Load, L = T + T = 2T
And Effort, E = T
Now, M.A. = $\frac{Load}{Effort}$ $\therefore M.A. = \frac{2T}{T} = 2$



70.

a) Man having a box on his head who climbs up a slope does more work against the force of gravity because he has more potential energy by virtue of his position i.e., height.
As, P.E. = Work done = F × S = mg × h

b) The two forces each of 5 N form a couple.
∴ Moment of the couple
= Either force × Perpendicular distance between the two forces
= 5 × 1 = 5 Nm (anti-clockwise)

71.

a) Centre of gravity of a uniform ring is at its centre

b) False

72.

a) Direction of centripetal force is towards the centre of the circle whereas centrifugal force is directed radially outwards.

b) As stated by the Principle of Conservation of Energy, energy cannot be created or destroyed. It's capable of changing from one form to another.

c) Potential energy

73. Work done, $W = \frac{1}{2} m (v_2^2 - v_1^2)$
$= \frac{1}{2} \times 20 (50^2 - 40^2) = 9000\ J$

74.

a) Single fixed pulley

b) Single fixed pulley is used to change the direction of effort applied.

75.

a) Ideal machine has 100% efficiency.
i.e., work done on the machine is equal to the work done by the machine while a practical machine is not 100% efficient due to the energy loss in friction etc.

b) No, it will either be acting as a speed multiplier or a force multiplier.

76. Increase in gravitational potential energy:
$= mg (h_2 - h_1) = 35 \times 10 (12 - 4)$
$= 350 \times 8 = 2800\ J$

77.

a) Class III lever

b) Class II lever

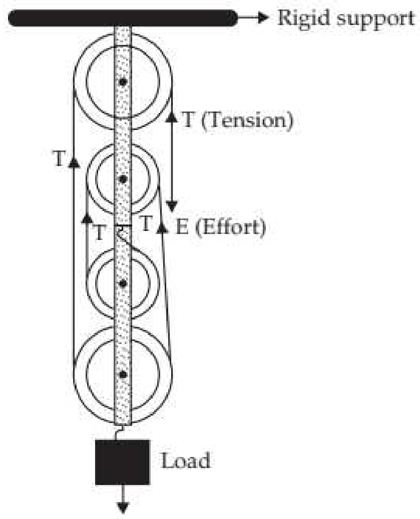
78.

a) Principle of conversation of energy: It states that energy can neither be created nor be destroyed but can be transformed from one form to another form. The total sum of energy in the universe always remains the same.

b) Potential energy

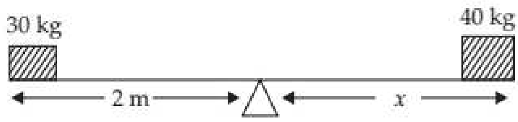
79.

a)



b) M.A. = V.A. = 4, for an ideal pulley system.

80.



By principle of moments,
$30 \times 2 = x \times 40$
Or $x = \frac{30 \times 2}{40} = 1.5\ m$
So, the other boy should sit at 1.5 m from the mean position.

81.

a) **Moment of force:** It is equal to the product of the magnitude of the force and the perpendicular distance of the line of action of force from the axis of rotation.

b) If moment of force is assigned a negative value, it means turning tendency of force is in clockwise direction.

82.

a) In uniform circular motion, speed remains constant.

b) Force required for uniform circular motion is centripetal force. It is always directed along the radius of the circular path i.e., towards the centre of the circle.

83.

a) The compressed spring possess potential energy.

b) Potential energy of the spring is imparted to the ball in the form of kinetic energy.

84. Given, Mass = 0.2 kg
Height, h = 10 m to 6 m
Loss in Potential Energy
= mg $(h_2 - h_1)$
= $0.2 \times 10 \times (10 \times 6) = 8\ J$

85.

a) **A bottle opener:** It is a class II lever. Here the load (L) is in between the effort (E) and fulcrum (F).

b) **Sugar tongs:** It is a class III lever. Here the effort (E) is in between the function (F) and the load (L).

86. Given: Weight = 400 N
W = mg
400 = m × 10
m = 40 kg
Now, Kinetic Energy
$= \frac{1}{2} mv^2$
$500 = \frac{1}{2} \times 40 \times v^2$
v = 5 m/s

87. **One Newton**: If a body of mass 1 kg moves with an acceleration of 1m/s² then force acting on the body is said to be one Newton.

88.

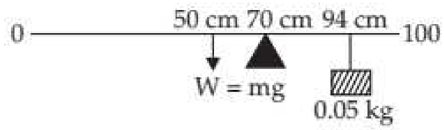
a) Circular lamina - Centre of the lamina.

b) Triangular lamina- Point of intersection of medians

89. Given,
$F_1 = 150\ N \quad l_1 = 0.4\ m$
$F_2 = 60\ N \quad l_2 = ?$
$\because$ *Force* × *Perpendicular distance*
= *Constant*
$F_1 \times l_1 = F_2 \times l_2$
or $150 \times 0.4 = 60 \times l_2$
$l_2 = 1\ m$

90.

a) Diagram of the given arrangement is shown below:



b) As the given meter scale is a uniform scale. So, its centre of gravity lies at its centre, ie., 50 cm.
Let mass of metre scale be
By principle of moments,
$m_1 x_1 = m_2 x_2$
or
$m \times (70 - 50) = 0.05 \times (94 - 70)$
$\therefore m = \frac{0.05 \times 24}{20}$
$= 0.06\ kg = 60\ g$

91.

a) Nutcracker

b) Single fixed pulley

92.

a) Class II lever,

b) We know,
$L \times L.A. = E \times E.A.$
$M.A. = \frac{L}{E} = \frac{E.A.}{L.A.} = \frac{100}{40} = 2.5$

93. Given: m= 200 g, h=5 m
When the ball reaches the ground, then
P.E. = K.E.
$\therefore K.E. = mgh = \frac{200}{1000} \times 9.8 \times 5$
$= 9.8\ joule$

94.

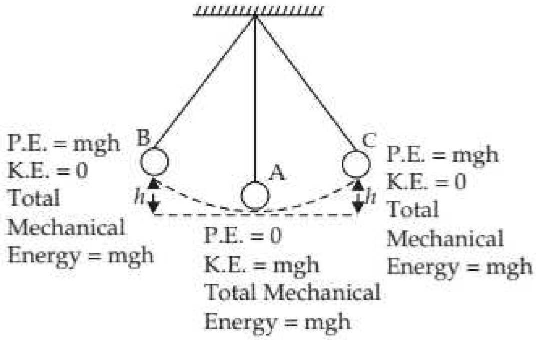
a) Ideal Machine: It is a machine in which work done on the machine is equal to the work done by the machine,

b) We know
$Efficiency\ (\eta)$
$= \frac{Mechanical\ Advantage\ (M.A.)}{\text{Velocity Ratio (V.R.)}}$
And for an ideal machine
a. $\eta = 1$
So, M.A. = V.R.

c) We know, $W = F\ d\ cos\theta$.

Since force is normal to displacement, so
$\theta = 90°$ Hence work done,
$W = Fd \cos 90° = 0$.

95.



96.

a) The momentum of a body is the product of the mass of the body and its velocity i.e., $p = mv$.

b) Force is equal to the rate of change of momentum of the body.

c) If mass of the body m remains constant, then the change in momentum of the body depends only on the change in its velocity.

97. Two conditions under which the work done is zero are:

a) when displacement = 0

b) when displacement is normal to the direction of force applied

98. Given: $m = 0.5\ kg, v = 2\ ms^{-1}$

By law of conservation of energy,

$P.E. = K.E.$

$\therefore U = \frac{1}{2}mv^2$

$= \frac{1}{2} \times 0.5 \times 2^2 = 1J$

99.

a) The mechanical advantage of a lever of the second order is always greater than one because its effort arm is always longer than the load arm i.e.,
Effort arm > Load arm.

b) Single movable pulley has a mechanical advantage greater than one.

100.

a) Given: m = 50 kg, p = 3000 kg ms^{-1}

We know that P = mv

$\therefore v = \frac{3000}{50} = 60\ ms^{-1}$

Kinetic energy of the body $= \frac{1}{2}mv^2$

$= \frac{1}{2} \times 50\ (60)^2 = 25 \times 3600 = 90000$ J

b) Velocity of the body, $v = 60\ ms^{-1}$

101.

a) Mechanical advantage of a lever
$= \frac{Effort\ arm}{Load\ arm}$

b) The efficiency of a single movable pulley system is always less than 100% because of the friction of the pulley and the weight of the pulley.

102.

a) Velocity ratio of a machine

b) Velocity ratio is defined as the ratio of the displacement of the effort to the displacement of the load.

103. The S.I. unit of energy is joule.

$1\ eV = 1.6 \times 10^{-19} J$

104.

a) Light energy to electrical energy

b) Electrical energy to magnetic energy

105. Given: $m_1 = 5\ kg,\ v_1 = 10\ m/sec.,\ m_2 = 10\ kg,\ v_2 = 5\ m/sec$

$$\frac{KE_1}{KE_2} = \frac{\frac{1}{2}m_1{v_1}^2}{\frac{1}{2}m_2{v_2}^2}$$

$$= \frac{5 \times 10^2}{10 \times 5^2} = \frac{2}{1}$$

Hence, the ratio of initial to final kinetic energy is 2:1.

106.

a) We know, W = F × d

$\Rightarrow 6.4 \times 10 = F \times 64$

$\Rightarrow F = 100$ N

b) We have, $P = \frac{W}{t}$

$\Rightarrow P = \frac{6.4 \times 10^3}{2.5}$

$\Rightarrow P = 2560$ watt

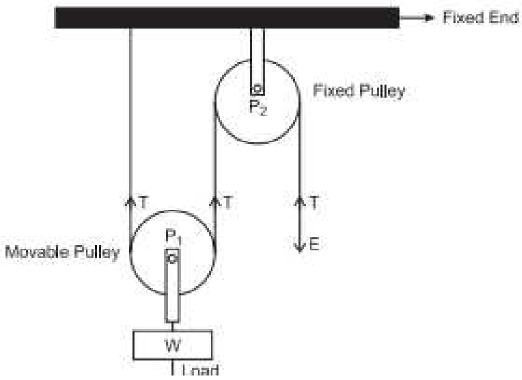
$\because$ 746 watt = 1 hp

$\Rightarrow 2560\ watt = \frac{1 \times 2560}{746}$

$P = 3.43\ hp$

107.

a)



b) Mechanical advantage of the system can be increased by reducing the friction in the pulley bearings and reducing the weight of the pulley.

108.

a) Since at point A, height is x + y and velocity = 0

$\therefore$ Total energy at A = P.E. at A+K.E. at A

= mg (x + y) + $\frac{1}{2} \times m \times 0^2$

= mg (x + y)

b) At point B, height is y and velocity = v_1

Total energy at B = P.E. at B + K.E. at B

= mg y + $\frac{1}{2} mv_1^2$

But $v_1^2 = u^2 + 2gh$

$v_1^2 = 2\ gx\ [\because u = 0\ during\ free\ fall]$

$\therefore$ Total energy at B= mg y+$\frac{1}{2}$m$\times$ 2 gx

= mg (x + y)

c) At point C, height = 0 and velocity =v_2.

Total energy at C =P.E. at C + K.E. at C

= 0 + $\frac{1}{2} mv_2^2$

But $v_2^2 = u^2 + 2gh$

$v_2^2 = 0 + 2g\ (x + y)$

$v_2^2 = 2g\ (x + y)$

$\therefore$ Total energy at $C = \frac{1}{2}\ m \times 2g(x + y)$

$= mg\ (x + y)$

d) Law of conservation of mechanical energy

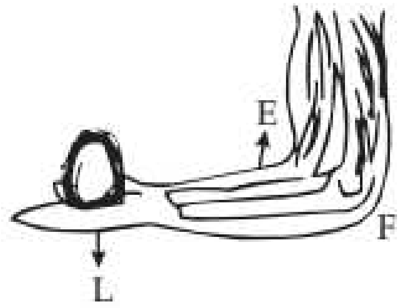
109. Stretched string of the bow possesses potential energy on account of a change in its shape. When the arrow is released, the potential energy of the bow gets converted into the kinetic energy of the arrow.

110. Energy conversion taking place in:

a) **Electric toaster**: Electrical energy to heat energy

b) **Microphone**: Sound energy to electrical energy

111. Position of Load, Fulcrum and Effort are shown below.



112. When water falls from a height, the potential energy stored changes into kinetic energy during the fall. On reaching the bottom, K.E. changes to heat energy.
So, water at the top will have slightly less temperature as compared to its bottom.

113.

a) Given: Mass of stone = 64.0 g

Initial speed = 20.0 m/sec

Initial K.E. = $\frac{1}{2}\ mv^2$

= $\frac{1}{2} \times \frac{64}{1000} \times 20^2$

= 12.8 J

According to the principle of conservation of energy, initial K.E. = P.E

at maximum height.

So, P.E. at maximum height = 12.8 joule.

b) Total energy of the body at its halfway will also be the same, because we know at every point of its path, total energy will be conserved.

So, Total energy = 12.8 joule

114. Joule: 1 joule of work is said to be done when a force of 1 N displaces a body through 1 meter in its own direction. $1\ J = 1\ N \times 1\ m$

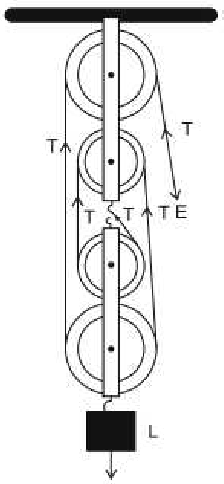
$= 10^5\ dyne \times 100\ cm$

$= 10^7\ dyne \times cm$

$1J = 10^7\ erg$

115.

a) A labelled diagram of a block and tackle system with two pulleys in each block is shown alongside. Load, effort, and tension are marked in the diagram.



b) L = 4T E = T

So, L = 4 E Or $E = \frac{L}{4}$

116. Class II levers has mechanical advantage always greater than one. To increase the mechanical advantage, length of effort arm must be increased and distance between fulcrum and load should be decreased.

117. Let the equal mass of two bodies A and B be m.

Given: height $h_1 = 20\,m$ and $h_2 = 30\,m$

(P_1) Potential energy of body

$A = mgh_1 = m \times g \times 20$

(P_2) Potential energy of body

$B = mgh_2 = m \times g \times 30$

$\therefore Ratio\ \frac{P_1}{P_2} = \frac{m \times g \times 20}{m \times g \times 30} = \frac{2}{3}$

118.

a) One kilowatt-hour is the electrical energy consumed by an electrical appliance of power 1 kilowatt when it is used for one hour. 1 kWh = 3.6 x 10^6 joule

$Work = F \times d\ cos\theta$

b) Where θ is angle between force and the displacement.

119.

a)

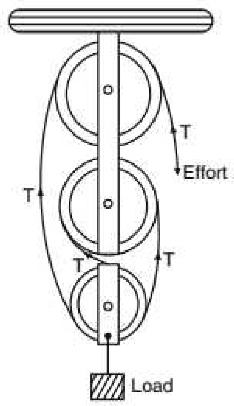
i) Light energy to chemical energy

ii) Electric energy to chemical energy

b) $Efficiency = \frac{\text{Mechanical advantage}}{Velocity\ ratio} \times 100$

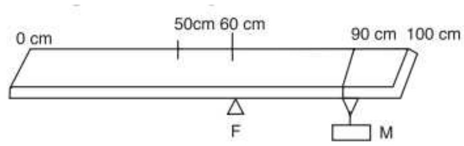
120.

a) Figure is shown below:



b) For greater efficiency

121.



Let M be load

$\therefore Load\ arm = 90 - 60 = 30\,cm$

Since weight of scale will act at centre of gravity of scale which is the midpoint of the scale.

$\therefore Effort\ arm = 60 - 50 = 10\,cm$

Let weight of scale be W

By principal of moments:

$L \times d_L = E \times d_E$

$M \times 30 = W \times 10$

$W = 3M$

Since weight of scale is three times that of M, weight of scale is greater than weight of M.

122. Amount of work done is equal to zero. Work is said to be done only when there is displacement produced. In case of a body moving in a circular path, then body comes to its original place, therefore, net displacement is zero hence work done is zero.

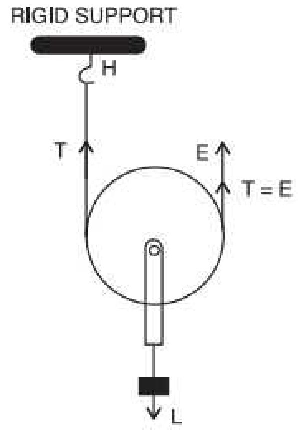
123. Given that: $m = 0.5\,kg,$

$P.E. = 1.0\,J, g = 10\frac{m}{s^2}$

$We\ know\ that\ P.E. = mgh$

$or\ \ h = \frac{P.E.}{mg} = \frac{1}{.5 \times 10} = \frac{1}{5} = 0.2\,m$

124. Single Movable Pulley



i) $V.R. = 4, \eta = 90\%$

$M.A. = V.R. \times n\%$

$= 4 \times \frac{90}{100} = 3.6$

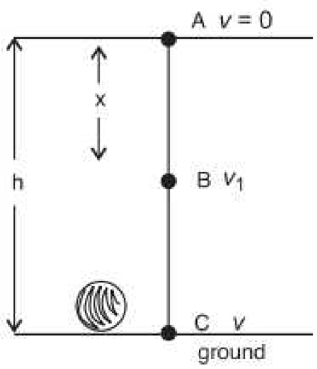
ii) $Since, \ MA. = \frac{Load}{Effort}$

$Effort = \frac{Load}{MA} = \frac{300}{3.6} = 83.33 \ N$

125. Let a body of mass *m* fall freely under gravity from height *h* above ground.

Let A, B and C be the positions of body.

Let x be the distance fallen from A to B



At position A:

K.E. = 0 (body is at rest)

and P.E. = mgh

∴ Total energy = 0 + mgh = mgh ..a)

At position B:

Let v_1 be velocity of body, then u = 0, s = x.

From equation $v^2 = u^2 + 2as$

$v_1^2 = 0 + 2gx = 2gx$

Since K.E. $= \frac{1}{2}mv^2$

$= \frac{1}{2}m \times 2gx = mgx$

And P.E. = mg (h – x)

= mgh – mgx

$\therefore Total \ energy = mgx + mgh - mgx$

= mgh ….b)

At position C:

Let velocity of body be v, then u = 0, s = h.

From equation $v^2 = u^2 + 2gs$

$v^2 = 0 + 2gh = 2gh$

Science K.E. $= \frac{1}{2}mv^2$

$= \frac{1}{2}m \times 2gh = mgh$

and P.E. = 0 (body at ground)

∴ Total energy = mgh + 0 = mgh ...c)

∴ From a), b) and c) it is clear that sum of mechanical energy remains same at any point in the path of free fall of a body.

Chapter 2 – Light

PART 1

1. b) Refraction of light

2. a) Air

3. c) 3 x 10^8m/s

4. a) Green

5. b) Cyan

6. d) 1.33

7. a) Wavelength of light

8. b) Optical centre

9. a) Red

10. a) Ultraviolet

11. d) Frequency

PART 2

I. Answer the following

1. The phenomenon due to which a ray of light deviates from its original path, while travelling from one optical medium to another optical medium is called refraction.

2. The refraction of light occurs because light travels with different speed in different media.

3. Laws of Refraction:

i) The incident ray, the normal at the point of incidence and the refracted ray are all in the same plane.

ii) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a given point of media.
This Law is known as Snell's Law.

4. Conditions of no refraction are:

i) When refractive index of both the media is same; and

ii) When the angle of incidence on the boundary of two media is zero, i.e., i = 0

5. The refractive index is the ratio between the sine of angle of incidence to the sine of angle of refraction in another optical medium. $_a\mu_g = \frac{\sin i}{\sin r}$

6. If the first medium is vacuum, the index of refraction is called absolute refractive index.

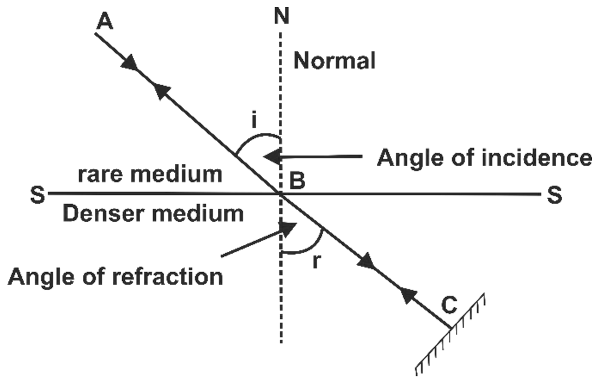
7. The refractive index of a medium depends on:

i) Nature of material

ii) Colour or wavelength of light and

iii) Temperature

8. The principle of reversibility of light states that the path of a ray of light is reversible. According to this principle, if a ray of light travels from A to C along a certain path, it will follow the same path, while travelling from C to A.



9. The perpendicular distance between incident ray and emergent ray is called **lateral displacement**.
It depends on the following factors:

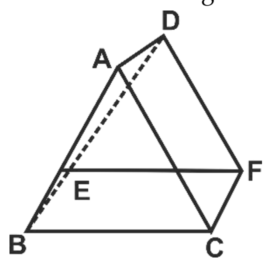
i) Thickness of medium – Increase with increase in thickness and vice versa.

ii) Angle of incidence – Increases with the increase in the angle of incidence.

iii) Refractive index of the medium.

iv) Wavelength (or colour) of light – Increases with decrease in wavelength.

10. A prism is a piece of glass or any other transparent material, bounded by two triangular and three rectangular surfaces.



When light passes through a glass prism, it is bent, or refracted, as it travels through the different mediums of the prism's material and the surrounding air. This refraction causes the light to spread out into its component colours, creating a spectrum of colours.

11. A prism can transmit rays at all angles of incidence within a certain range, but beyond that range the rays will be totally internally reflected and will not pass through the prism. Since refractive index is a pure ratio, it has no unit.

12.

a) It is *directly proportional* to thickness of optical slab.
b) It is *directly proportional* to refractive index.
c) It is *inversely proportional* to wavelength of incident light.
d) It is *directly proportional* to angle of incidence.

13. Dispersion of light refers to the phenomenon where light is separated into its component colours. This occurs because light is made up of electromagnetic waves that have different wavelengths, and each wavelength corresponds to a different colour. When light passes through a medium that has a different refractive index for different wavelengths, such as a prism, the different wavelengths of light are refracted (or bent) at different angles, resulting in the separation of the colours.

14. If an object is placed in front of a plane mirror, then the right side of the object appears to be on the left side of the image and the left side of the object appears to be on the right side of its image. This change of sides of an object and its mirror image is called *lateral inversion*.

For example, when we sit in front of a plane mirror and write with our right hand, it appears in the mirror that we are writing with the left hand.

15. Factors which determine angle of deviation are:
i) Angle of incidence
ii) Refractive index
iii) Refractive angle of prism
iv) Wavelength of incident light

16. There are two necessary conditions for total internal reflection:
i) Light must travel from a denser to a rarer medium.
ii) The angle of incidence must be greater than the critical angle.

17. When an object is placed at infinity from a concave mirror, the image formed is:
i) Real and inverted
ii) Highly diminished; and
iii) At the focus

In the case of a doctor's mirror, the lens is typically a concave (curved inward) mirror, which is used to form a virtual, inverted image of the object at infinity. The size of the image is determined by the curvature of the mirror and the distance between the mirror and the object being viewed. The position of the image depends on the distance between the mirror and the object being viewed, as well as the size and curvature of the mirror.

18. The image obtained by using a plane mirror is virtual and at a distance which is equal to the object distance.

19. A lens is a transparent optical element that is used to focus light rays to form an image. Lenses are used in a wide variety of optical instruments, such as cameras, telescopes, microscopes, and eyeglasses.

20. Lens are divided into two broad classes:
i) Convex lens or converging lens.
ii) Concave lens or diverging lens.

21.

a) **Principal Axis** – An imaginary line joining the centres of curvature of two spherical surfaces of a lens is called principal axis.
b) **Focal Plane** – A vertical plane, passing through principal focus of lens is called focal plane.
c) **Focal Length** – The distance between optical centre and principal focus of lens is called focal length.
d) **Optical Centre** – A point within the lens is situated on the principal axis, such that any ray of light passing through it, does not suffer any refraction is called optical centre.
e) **First Principal Focus** – It is a point on the principal axis of a lens, such that the rays of light, travelling parallel to principal axis, either actually meet at this point, or appear to meet at this point.
f) **Second Principal Focus** – It is a point on the principal axis of lens such that rays of light, travelling parallel to principal axis, either

actually meet at this point, or appear to meet at this point.

22.

a) Bi-Convex
b) Plano Convex
c) Concavo-Convex
d) Bi-Concave
e) Plano Concave
f) Convexo-Concave

23. The power of lens is a measure of deviation produced in the path of the rays by the lens. It is expressed in terms of the reciprocal of focal length.

a) If 'f' is the focal length in metres then
Power of lens P = $\frac{1}{focal\ length\ (in\ metre)}$

b) If focal length is expressed in centimetres,
then P = $\frac{1}{\frac{f\ (in\ cms)}{100}} = \frac{100}{f\ (in\ cms)}$

24. Lenses are used in our daily life for many purposes.

Applications of Convex Lens:

i) The simple magnifying glass or watch maker's lens is a convex lens of small focal length
ii) The objective lens of telescope, slide projector, camera, is a convex lens which gives real and inverted image of the object on the screen.

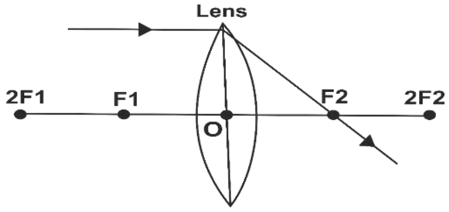
Applications of Concave Lens:

i) When our eyesight weakens, we use spectacles to see the distant objects.
ii) Combinations of concave and convex lenses are used as achromatic aberration free eye pieces for the good optical instruments such as telescopes microscopes.

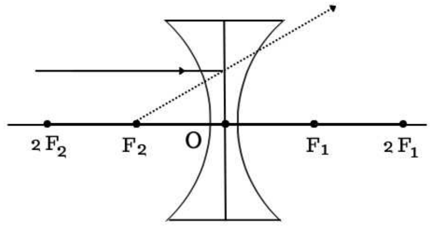
25. In periscopes, reflecting prisms are used in which the incoming light is reflected perpendicularly, and this reflected light is again reflected by another prism to get the image.

26.

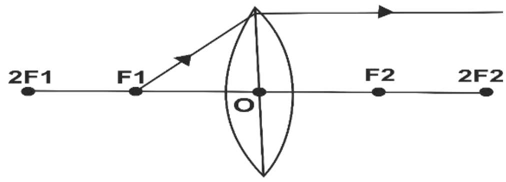
i) Any ray of light travelling parallel to principal axis after refraction through lens either passes through principal focus (second focal point F_2) or appears to pass through principal focus (second focal point F_2).



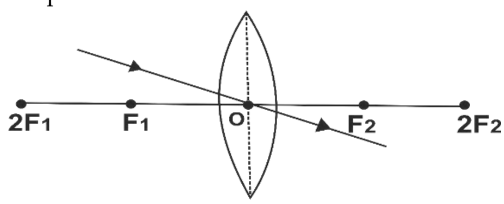
ii) In case of convex lens, it actually passes through F_2 whereas in case of concave lens it appears to pass through F_2.



iii) Any ray of light, which first passes through principal focus or comes along principal focus (first focal point F_1), after refracting through lens, always travels parallel to principal axis.



iv) Any ray of light which passes through optical centre of lens does not deviate from its path, i.e. passes on un deviated.



27.

Nature of the image	**Virtual and erect**
Size of the image as compared with the object	Diminished
Position of the image	Between optical centre and focus F_2 on the same side of the lens as the object.

28.

Nature of the image	**Virtual and erect**

Size of the image as compared with the object	Extremely diminished
Position of the image	At principal focus F_2 on the same side of lens as the object.

29.

i) Observing lines of hand by Palmist
ii) Observing wave patterns of cloth
iii) For reading the fine print
iv) Observing biological specimens

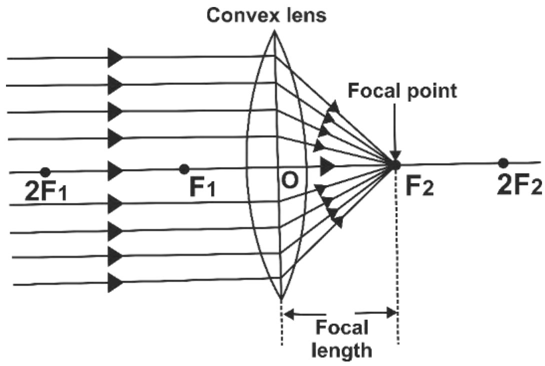
30.

Position of the Object	**Position of the Image**
At $2F_1$	At $2F_2$ on the other side of the lens.
Between focus and optical centre	On the same side of the lens and behind object
Between $2F_1$ and F_1	Beyond $2F_2$ on the other side of the lens
At focus F_1	At infinity on the other side of the lens
Beyond $2F_1$	Between F_2 and $2F_2$ on the other side of the lens
Infinity	At principal focus F_2 on the other side of the lens

Nature of the Image	**Size of the Image as Compared with the Object**
Real and inverted	Equal to that of object
Erect and virtual	Enlarged
Real and inverted	Highly enlarged
Real and inverted	Diminished
Real and inverted	Extremely Diminished

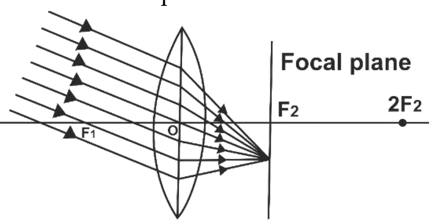
31.

a) Burning Glass



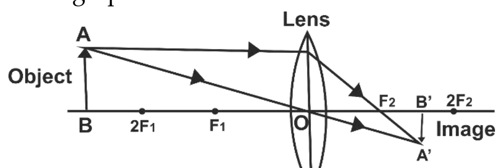
When an object is at infinity and rays are parallel to the principal axis, an image of the real, inverted and diminished to a point, is formed at F_2 on the other side of the lens. It is used as Burning Glass.

b) Astronomical Telescope



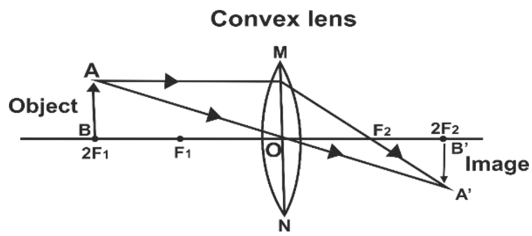
When an object is at infinity and rays are not parallel to the principal axis. The image is real, inverted, and diminished to a point. It is formed in a second focal plane on the other side of lens. It is used as eye lens for Astronomical Telescope.

c) Photographic Camera



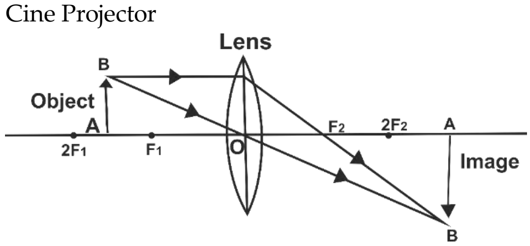
When the object is between infinity and double first principal focus (or centre of curvature) [$\propto$ and $2F_1$] image is real, inverted and diminished. It is formed between F_2 and $2F_2$ on the other side of the lens. It is used in Photographic Camera.

d) Terrestrial Telescope



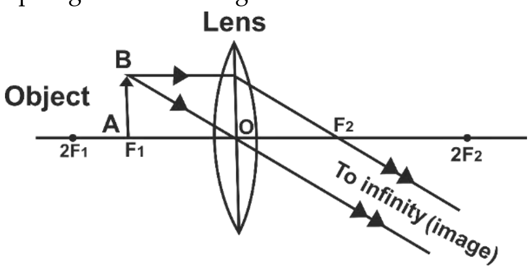
When the object is at double the first principal focus (or centre of curvature) (at $2F_1$) image is real, inverted, and same size as object. Formed at $2F_2$ on the other side of the lens. It is used as erecting lens in Terrestrial Telescope.

e) Cine Projector



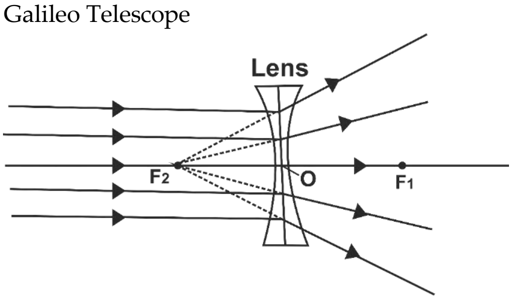
When the object is between $2F_1$ and F_1 image is real, inverted and magnified. Formed between $2F_2$ and infinity. It is used in Cine Projectors.

f) Spotlight or Search Light



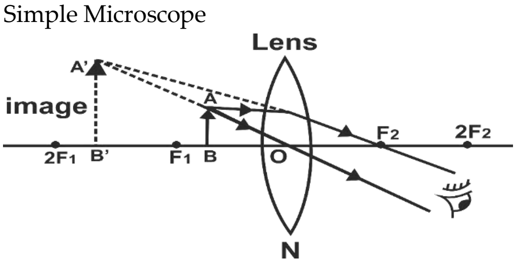
When the object is at (F_1) first principal focus image is real, inverted and enlarged. Formed at infinity. It is used in Search Light, Spotlight, etc.

g) Galileo Telescope



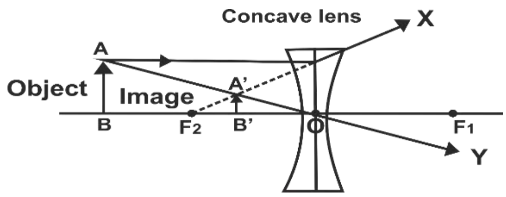
When object is at infinity image is virtual, erect and diminished to a point. It is formed at F_2 on the same side of lens. It is used as eye lens in Galileo Telescope.

h) Simple Microscope



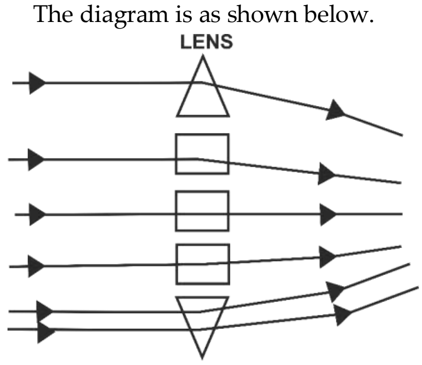
When the object is in between first principal focus and optical centre (Between F_1 and O), image is erect, virtual, and enlarged. It is formed on the same side of the lens. It is used as Simple Microscope.

i) Correcting Short Sightedness



When the object is anywhere, between the optical centre and infinity, image is erect, virtual and diminished. It is always formed between F_2 and the optical centre (o). It is used for correcting short sightedness.

32. The diagram is as shown below.



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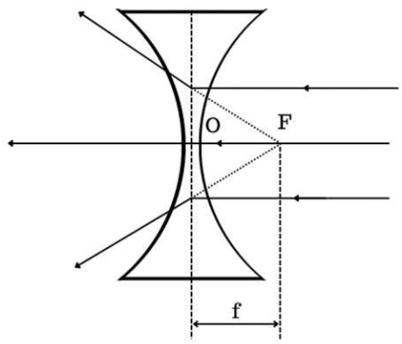
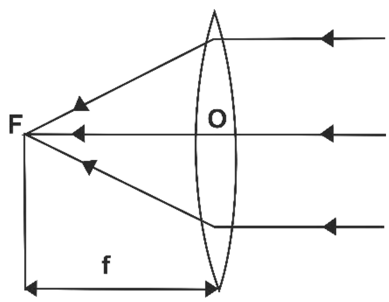
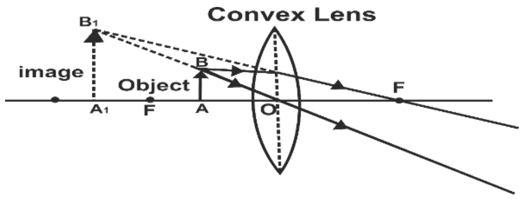




34. The image is formed on the same side as the object. It is virtual, erect and magnified.

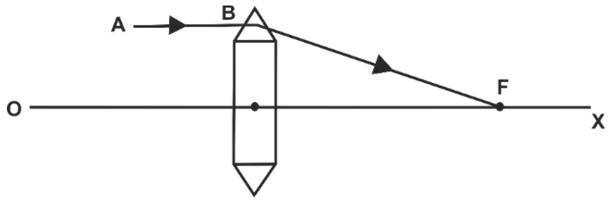


35.

a) The lens is convex.

b) The line OX is called the <u>principal axis</u> of the lens.

c)



36.

a) The lens LL′ is concave lens.

b) They are called first and second focus.

c) Between A and X the image would be formed.

d) The nature of the image is erect, virtual and diminished.

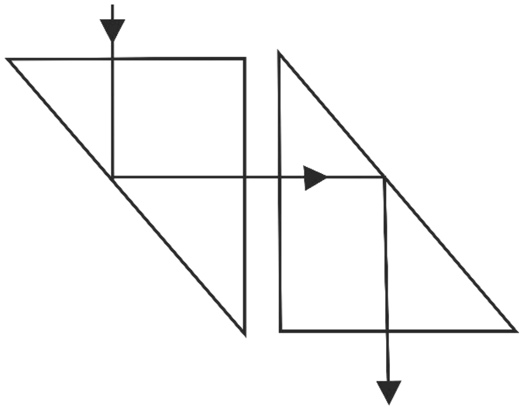
37.

Real Image	Virtual Image
Inverted.	Upright.
Obtained on a screen.	Cannot be obtained on a screen.
It is formed when the rays of light actually meet to form a focus at the image position.	It is formed when the rays of light appear to come from where the image seems to be.

38.

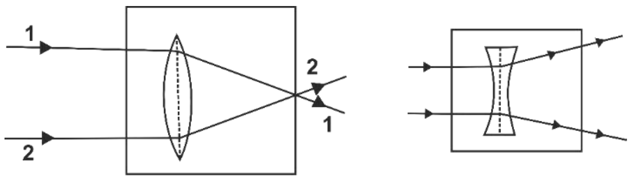
Convex Lens 	Concave Lens 
It is thick at the centre and thin at the edges.	It is thick at the edges and thin at the centre.
It forms both magnified and diminished images.	It always forms diminished images.
It forms a real and inverted image except when the object is between lens and its focus.	It always forms a virtual and erect image.

39.



40. Yes, when a concave lens is placed in the path of a converging beam, it produces a real image.

41. The ray diagrams are as follows:



(a) (b)

42. Hold the given piece of glass over some printed matter.

i. If the letters appear *magnified*, the given piece is a *convex* lens.

ii. If the letters appear *diminished*, the given piece is a *concave* lens.

iii. If the letters appear to be of the *same size*, then is it a *plane glass* piece.

43. Every part of a lens forms a complete image. If the lower part of the lens is blackened the complete image will be formed but its intensity will decrease.

44. A mirage is an optical illusion that appears to be a pool of water or other objects in the distance, when in fact it is not really there. It is caused by the refraction of light through layers of air with different temperatures. When light travels through air with a higher temperature, it slows down and bends, causing the light to appear to come from a different direction. This can cause objects in the distance to appear distorted or displaced and can create the illusion of a mirage.

45. Linear magnification of lens is defined as the ratio of size of image to the size of object.

a) $m = \frac{Size\ of\ image}{Size\ of\ object} = \frac{Image\ distance\ (v)}{Object\ distance\ (u)}$

b) $m = \frac{Size\ of\ image}{Size\ of\ Object} = \frac{Image\ distance\ (v)}{Object\ distance\ (u)}$

46. The focal length of a lens depends on the following:

i) Radii of curvature of lens surfaces.
ii) Refractive index of the material of lens.
iii) Colour of the light.

47. The object should be placed at $2F_1$ so that a real and inverted image of the same size as the object is obtained using a convex lens.

48. Infinity because the speed of light for an opaque medium is O.
i.e. $\eta = \frac{Speed\ of\ light\ in\ air}{O} = \infty$

49. It has no unit.

50. a) 1 b) 1.33

51. The refraction of light occurs because light travels with different speeds in different media.

52. One diopter is the power of a lens of focal length one metre.

53.

a) Magnifying power, $m = 1 + \frac{D}{f}$
Where, D = distance between the virtual image and optical centre, and f = focal length of the lens.

b) Convex lens

54.

i) Concave lens ii) Convex lens

55. It means that the speed of white light in glass is 1.5 times less than that in air or vacuum.

56. The angle formed between the normal and the incident ray at the point of incident is called the angle of incidence.

57. The angle between the incident ray and the emergent ray, when it passes through prism is called angle of deviation.

58. It is a piece of glass or any other transparent material, bounded by two triangular and three rectangular surfaces.

59. A concave lens produces a virtual and diminished image.

60. A convex lens produces an erect and magnified image when the object is kept between focus and optic centre.

61. Convex lens

62. Power of a lens = $\frac{1}{focal\ length\ of\ lens}$

63. Refractive index

64.

a) **Spectrum:** The band of colours seen on passing white light through a prism is called the Spectrum.

b) **Dispersion of light:** The phenomenon of splitting white light by a prism into its constituent colours is known as dispersion.

65.

a) Violet is deviated most.

b) Red is deviated the least.

66. When in the emergent beam of light different colours of the spectrum get mixed up and overlap on each other, the spectrum is said to be an impure spectrum.

67. Pure spectrum is that in which each colour is distinctly seen. Three conditions to obtain a pure spectrum are:

i) Prism should be placed in the position of minimum deviation.
ii) A narrow parallel beam of white light should be made incident on the prism.
iii) The emergent parallel beam should be focused on the screen.

68. Spectrometer.

69.

i) Speed for different colours is same in vacuum so red and blue colours have same speed in vacuum.

ii) In glass red has greater speed because of greater wavelength.

70. Dispersion of light by glass prism takes place because different colours have different speeds in a medium (glass).

71. Gamma Ray

72.

a) Infra-red

b) Ultra-violet

73.

a) Infra-red radiations

b) Ultra-violet radiations

74. Gamma rays and Infra-red radiations. Speed of A and B is same in vacuum i.e. ratio in their speed is 1:1.

75. These are related as $C = f\lambda$

76. Because the rock-salt prism does not absorb infrared radiations, whereas a glass prism absorbs them.

77.

i) The angle of prism.

ii) The angle of incidence.

iii) The refractive index of material of prism.

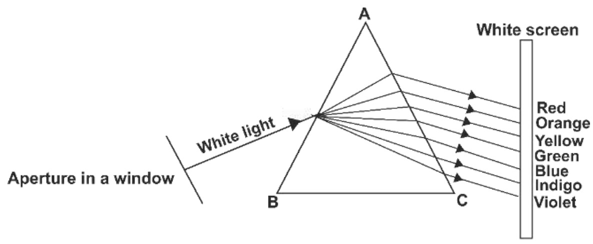
iv) The colour of incident light.

78. Deviation produced by a triangular prism depend on the colours (or wavelength) of light incident on it because different colours have different speeds in medium.

Therefore, the refractive index of glass is different for different colours of light and deviation caused by prism is different for different colours of light.

Violet is deviated the most and red is deviated the least.

79.



(Dispersion of white light through a prism)

80. Speed of light increases with increase in its wavelength.

81.

a) Red colour

b) Blue colour

82.

i) 4000 **Å** to 8000 **Å**

ii) 400 nm to 800 nm.

83.

i) 4800 **Å**

ii) 8000 **Å**

84. Green, Yellow, Orange and Red colour.

85. In glass red light has greater speed.

86.

a) Quartz

b) Rock salt

87.

a) Gamma rays,

b) Infrared rays,

c) Gamma rays and

d) X – rays

88. Visible radiations

89. Sir Isaac Newton

90. Mr. Rayleigh

91. Microwaves

92.
a) Gamma ray
b) Strong penetrating power

93.
a) Infrared
b) Ultraviolet

94.
a) Infrared radiation
b) Ultraviolet radiation

95.
a) X – rays
b) Detect fracture in bones.

96.
a) X – ray
b) 3×10^8 ms^{-1}
c) Used for the detection of fractures in bone, teeth, etc.

97.
i) Infrared
ii) Ultraviolet

98.
a) Gamma rays b) X - rays c) Ultraviolet rays d) Visible light e) Infrared waves f) Microwaves g) radio waves.

99.
i) Radioactive substances
ii) Cosmic radiations

100. Prof. J. Ritter in 1801.

101.
i) The sun is the natural source of infrared radiations.
ii) All red-hot bodies such as heated iron ball, flame, fire, etc.

102. Electronic device such as the crystal oscillators.

103.
a) The ultraviolet radiations cause health hazards like skin cancer if human body is exposed to them for a long period.
b) A high dose of infrared radiation also causes skin diseases and damages eyes.

104. They are used for satellite communication, for analysis of atomic and molecular structure, for cooking in microwave ovens and in radar communication.

105. Radio waves are the waves of longest wavelength among all the electromagnetic waves. They have wavelength above 10m (or 10^{11} **Å**) or frequency below 3×10^7 Hz. They show all the properties of the electromagnetic waves.
Uses: Used mainly in radar communication and in radio and television transmission

106. Ultraviolet radiation

107. Visible radiations and ultraviolet radiations

108.
i) They travel with the speed of light.
ii) They are not affected by electric and magnetic fields.
iii) They obey the laws of reflection and refraction.

109.
i) They travel in a straight line with a speed of 3×10^8 ms^{-1} in vacuum or air.
ii) They obey the laws of reflection and refraction.
iii) They have no charge.

110.

Colour Of Light	Colour of Roses	Colour of Leaves
Green Light	Black	Green
Red Light	Red	Black
Blue Light	Black	Black

111.
a) 8000 Å to 10^7 Å
b) 100 Å to 4000 Å

112. The wavelength of infrared rays ranges from 800 **Å** to 3×10^7 **Å**, whereas it is less than 0.1 Å for ***γ***- rays.

113. The penetrating power of infrared rays is smaller than that of ***γ*** - rays.

114. The deviation produced by glass prism is least for the red colour. The refractive index of glass is maximum for violet colour.

115. In increasing order of wavelengths, they are: ***γ*** Rays, X-Rays, Ultraviolet Rays, Infrared Radiations, Micro-waves and radio waves.

116.
a) X-rays
b) For detecting the fracture in bones

117.
a) The speed of light in air is 3×10^8 m/s but in water is 2.25×10^8 m/s, hence speed of light will decrease.
b) Red light travels fastest in any medium except air.

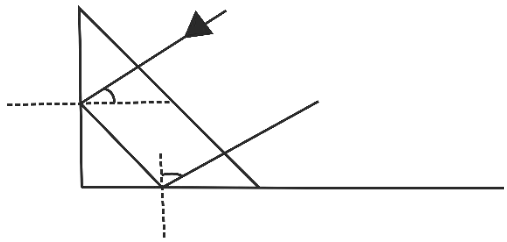
118.
a) Quartz prism
b) Infrared Rays

119.
a) Infrared radiations
b) X-Rays
c) Ultraviolet waves

120. Red colour disperses the minimum, which makes it highly visible even from far hence it is used as a sign of danger.

121.
a) The phenomenon of splitting of white light by a prism into its constituent colours is known as dispersion of light.
b) In the atmosphere red colour of light gets scattered the least as red colour has maximum wavelength.

122.
a)



b) The ray is deviated by an angle of 180^0
c) Periscope

123. The scattering of light is responsible for the blue colour of the sky.

124.
a) They can be detected easily by using a blackened bulb thermometer because of their heating effects.
b) They can be detected by the fluorescence produced on photographic plate.

125.
a) No, because the wavelength of red colour in glass is more than that of violet colour.
b) Speed of red colour will be more than that of violet colour in the glass.

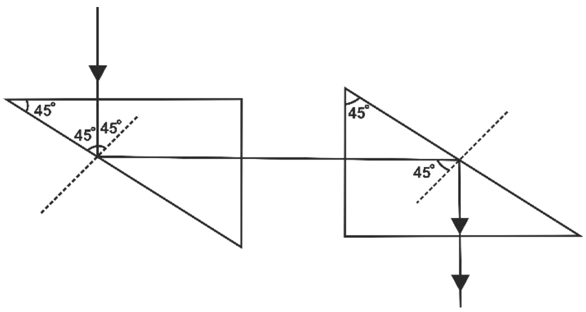
126.
a) White light is considered to be polychromatic in nature because it consists of light having several wavelengths.
b) The range visible to human beings is 4000Å to 8000Å.

127. Infrared radiations are preferred over ordinary visible light for taking photographs in fog because they are not much scattered by fog and therefore, they can penetrate appreciably through it.

128. To study the structure of crystals, we use X-rays.
Another important use of X-rays is in medical science for the detection of fracture in bones, teeth etc.

129. The speed of light in glass increases with the increase in wavelength of light.

130. Primary colours are the colours of light when mixed in equal proportions gives white light. They are red, green, and blue.



131.

a) Microwaves are used in radar to detect the presence of aircrafts of enemy during a war.

b) Ultraviolet radiations are used for detecting fake currency and diamonds.

c) Infrared radiations are used for therapeutic purposes by doctors.

132.

i) Gamma Rays: Gamma radiations are used in the cure of cancer.

ii) X-Rays: They are used for diagnostic purpose in medical science to detect bone fractures by studying X-rays photographs.

133.

a) No, the image of all the letters will not be in the same place.

b) The image of the letter V (violet) will be raised to the maximum. This is because violet light has the shortest wavelength of all the colours in the visible spectrum, and therefore it is refracted the most when it passes through the glass slab. The other colours with longer wavelengths, such as red and orange, will be refracted less and will appear closer to their original positions on the page.

134. The four regions of electromagnetic spectrum are:
i) Gamma Rays ii) X-Rays iii) UV Rays and iv) Infrared rays

135. The two extreme colours in a pure spectrum of white light are violet and red.

136. The equation is $C = f \times \lambda$

137. In daylight or in white light, when an object is seen through a red glass, it transmits only red light. This light makes the object to appear red because it reflects only red light. When the same object is seen through blue glass, the same red light reflected by the object is not transmitted through the blue-glass and the object appears black, since no light reaches our eye.

138. The extreme colours of a pure spectrum are violet at one end and red at the other end.

139.

a) Absorbs, reflects

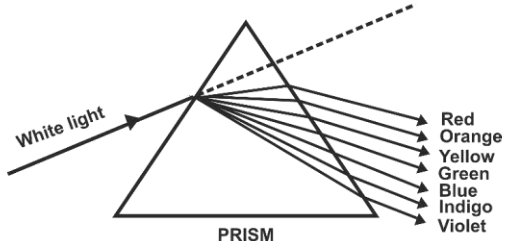
b) Green

c) White

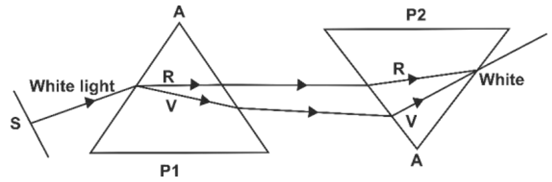
140. If a blackened bulb thermometer is moved from violet end towards the red end, first a steady rise in temperature is observed, but as the thermometer goes beyond the red end, there is rapid rise in temperature. This shows the existence of some kind of radiation producing the heating effect beyond the red end of the spectrum. If the radiations from the red end to the violet end are made to fall on the silver chloride solution, it almost remains unaffected beyond the violet end of the spectrum.

141.

a) The diagram is as shown below:



b) Colours can be combined to give the effect of white light as shown below:



142. The splitting of white light into its seven constituent colours is called dispersion of light.

143. When white light is incident on the surface of a prism, different colours are deviated by different amounts as the deviation depends upon refractive index which is different for different colours. Of these, violet is deviated the most and red is deviated the least. Thus, all the colours come out of the prism from different points.

144.

i) For UV radiations the range is 3×10^{-8} m to 4×10^{-7} m.

ii) For visible light, the range is 4×10^{-7} to 8×10^{-7} m.

145. Given V = 200 MHz
C = 3×10^8 ms^{-1}

Using C = V, we have; $\lambda = \frac{C}{V} = \frac{3 \times 10^8}{200 \times 10^6} = 1.5$m

146.

i) **Useful Effect:** Vitamin-D is formed in the human body when exposed to ultraviolet radiations. It is essential for the prevention of rickets and making bones and teeth strong.

ii) **Harmful Effect**: Overdose of ultraviolet radiations on the human body produces skin cancer. This radiation is also harmful to the eye.

147. The wavelength of the electromagnetic wave is 3×10^{-4} m. This electromagnetic wave is microwave.

148. The colours of the spectrum are violet, indigo, blue, green, yellow, orange and red. The violet colour is deviated most.

149. The colour of the object would be green.

150.

a) Yellow, Red, and Green

b) Red

151. The green shirt would appear black when it is observed in blue light (which is primary colour itself and does not contain green at all), as it cannot reflect any of this light.

II. Give reason-based questions & answers

1. The stars twinkle because they are very far away from us and the light from them has to travel through the Earth's atmosphere to reach us. The light is affected by the Earth's atmosphere, which can cause it to seem like the star is twinkling. Planets are closer to us, so their light doesn't have to travel through as much of the Earth's atmosphere, which is why they don't twinkle as much.

2. The faces of people sitting around a campfire appear to shimmer because the light from the fire is reflecting off of their skin and other objects around them. The light is flickering and moving, which causes the reflections to appear to shimmer.

3. A coin placed in a water tank appears raised because light travels through the water and bends (refracts) when it hits the coin. This makes the coin appear to be in a different position than it actually is.

4. The sun appears bigger during sunset or sunrise because it is closer to the horizon, so it appears larger in the sky. When the sun is higher in the sky, it appears smaller because it is farther away from the horizon.

5. An empty test tube placed in a beaker of water appears to have a shiny surface because light is reflecting off the water and the test tube. When light hits the water, it reflects off the surface and can also reflect off the test tube. This creates the appearance of a shiny surface.

6. Diamonds sparkle because they are made up of many tiny, flat surfaces called facets. When light hits a diamond, it reflects off of these facets and creates a sparkling effect.

7. When light is reflected off of a surface, some of it is absorbed and some of it is scattered. When light is reflected off of a totally reflecting prism, all of the light is reflected back, so none of it is absorbed or scattered. This means that the image formed by the totally reflecting prism is brighter than the image formed by ordinary reflected light.

8. A welder keeps a special kind of glass between the object to be welded and his eyes because the bright light produced by welding can be harmful to the eyes. The special glass helps to protect the welder's eyes from the bright light.

9. An object appears green when viewed through white light because the object absorbs all of the colours of light except for green, which it reflects back to our eyes. Our eyes see the green light that is reflected back to us, so the object appears green to us.

10. Infrared radiations are used for photography in fog because fog is made up of tiny water droplets that scatter light. This makes it difficult to see objects in the fog because the light is scattered in all directions. Infrared radiation is not affected by the water droplets in the same way that visible light is, so it can be used to take pictures through the fog and see objects more clearly.

11. If a green shirt is observed in blue light, the shirt will appear to be a different colour because the blue light is absorbed by the shirt and only the colours that are not absorbed are reflected back to our eyes. Since green is not absorbed by the shirt and is instead reflected back to our eyes, the shirt will appear to be a different colour when viewed in blue light.

12. When an object is viewed through a red glass, the glass absorbs all of the colours of light except for red, which is transmitted through the glass. Since the object is seen through a red filter, it appears red to us.

Similarly, when an object is viewed through a blue glass, the glass absorbs all of the colours of light except for blue, which is transmitted through the glass. Since the object is seen through a blue filter, it appears black to us because the blue light is absorbed by the object and none of the other colours are transmitted through the glass.

13.

a) Infrared radiations are absorbed by glass but not by rock-salt.

b) This is because ultraviolet radiations can pass through quartz but not through glass.

14. Scattering of light occurs when light is deflected or absorbed by particles in its path. This can happen when light travels through a medium with particles that are larger than the wavelength of the light, such as air molecules or water droplets. When light is scattered, it can change direction and become visible to an observer.

15. Quartz prisms are required for obtaining the spectrum of ultraviolet light because quartz is transparent to ultraviolet light. Other materials such as glass or plastic are not transparent to ultraviolet light and so cannot be used to produce a spectrum of ultraviolet light.

16. Danger signals are often made red because red is a highly visible colour that is easily noticed. Red is also associated with danger and caution, which makes it an effective colour to use for warning signs and signals.

17. The sky would appear black to a person seeing it from outer space, as there is no atmosphere to scatter light. When light travels through Earth's atmosphere, it is scattered by particles in the air, which is what causes the sky to appear blue.

18. The cause of dispersion of white light by a prism is the refraction of light as it passes through the different mediums of the prism. When white light enters a prism, it is refracted at different angles depending on its wavelength. This results in the different colours of the spectrum being separated, which is known as dispersion.

19. The sky appears blue on a sunny, clear day because of the scattering of light by the Earth's atmosphere. When sunlight hits the Earth's atmosphere, the short-wavelength blue light is scattered in all directions by the molecules in the air. This makes the sky appear blue to an observer on the ground.

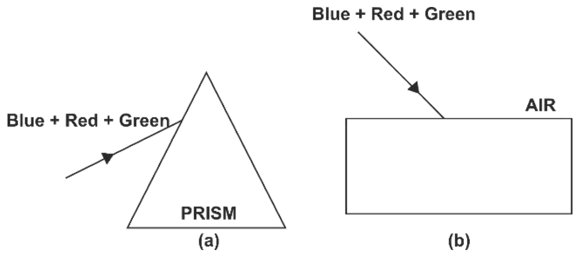
20. The sun appears reddish at sunrise and sunset because of the scattering of light by the Earth's atmosphere. When sunlight travels through a long distance through the Earth's atmosphere, the short-wavelength blue light is scattered in all directions by the molecules in the air. This leaves the longer-wavelength red light, which is less affected by scattering, to reach the observer. This is why the sun appears reddish at sunrise and sunset.

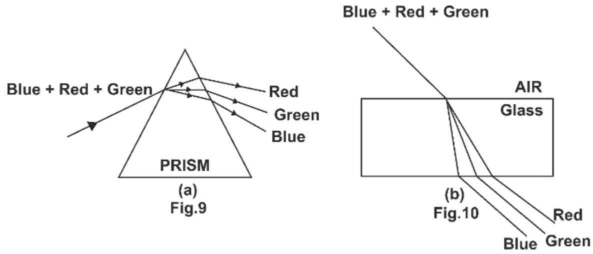
21. Infrared radiation is used as a signal during a war because it is difficult for an enemy to detect. Infrared radiation is not visible to the human eye and cannot be seen by the naked eye, so it is an effective way to communicate without being detected.

22. The sky appears white at noon because the sun is directly overhead, and the light from the sun is scattered equally in all directions by the Earth's atmosphere. This causes the sky to appear white because all the colours of the spectrum are present and are not separated by dispersion.

III. Figure based questions & answers

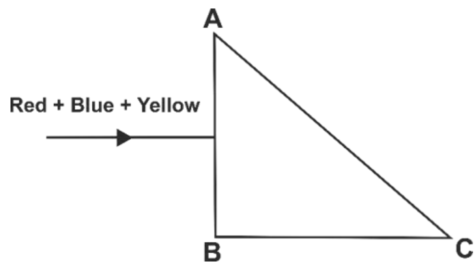
1.

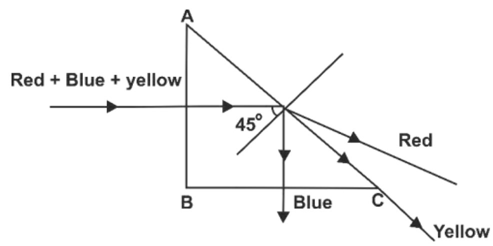




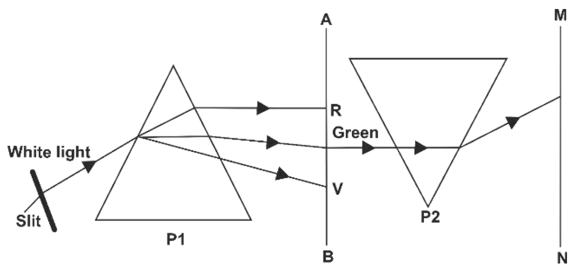
2.

(Given that the critical angle of glass-air interface for yellow colour is 45°)





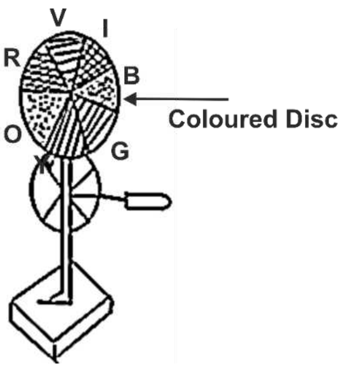
3. For this, we consider Newton's experiment which is described below:



- White light from a source is made to pass through a prism P1 which forms the spectrum VR on a white cardboard screen AB.
- A slit S is made in the cardboard to allow the light of a colour to pass through it and to fall on a second prism P2.

- The light after passing through the second prism P2 was received on the screen MN. It was found that the colour of the light obtained on the screen MN is the same as that of the light incident on second prism P2 through the slit S.
- If green light was incident on the prism P2, it was of the same green colour on passing through the second prism.
  This proves that the prism itself produces no colours.

4.



- Recombination of colours of the spectrum can be demonstrated by Newton's colour disc.
- It is a circular disc on which all the colours of the spectrum of white light are painted in proper sequence in which they occur (VIBGYOR) and in correct proportion.
- When the wheel is rotated with the help of a handle, the disc starts rotating in the vertical plane. As the speed of rotation increases, the sectors of colours are no longer separately visible and a sensation of dull white colour is produced.

5.

a)

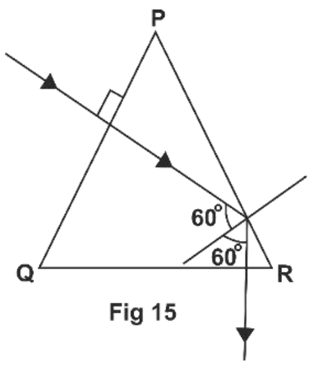
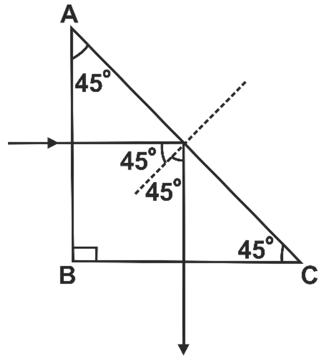


Fig 15

b) The assumption is that the critical angle of glass-air interface is less than 60° for all the colours of white light.

c) The phenomenon exhibited by light is total internal reflection.

6. At AC, angle of incidence is 45° and at BC, angle of incidence is 0°



PART 3

1. Speed of light in vacuum = 3.0×10^8 m/s

Speed of light in water = 2.25×10^8 m/s

Refractive index of water = ?

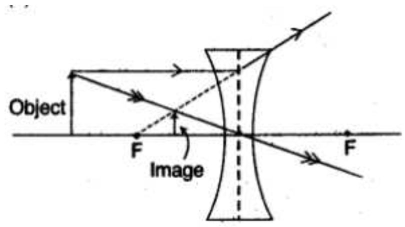
We know that,

Refractive index of water = $\frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ water}$

Refractive index of water = $\frac{3 \times 10^8}{2.25 \times 10^8}$ = 1.33

2. a) Concave lens

b)



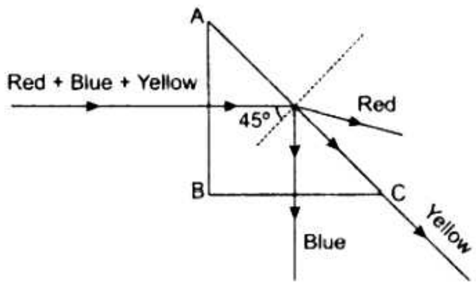
3. Scattering of light is the process by which light is deflected or scattered in different directions as it travels through a medium or encounters an obstacle or particle.

This can occur due to the interaction between light and particles in the medium, or due to the shape or structure of the obstacle or particle.

In the visible spectrum, **blue light** is scattered the most because it has a shorter wavelength than other colours of visible light. This means that it is more likely to interact with particles in the medium or obstacle, causing it to be scattered in different directions. This is why the sky appears blue, as the short wavelengths of blue light are scattered more effectively by the molecules in the Earth's atmosphere.

4. The subjective property of light related to its wavelength is **colour** whereas the subjective property of sound related to its frequency is **pitch**.

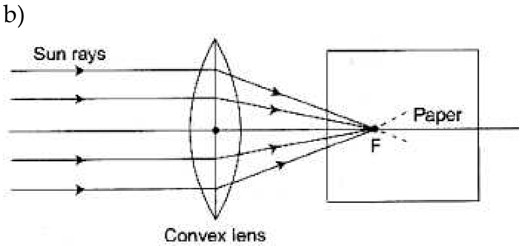
5.



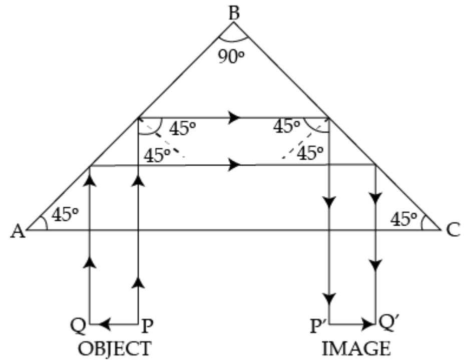
45° is the given critical angle for yellow light. Since $\mu_{blue} > \mu_{yellow}$ and $\mu_{red} < \mu_{yellow}$ thus, it indicates that the critical angle for blue light will definitely be less than 45° and the red light will be definitely BE more than 45°.

6. a) Convex lens is used for burning a piece of paper by focusing the sun's rays as it converges all sunlight to a point called focus.

b)



7.



a) The device that can be used instead of plane mirror to turn a ray of light by 180° is a **total reflecting prism**.

b) This device is used in Binoculars.

8.

a) The phenomenon that causes the illusion of water in a desert is called Mirage.

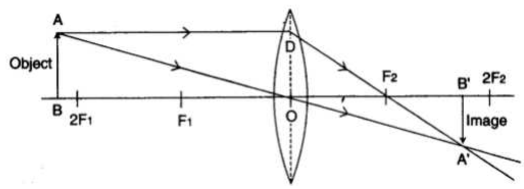
b) Mirage happens when **total reflection** takes place.
The conditions necessary for total reflection are:

i. Light must move from a denser to a rarer medium; and

ii. the angle of incidence within the denser medium must be greater than the critical angle for total internal reflection to occur.

9. a) The objected is positioned beyond $2F_1$.

b)



10.

a) The image of all letters will not be in the same place when viewed through the glass slab. The letters that are farther away from the glass slab will appear to be raised higher than the letters that are closer to the glass slab. This is because the glass slab will refract the light from the letters, causing the image of the letters to be displaced from their actual positions.

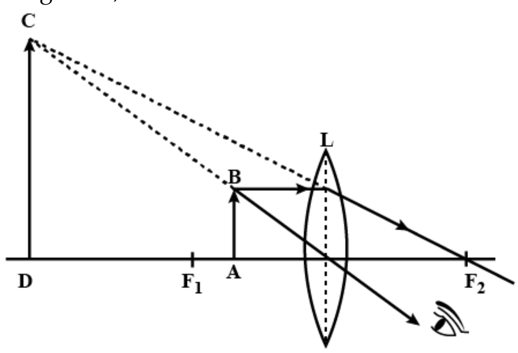
The amount of refraction will depend on the thickness and refractive index of the glass slab, as well as the distance of the letters from the glass slab.

The letters that are farther away from the glass slab will experience greater refraction and will therefore appear to be raised to a greater extent.

b) The two electromagnetic waves with frequencies greater than violet light, are: **X-rays**: X-rays are widely employed in medicine, for example, during surgery to identify bone fractures through the analysis of X-ray images. **Gamma radiation**: This type of radiation is used to treat cancer.

11. a) Infrared radiation
b) X-rays
c) Ultraviolet radiation

12. The image of the object (AB) will form on the same side of the convex lens if it is placed between the focal length and optical centre of the lens. The resulting image will be virtual, magnified, and erect.



13. Given
h_1 = 2 cm u = -25 cm
f = -15 cm

a) Position of image v =?

$\frac{1}{f} - \frac{1}{v} \neq \frac{1}{u}$

$\therefore \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$\Longrightarrow \frac{1}{v} = -\frac{1}{15} - \frac{1}{25} = \frac{-5-3}{75} = \frac{-8}{75}$

$\Longrightarrow$ v = $\frac{-75}{8}$ = -9.37cm

b) Size of image h_2 =?

m = $\frac{v}{u} = \frac{h_2}{h_1}$

$\Longrightarrow \frac{-75}{8 \times -25} = \frac{h_2}{2}$

$\Longrightarrow \frac{h_2}{2} = \frac{3}{8}$

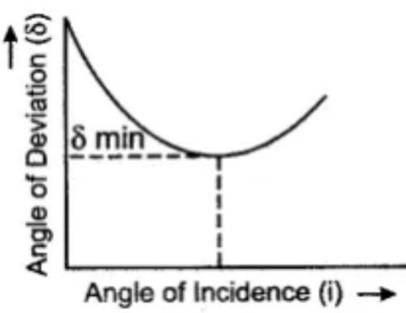
$\therefore h_2 = \frac{3}{8} \times 2 = \frac{3}{4}$ = 0.75cm

14. Light will pass straight through a glass medium without bending if the **indices** of refraction of the liquid and glass are equal. If the indices of refraction are different, the light will bend, or refract, as it passes from the liquid into the glass. This phenomenon is known as refraction and is described by the laws of refraction.

The amount of bending depends on the difference in the indices of refraction of the two media and the angle at which the light hits the boundary. The glass will be visible if it is transparent, meaning that light can pass through it without being absorbed.

15. will decrease.
Explanation: When half of a convex lens is covered, the amount of light that is able to pass through the lens is reduced. This can cause the intensity of the image to decrease. Additionally, the shape of the lens is altered, which can also affect the focal length.

16. When the angle of incidence is increased, the angle of deviation that is created by the prism initially drops. However, when the angle of incidence is increased even further, the angle of deviation grows. The graph for the fluctuation of the angle of deviation with the angle of incidence is shown in the figure that is presented on the side.



17.

a) The power of a lens refers to its ability to focus light.

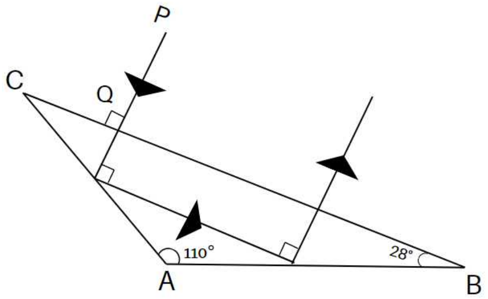
b) The SI unit of power for a lens is the diopter (D).

c) A lens with a higher power is able to focus light more effectively. A thicker lens generally has a higher power, while a thinner lens generally has a lower power. However, other factors can also affect the power of a lens.

18.

a) The angle 'i' in this context is the critical angle.

b)



19.

a) The concave lens is used as eye lens in a Galilean Telescope.

b) Convex lens is used as remedy for hypermetropia.

20.

a) X - rays are the part of electromagnetic spectrum which produced by bombarding a metal target by high-speed electrons.

b) Microwaves are the part of electromagnetic spectrum which is adjacent to radar system used in aircraft navigation.

21. Refractive Index = $\frac{real\ depth}{apparent\ depth}$

If thickness of glass block is x ; real depth = x and apparent depth = x - 7

$1.5 = \frac{x}{x-7}$

1.5 (x - 7) = x

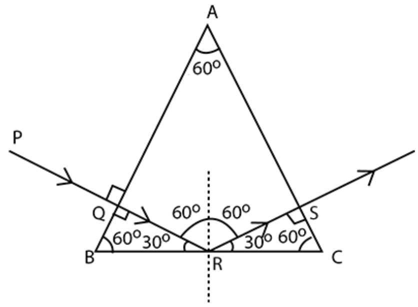
1.5x – 10.5 = x

0.5x = 10.5

$x = \frac{10.5}{0.5} = 21mm$

Therefore, thickness of glass block x is 21mm or 2.1cm.

22.



The angle of incidence of the ray PQ, which enters the prism from the side AB, is 0°. As a result, there is no refraction. It also has a 0° angle of refraction. This light ray's angle of incidence (on the boundary of BC) is 60° when it reaches the base of the prism (BC), which is greater than its critical angle of 42°. As a result, an incident light ray (QR) completely internally reflects rather than entering the subsequent medium. The angle of incidence of this reflected light ray (RS) is 0° when it reaches the side AC. Once more, there is no refraction, therefore the angle of emergence is zero degrees.

23. Real depth = apparent depth + shift given

= 15 + 5 = 20 cm

Refractive index of the liquid

$= \frac{Real\ depth}{Apparent\ depth} = \frac{20}{15} = 1.33$

24. The angle of incidence is the angle formed by the incident ray and the normal.

a)

i) The angle of incidence is the angle which the incident ray makes with the normal.

$\therefore \angle i = 90° - 30° = 60°$

ii) Angle of refraction is the angle which the refracted ray makes with the normal.

$\angle r = 90° - 45° = 45°$

b) According to Snell's law,

$_{air}\mu_{liquid} = \frac{\sin i}{\sin r} = \frac{\sin 60°}{\sin 45°}$

or $_{air}\mu_{liquid} = \frac{\frac{\sqrt{3}}{2}}{\frac{1}{\sqrt{2}}}$

$= \sqrt{\frac{3}{2}} = 1.22$

25. The focus of a convex lens is a point where parallel rays of light are brought to a single point after passing through the lens.

The focus can be either real, located behind the lens, or virtual, located in front of the lens. The type of focus depends on the shape and size of the lens and the distance between the lens and the object being observed.

26. It is not possible for a concave lens to produce an image that is twice the size of the object. A concave lens is a lens that is thinner at the centre than at the edges, and it is used to diverge light rays. When light rays pass through a concave lens, they are spread out and the image formed is always smaller than the object.

On the other hand, a convex lens, which is thicker at the centre than at the edges, can produce an image that is larger than the object when it is used to converge light rays. However, it is still not possible for a convex lens to produce an image that is twice the size of the object. In conclusion, Ranbir's claim that he obtained an image twice the size of the object with a concave lens is incorrect.

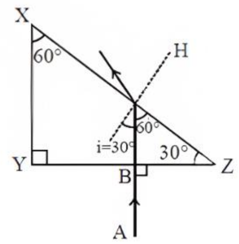
27. False. The refractive index of a medium is a measure of the speed of light in that medium relative to the speed of light in a vacuum. It is defined as the ratio of the speed of light in a vacuum to the speed of light in the medium. Since the speed of light in a vacuum is a fixed constant, the refractive index of a medium is always greater than or equal to 1.

28.

a) The property of light responsible for the Sun appearing red at sunrise is called **atmospheric scattering**.

b) Atmospheric scattering is the scattering of light by particles in the Earth's atmosphere. When light from the Sun travels through the atmosphere, it can be scattered by particles such as molecules of air, water vapor, and dust. This scattering causes the light to be redirected in all directions, including back towards the Earth.

29.

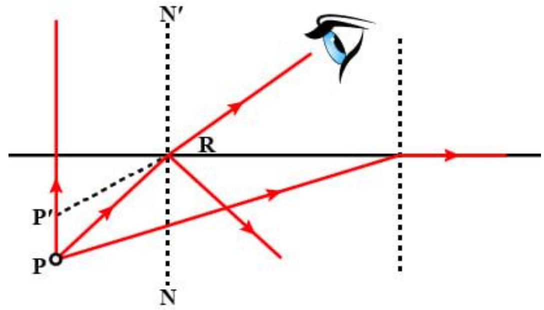


Here 'i' is less than 'i_c'

30.

a) The special name given to the angle of incidence, denoted by the notation PQN, is the crucial angle.

b)



c) The total internal reflection takes place whenever the angle of incidence, PQN, is increased to a greater degree.

31.

a) **Measuring the curvature of the lens**: A convex lens has a positive curvature, while a concave lens has a negative curvature. This can be determined by placing the lens on a flat surface and measuring the distance from the centre of the lens to the surface.
Determining the direction of the lens surface: A convex lens has a bulging outward surface, while a concave lens has a curving inward surface. This can be determined by running your finger along the surface of the lens.

b) **Observing the shape of the lens**: A convex lens is thicker at the centre and thinner at the edges, while a concave lens is thinner at the centre and thicker at the edges.
Observing the way the lens bends light: When light passes through a convex lens, it is bent inward (toward the centre of the lens), while when light passes through a concave lens, it is bent outward (away from the centre of the lens).

PART 4

1. b) the size of the prism

2. c) the speed of light in vacuum is 2.4 times the speed of light in the diamond.
Explanation:
Refractive index = $\frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ medium}$
$2.4 = \frac{c}{v}$
Where, c = speed of digit in vacuum
v = speed of light in diamond
$\Longrightarrow 2.4 \times v = c$

3. b) angle of incidence is less than angle of refraction

4. b) The path of a light ray is reversible.
Explanation: According to principle of reversibility of light, the path of a light ray is reversible.

5. Yes, as the image formed will be real.
Explanation: Given focal length
f = 20 cm
object distance = 25 cm
Hence object is placed between F and 2F of a convex lens. The image formed will be real and can be captured on screen.

6. d) Virtual
Explanation: as object is placed between F to O image formed is virtual and erect.

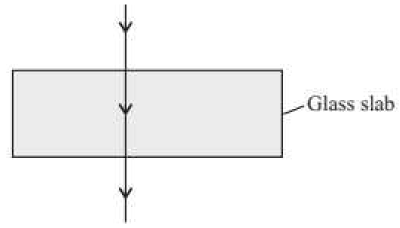
7. c) Red

8. d) 400 nm to 800 nm

9. a) ultraviolet

10. b) Infrared

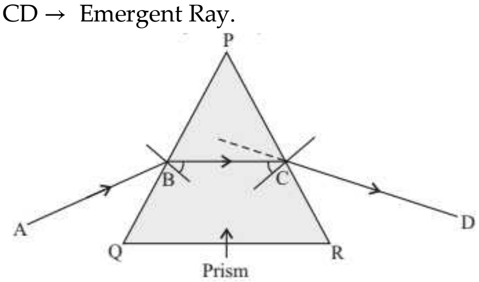
11.



According to Board Examiners

Some candidates took the ray normal at one surface but after refraction, the ray shown was bent at the other surface. The angle with the second surface was marked as 90^0 by them. Several candidates did not mark arrows on the rays.

12. AB → Incident Ray
BC → Refracted Ray
CD → Emergent Ray.



According to Board Examiners

Majority of the candidates answered correctly barring some who showed dispersion or some who missed marking arrows on the rays.

13.
Apparent depth = 2.7m
$\mu_w = \frac{4}{3}$
$\because \mu_w = \frac{Actual\ depth}{Apparent\ depth}$
$\frac{4}{3} = \frac{Actual\ depth}{2.7}$
$Actual\ depth = \frac{4}{3} \times 2.7m = 3.6m$

According to Board Examiners

Most candidates answered this part correctly. However, some made the following errors:
- Wrote incorrect formula.
- Took shift as apparent depth.
- Made calculation errors.
- Did not write the unit in the final answer.

14.
a) Both colours of light have same speed in vacuum.
b) In glass speed of red light is more than that of blue light.

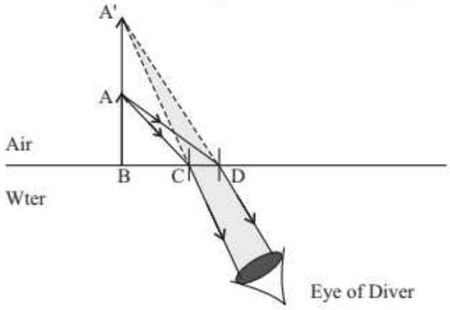
According to Board Examiners

a) Most candidates answered this part correctly but a few who did not know the concept wrote blue or red randomly. Some candidates treated wavelengths as speed. b) Some candidates did not establish a relation between speed and wavelength in a medium and thus wrote incorrect answers. Several candidates just wrote blue randomly.

15.

a) The object will appear taller.

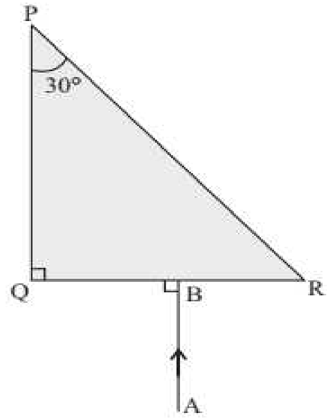
b) A'B is the image formed of the object AB. Air B Eye of Diver



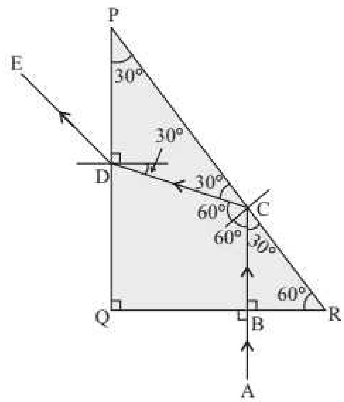
According to Board Examiners

a) Many candidates answered the part correctly. A few candidates made mistakes as they could not establish the relation of between the size image and change in medium. Some candidates considered the light ray passing from denser medium to rarer medium. Some wrote that the object appears shorter while others wrote, of the same size.
b) Candidates made several mistakes like:
1. Not marking arrows on rays.
2. Showing partial reflection with refraction.
3. Not showing extension of rays and dotted image.
4. Showing incorrect image position and incorrect refraction.

16.



The path of the ray till it emerges out of the prism is ABCDE.



According to Board Examiners

Following errors were observed in this part:
– The ray entering the prism was shown bending.
– No angle of incidence was marked.
– After total internal reflection, the ray was shown coming out undeviated. – Refraction was shown at the second surface.
– The diagram was completed by treating it as right-angled isosceles prism.

17.

a) Object must be placed between first focal point (F_1) and the centre of curvature ($2F_1$) of the lens.

b) Object must be placed between the first focal point (F_1) and the lens.

According to Board Examiners

Many candidates wrote the positions of the objects correctly in subparts a) and b) corresponding to the asked nature of the images. However, some candidates were confused in F_1 and $2F_1$, F_2 and $2F_2$, between virtual and real image, etc. A few candidates answered by drawing ray diagram, which was not asked.

18.

a) Convex lens

b) $f = +20\,cm, v = +60\,cm$

$\because \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\Rightarrow \frac{1}{20} = \frac{1}{60} - \frac{1}{u}$

$\Rightarrow \frac{1}{u} = \frac{1}{60} - \frac{1}{20}$

$= \frac{1-3}{60} = -\frac{2}{60} = -\frac{1}{30}$

$\therefore u = -30\,cm$

The lens is at a distance 30 cm in front of the object.

c) $m = \frac{v}{u} = \frac{+60}{-30} = -2$ [$-ve$ sign because image is real]

According to Board Examiners

a) Barring a few, all candidates identified the lens correctly.
b) Some candidates got incorrect answers due to improper sign convention and incorrect substitution.
c) Some candidates did not consider the sign convention. A few candidates wrote unit for magnification.

19.

a) During the day, clouds appear white because they contain dust particles and aggregates of water molecules of size bigger than the wavelength of visible light, hence they scatter all colours of incident white light from the sun to the same extent.

b) During the day, sky appears blue because blue (or violet) light due to its short wavelength is scattered more as compared to the red light of long wavelength. Hence, the sky other than the direction of the sun appears blue.

According to Board Examiners

a) Many candidates used the term reflection or dispersion instead of scattering. The size of the particles and uniform scattering was not mentioned by some candidates. Some candidates were confused between the white colour of the sky at noon and white colour of clouds. They mixed both concepts and wrote the answer.
b) Most of the candidates explained this part correctly. However, some candidates did not compare the wavelength. A few candidates gave incorrect reasons.

20.

a) The angle of incidence in the denser medium corresponding to which the angle of refraction in the rarer medium is 90° is called critical angle

Critical angle $(i_c) = sin^{-1}\left(\frac{1}{\mu}\right)$

b) Critical angle for a given pair of media depends on their refractive indices.

According to Board Examiners

a) Many candidates defined critical angle correctly. But quite a number of candidates made following errors. - key words such as rarer, denser were missing. - did not make it clear that it is the angle of incidence. - 90^0 was missing. b) Many candidates wrote it correctly but quite a number of candidates wrote - conditions of total internal reflection. - factor as angle of incidence/frequency. - additional point/s which were incorrect.

21.

a) $_a\mu_w = \frac{\mu_w}{\mu_a}$

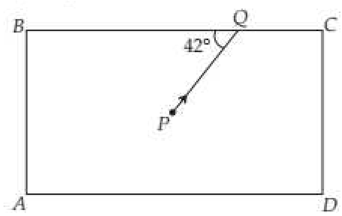
$_w\mu_a = \frac{\mu_a}{\mu_w}$

$\therefore\ _a\mu_w = \frac{1}{_w\mu_a}$

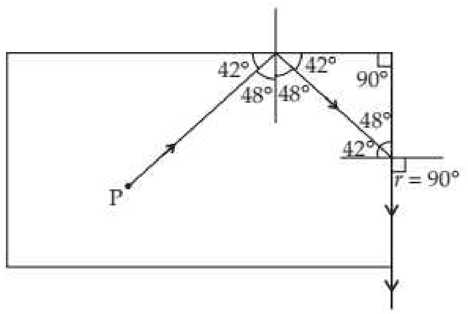
b) Given, $_a\mu_w = \frac{5}{3}$

$\therefore\ _w\mu_a = \frac{1}{_a\mu_w} = \frac{3}{5}$

22.



The complete ray diagram with necessary angles is as follows:

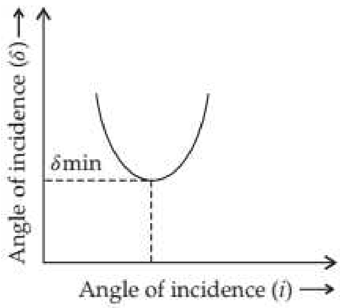


According to Board Examiners

Many candidates could complete the path of first reflected ray correctly but made a mistake in completing the path of the second ray after total

internal reflection. Following lapses were observed in the diagram:
- Assuming 420 as the angle of incidence some candidates showed the first refracted ray along the surface.
- Many candidates did not calculate the angle of incidence at the new surface they showed incorrect path (refracting out or going along the normal) of the second ray.
- Angle of incidence was not marked and written.
- Arrows were missing on the rays.

23. Experimentally it has been observed that as the angle of incidence increases, the angle of deviation first decreases, reaches to a minimum value for a certain angle of incidence and then on further increasing the angle of incidence, the angle of deviation begins to increase.



According to Board Examiners

a) Most candidates answered this subpart correctly. However, a few made following errors:
- gave incorrect relation between the angle of incidence and the angle of deviation.
- drew diagram of prism instead of graph.
- incorrect graph showing the variation in the angle of deviation with the angle of incidence
- incorrect labelling on the graph.

24.

a) The focal length of the lens will increase in water (Focal length of the lens depends on the refractive index of the material of lens relative to its surrounding medium)

b) Thin lens will have greater focal length.

According to Board Examiners

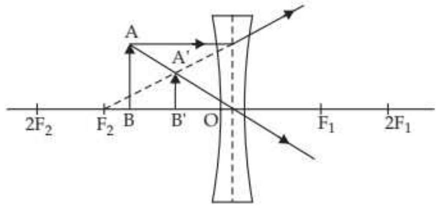
a) Many candidates could not comprehend the question correctly. Some candidates answered that focal length changes, but they could not give the correct reason. Several candidates could not write about the effect on the focal length of the lens due to change in the refractive index of the outside medium.

b) While many candidates answered it correctly, quite a few could not comprehend it. They wrote convex lens as a thicker lens and concave lens as a thinner lens. Some candidates wrote thicker lens has greater focal length.

25.

a) A concave lens forms the given image.

b) Ray diagram to show the formation of image (A'B') is given below.



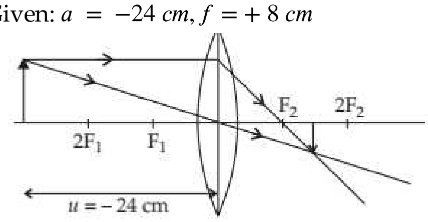
According to Board Examiners

Many candidates named the type of lens correctly as a concave lens. Some candidates were tricked by the words 'object between the optical centre and the principal focus of a lens as well as virtual image' and they did not pay attention to the characteristic that image is virtual and diminished. Those who identified the lens correctly drew correct ray diagram but those who identified the lens incorrectly, draw incorrect ray diagram. Some candidates did not draw arrows on the rays in the diagram.

26.

a) A real, inverted, and diminished image is formed.

b) Given: $a = -24\ cm, f = +8\ cm$



From the relation,

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \frac{1}{v} = \frac{1}{u} + \frac{1}{f}$

$= \frac{1}{-24} + \frac{1}{8}$

$= \frac{-1+3}{24} = \frac{1}{12}$

$or\ \ v = 12cm$

Thus, the image is at a distance 12 cm behind the lens.

c) Magnification $(m) = \frac{v}{u} = \frac{12}{-14} - \frac{1}{2}$

Negative sign signifies inverted image.

27.

a) Infrared radiation
b) They have low frequency, the energy associated with them is also low so they do not scatter much and can penetrate appreciably through it.

28.
a) In vacuum, the velocity of light is always constant i.e., 3 x 10^8 ms^{-1} and it does not depend on wavelength or frequency.
b) We know that,
c = λv
Or v = $\frac{c}{\lambda}$
$\therefore v \propto \frac{1}{\lambda}$ (As c is always constant)
Hence, lower wavelength i.e., 4000 Å has higher frequency.

According to Board Examiners

a) Most of the candidates were able to answer this question. A few candidates however, arrived at the correct answer or an incorrect answer after long calculations. b) Most of the candidates answered it correctly as 4000 Å but some candidates wrote 8000 Å. A few candidates did huge calculations to arrive at the answer.

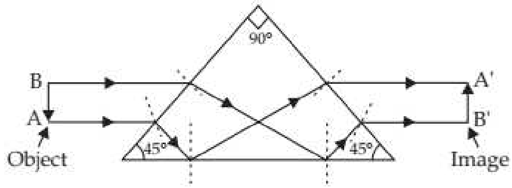
29.
a) (*i*) $\mu = \frac{1}{\sin C} = cosec\ C$
Where 'μ' is the absolute refractive index of medium and 'C' is the critical angle.
b) Critical angle increases with the increase in wavelength of light, since, red light has a longer wavelength than green light, thus it has a higher critical angle.

According to Board Examiners

a) Only a few candidates wrote the correct mathematical relation between the critical angle and the absolute refractive index of a medium. Many candidates simply mentioned increases and decreases. b) Most of the candidates wrote correct colour of light which has a higher critical angle. However, some candidates mentioned the colour as green which was incorrect.

30.
a) The angle through which the incident ray deviates and emerges out of the prism is 90%.
b) Refracting Periscope
c) The surface AB of the prism behaves as a mirror.

31. The diagram is shown below:



32.
a) Given: P= -5D
We know that,
$f = \frac{1}{P}$
$\Rightarrow f = \frac{1}{-5} m$
$= -0.2m = -20cm$
b) The negative power indicates that the lens is a concave lens/diverging lens.

According to Board Examiners

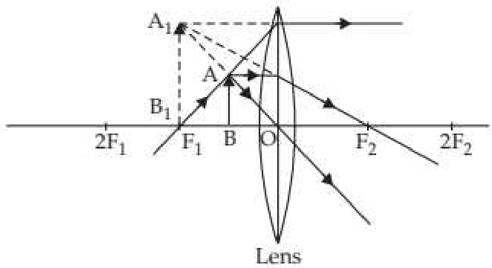
a) Most of the candidates answer this sub-part correctly. However, some candidates calculated the focal length of the given lens incorrectly or expressed the focal length in incorrect unit. b) Most candidates named the type of lens correctly. Some candidates, however, were unaware that the focal length of a lens with negative sign is for a concave lens.

33.
a) The object is placed on the principal axis at a distance equal to twice the focal length of the lens (or at $2F_1$).
b) The object is placed between the first principal focal point (F_1) and the optical centre of lens.

According to Board Examiners

Many candidates gave the incorrect position of the object. Some candidates even drew an incorrect diagram.

34. A_1B_1 is the image formed.



35.
a) Given: Object distance (u) = -12 cm
Focal length (f) = +8 cm (convex lens)
Using the relation,
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$or\ \frac{1}{v} - \frac{1}{(-12)} = \frac{1}{8}$

$or\ \frac{1}{v} + \frac{1}{12} = \frac{1}{8}$

$or\ \frac{1}{v} = \frac{1}{8} - \frac{1}{12} = \frac{3-2}{24} = \frac{1}{24}$

$or\ v = +24\ cm$

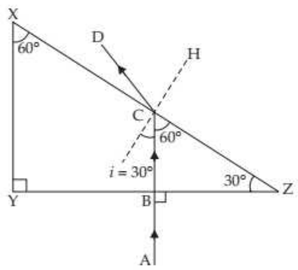
Therefore, the image is formed at a distance of 24 cm behind the lens (or on the other side).

b) The image is real, inverted and magnified.

According to Board Examiners

a) Majority of the candidates were unable to answer this question. The common flaws observed in most of the answer scripts were: - use of incorrect lens formula - incorrect use of sign convention. - incorrect substitutions. - incorrect characteristics of the images. - incorrect answer with correct unit or correct answer with incorrect unit or without unit.

36. CD is the emergent ray as shown in the figure. Angle of incidence on the surface YZ is 0° and on surface XZ is 30°.



According to Board Examiners

Majority of the candidates showed total internal reflection Some candidates showed the ray bending towards normal. The diagram drawn by a few candidates was ambiguous.

37.

a) The process of absorption and then reemission of light energy without changing its wavelength is called scattering of light.

b) Molecules of the smoke are bigger than the wavelength of light is the correct statement.

According to Board Examiners

a) Majority of the candidates stated the definition of dispersion which was incorrect. Some candidates did not state absorption and reemission without the change in the wavelength. Some candidates even changed the order and wrote reemission and absorption b) Almost all candidates identified the correct statement except a few who chose statement 2 as the correct option.

38. Let be the refractive index of the material,

(a) $\mu = \frac{Real\ depth}{\text{Apparent depth}}$

(b) $\mu = \frac{Speed\ of\ light\ in\ vacuum\ or\ air\ (c)}{Speed\ of\ light\ in\ medium\ (v)}$

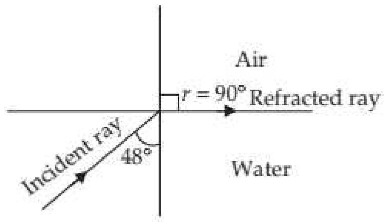
39.

i) The light must travel from a denser to a rarer medium.

ii) The angle of incidence must be greater than the critical angle for the given pair of media.

40.

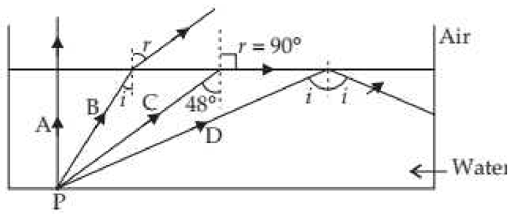
a)



b) For total internal reflection to occur in the above diagram, the angle of incidence must be greater than 48°.

41.

a)



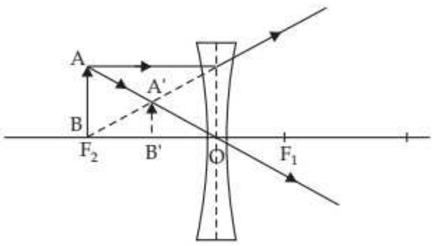
b) The ray B exhibits the phenomenon of refraction.

The ray D exhibits the phenomenon of total internal reflection.

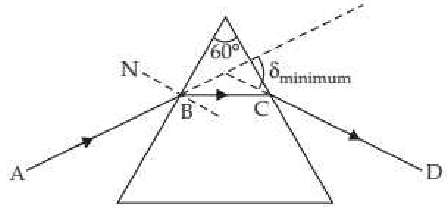
42.

a) Concave lens

b)

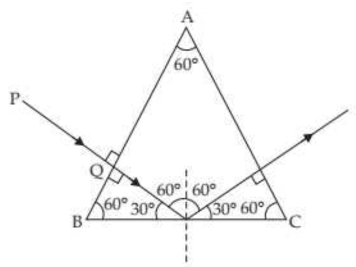


43. For minimum deviation, refracted ray (BC) must be parallel to the base of the prism.



44. The refractive index of a material is the measure of how much a light beam is refracted, or bent, when it passes through the material. It is generally dependent on the wavelength of the light and the material through which it is passing. In the case of the boy using blue light and then red light to find the refractive index of glass, it is likely that the refractive index will be different in the two cases. This is because different wavelengths of light, such as blue and red, can be refracted differently as they pass through a material. The refractive index of a material can vary with the wavelength of light, so the refractive index of glass will likely be different for blue light and red light.

45.



46.

a) If the refractive index of the material increases, the angle of deviation also increases.

b) Lesser the wavelength of light, greater is the angle of deviation.

47.

a) The ratio of the sine of the angle of incidence i to the sine of the angle of refraction is constant for a given pair of media. This constant is called refractive index.

$\Rightarrow \frac{\sin i}{\sin r} = 1\mu 2$ or $1n2$

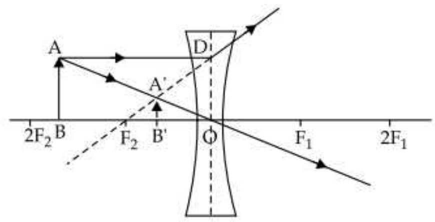
b) When a ray of light passes from one medium to another medium, its direction (or path) changes because of change in speed of light while travelling from one medium to another.

c) The ray of light which is incident normally on the surface separating the two media, passes undeviated (does not bend). Thus, if angle of incidence $\angle i = 0°$, then angle of refraction $\angle r = 0°$. The deviation of the ray is zero.

48.

a) Concave lens

b)



49. Scattering of light is the process of absorption and then re-emission of light energy in many different directions, without changing its wavelength.

The colour of white light which scattered the least is red. This is because red colour has the longest wavelength 8000 Å and lowest frequency 3.75×10^{24} Hz.

50. The thickness of glass slab affects the lateral displacement of light as it passes through a rectangular glass slab.

51. Given, Speed of light in glass

$= 2 \times 10^5$ km/s

$= 2 \times 10^5 \times 10^3$ m/s

$= 2 \times 10^8$ m/s

Refractive index of glass

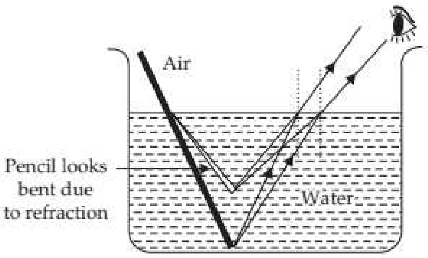
$= \frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ glass} = \frac{3\times10^8}{2\times10^8} = 1.5$

52.

a) He sees that the pencil appears to be bent.

b) Refraction of light

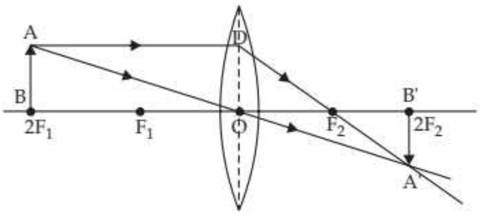
c)



53.

a) The object must be placed on the principal axis of a convex lens at a distance twice the focal length of the lens i.e., at $2F_1$.

b)



54.

a) X-rays

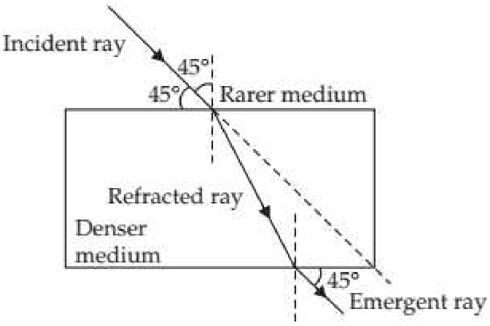
b) They are used for the detection of fracture in bones.

55.

a) At sunrise, light from the sun has to travel a very long distance to reach the observer on earth. The light while travelling from sun loses blue light due to scattering while the red light is scattered very little because of its long wavelength. So, the sun looks red during sunrise.

b) Colour of light

56.



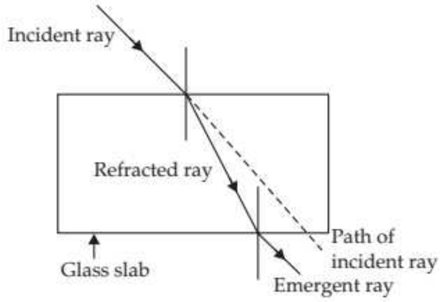
57. When light passes from water to air i.e., from denser to rarer medium, its speed increases.

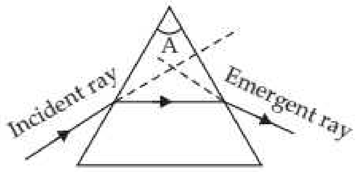
58. Factors affecting the critical angle:

a) Wavelength of light.

b) Temperature (on changing the temperature of medium, its refractive index changes).

59.

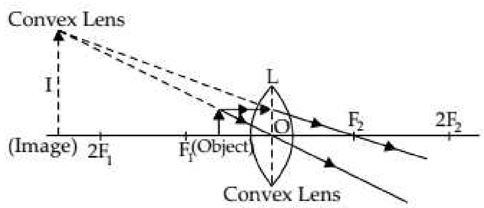




In a glass slab, the emergent ray is laterally displaced because the two refracting surfaces are parallel to each other whereas in case of prism, the emergent ray is deviated because two refracting surfaces are inclined at an angle A.

60. a) Convex lens

b)



61. Power of a lens is defined as the measure of deviation produced in the path of light when it passes through the lens.

Or

The power of a lens is defined as the reciprocal of its focal length in metres. The S.I. unit of power is dioptre (D).

Power of lens (in D)

$$= \frac{1}{\text{Focal length (in metre)}}$$

b) Given: $f = 25\ cm = 0.25\ m$

$$P = \frac{1}{f(in\ m)}$$

$P = \frac{1}{0.25} = +4D$

62. No, he is not correct because concave lens always forms virtual, erect and diminished image.

63. Red light travels fastest.

64.

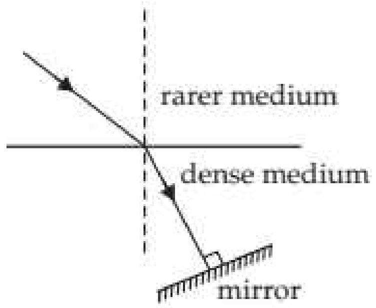
a) Quartz prism

b) Infra-red radiations

65. Red colour is used as a sign of danger due to its longest wavelength and lesser deviation (scattering). Therefore, it can reach to a longer distance.

66.

a)



b) Principle of reversibility of light.

67.

(a) He = 1.5 = 1 = 0.666 = 0.67

(b) Zi = 0

68.

a) No, the absolute refractive index of a medium cannot be less than one because speed of light in any medium is always less than that of in vacuum.

b) Let Real depth = x

Refractive Index,

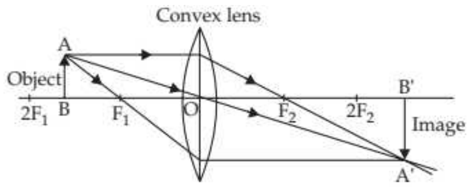
$\mu = \frac{\text{Real depth}}{\text{Apparent } depth}$

$\Rightarrow \frac{4}{3} = \frac{x}{x-4}$

$\Rightarrow 4x - 16 = 3x$

$\therefore x = 16cm.$

69.



70.

a) Infrared radiations.

b) X-rays

c) UV radiations

71.

a) **Refractive Index**: It is defined as the ratio of velocity of light in medium 1 to the velocity of light in medium 2.

b) Ray 2 shows partially reflected ray.

72.

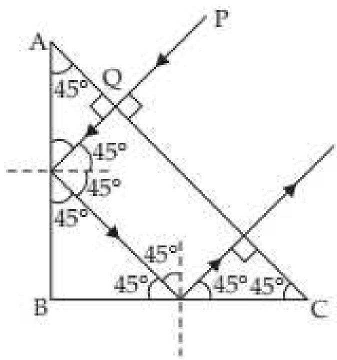
a) **Critical angle**: It is the angle of incidence in the denser medium corresponding to which the angle of refraction in the rarer medium is 90°. (b) $n = \frac{1}{\sin i_c}$

where, n = refractive index, i_c - critical angle.

c) Depth of the tank remains the same when viewed normally from above.

73.

a)



b) Angle of deviation of the ray = 180°.

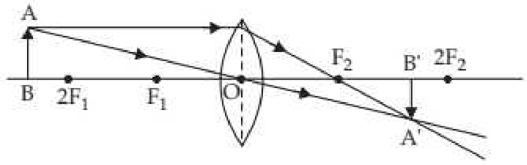
c) Prism binoculars.

74. First, we place the lens on a piece of printed paper. Then we lift it slowly. If the words of the printed paper, seen through the lens becomes bigger or magnified then it is convex lens otherwise concave lens.

75.

a) Object is beyond $2F_1$

b)



76.

a) **Dispersion of light**: When a beam of white light falls on a prism, it splits into the rays of constituent colours. This is known as dispersion of light.

(b) In atmosphere, red colour scatters the least because of its long wavelength.

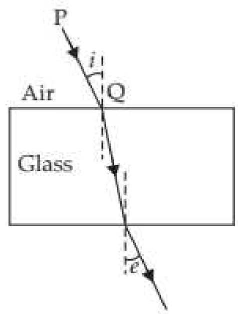
77.

a) Angle of emergence $\angle e$ = Angle of incidence $\angle i$

b) Angle of deviation becomes minimum in this situation.

78.

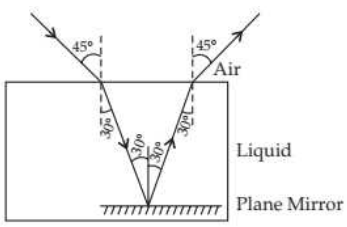
a)



b) When the incident ray is undergoing minimum deviation, the angle of incidence is equal to angle of emergence, i.e., $\angle i = \angle e$

79.

a)



b) Angles are marked in the diagram.

80.

a) Refractive index $= \frac{\text{Real Depth}}{\textit{Apparent Depth}}$

81. Laws of refraction of light:

(1) The incident ray, refracted ray and normal at the point of incidence all lie in the same plane.

(2) The ratio of sine of angle of incidence to the sine of angle of refraction is constant for a given pair of media and is known as refractive index of medium 2 with respect to medium 1. It is generally represented by the Greek letter $_1\mu_2$.

i = A + d.

82.

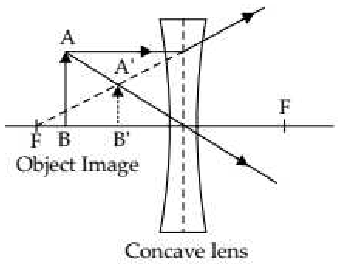
a) A ray of light falling on the lens passes through it undeviated when it passes through optical centre of the lens.

b) Convex lens

83.

a) Concave lens

b)



84. Scattering of light

85.

a) (A) Infra-red radiations: These are detected by a thermopile.

(B) Ultraviolet radiation: When a silver chloride solution is taken in a test tube and is passed from red to violet light no change is seen. But beyond the violet end, the solution first turns violet and then it turns dark brown.

b) Infrared radiations are used in remote control of television.

86.

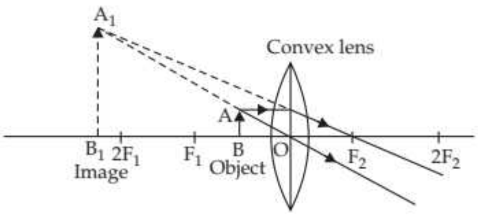
a) **Refraction of light**: The phenomenon in which a ray of light deviates from its original path while travelling from one optical medium to another medium having different optical densities is called refraction of light.

b) **Cause of refraction**: Speed of light changes as it passes from one medium to another medium, therefore, light shows refraction.

87.

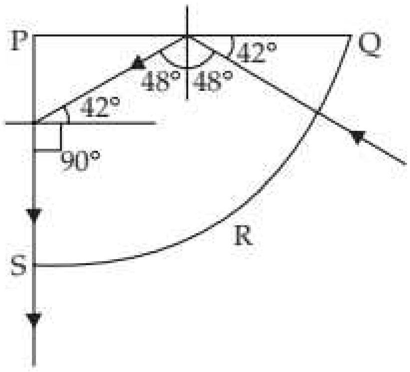
(a) The lens is convex

(b)

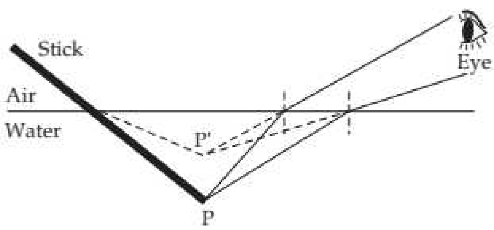


88. The velocity of light in diamond is 2.42 times less than that in air.

89. The diagram along with the complete path of ray is as shown below:

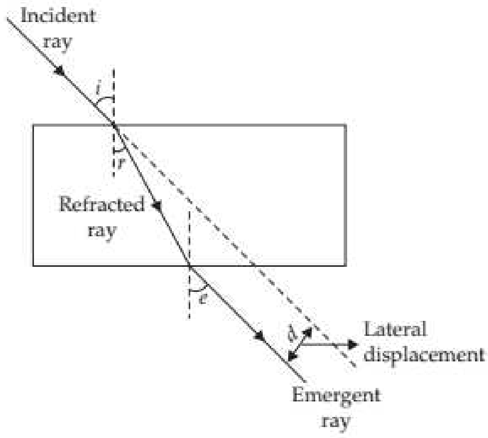


90.



91.

a)



b) Incident ray and emergent rays are parallel to each other.

c) Lateral displacement is marked by d in the diagram.

92.

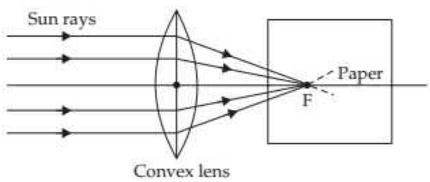
a) No, the paths inside the glass will not be parallel.
Reason: Deviation suffered by each ray will be different because refractive index is different for different colours of light.

b) $v_R > v_V$. In glass, the speed of red ray is greater than violet ray.

93.

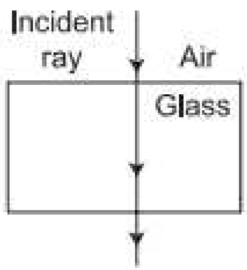
a) Convex lens

b) Ray diagram



94.

a)



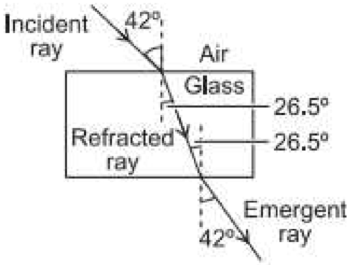
b) For rectangular glass block,
$n = 1.5$

We know that,

$n = \frac{\sin i}{\sin r}$

$\Rightarrow 1.5 = \frac{\sin 42^\circ}{\sin r}$

$r = 26.5^\circ$



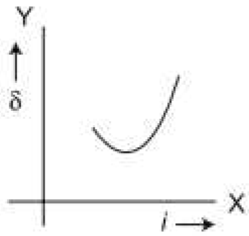
95. Conditions necessary for total internal reflection to take place are:

a) Angle of incidence must be greater than critical angle for the given pair of media.

b) The ray should travel from denser medium to rarer medium.

96.

a)

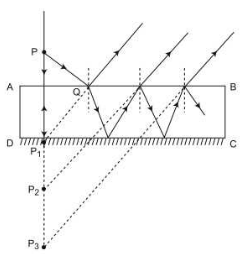


As the angle of incidence increases, the angle of deviation initially decreases and later increases after achieving a minimum value.

b) As wavelength increases, angle of deviation decreases.

97.

a)



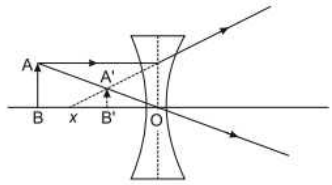
b) Second image will be the brightest.

98.

Types of lens	Position of Object	Nature of Size of Image	Size of image
Convex	At F	Real and inverted	Highly magnified
Concave	At infinity	Virtual and Erect	Diminished at a point

99.

a)



b) The name of x is principal focus.

100.

a) White light is made up of seven colours i.e., VIBGYOR that is why it is considered to be polychromatic.

b) Range of wavelength which are visible to us are 4000 Å to 8000 Å.

101.

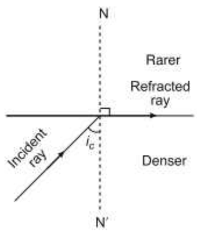
a) Relation between the speed of light in air and speed of light in glass is given by the following expression:

$_a\mu_g = \frac{Speed\ of\ light\ in\ air}{Speed\ of\ light\ in\ glass}$

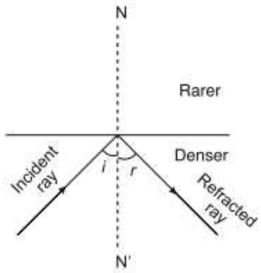
b) Wavelength of the light decreases as it passes from air to glass.

102.

a) (1) Ray diagram to illustrate critical angle is given below:



(2) Ray diagram to illustrate total internal reflection is given below:



$\angle i = \angle r$

And $\angle i > \angle c$.

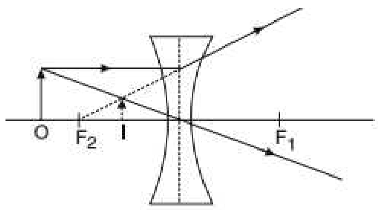
b) The relationship between refractive index of the denser medium (glass) with respect to the rarer medium (air) and its critical angle is given by

$_a\mu_g = \frac{1}{\sin i_c}$

103.

a) The lens is a concave lens.

b) Ray diagram is shown below:

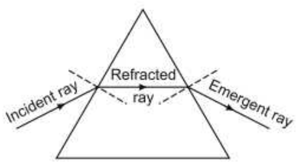


'O' is the object.

'I' is its image

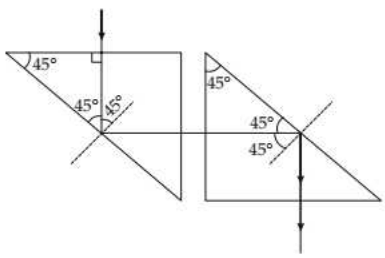
104.

a)



b) Angle of incidence = Angle of emergence, when the prism is in the position of minimum deviation.

105.



106. Snell's law states that the ratio of sine of the angle of incidence to the sine of the angle of refraction is constant for a pair of media. This constant is called refractive index of second media with respect to first media. Where, μ = refractive index

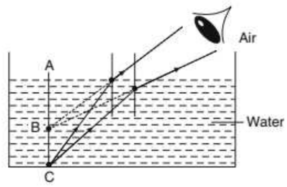
$\mu = \frac{\sin i}{\sin r}$

107. Light reflecting off a plane mirror undergoes partial reflection, with some of the light being refracted and transmitted. Conversely, when light undergoes total internal reflection in a prism, it results in 100% reflection.

108.

a) AB = Apparent depth

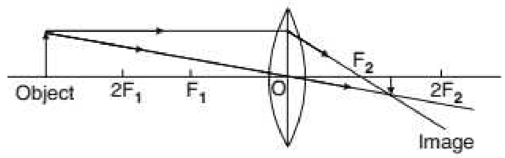
AC = Real depth



b) Relation between refractive index of water, real depth and apparent depth.

$_a\mu_w = \frac{Real\ depth}{Appparent\ depth}$

109.



110. Infrared radiations scatteres less so they can penetrate appreciably through fog and better photographs can be taken in comparison to visible light.

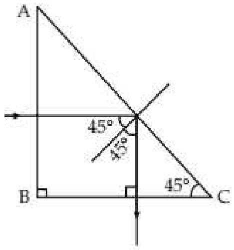
111.

a) X-rays are used for detection of fracture in bones, teeth, etc.

b) The speed of light increases on increasing the wavelength of light.

112.

(a) Figure

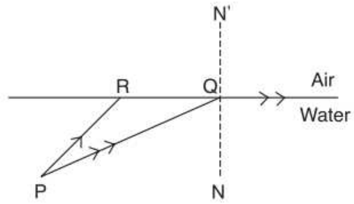


b) 90°

113.

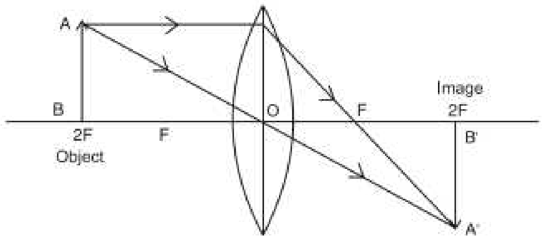
a) Critical angle

b) Diagram is completed as below:



c) Total internal reflection of light.

114.



Chapter 3 - Sound

PART 1

1. b) Forced vibration
2. a) Loudness
3. a) Longitudinal waves
4. d) Vibration produced in the diaphragm of a gramophone
5. c) One
6. a) Increase in frequency
7. c) directly proportional to square of amplitude
8. a) Only upon its displacement at that instant

PART 2

I.

1. Sound is a type of energy that travels through the air as a vibration of pressure waves. When an object or substance vibrates, it produces sound waves that can be heard when they reach a person's ear. Sound is often described in terms of *pitch*, which refers to the perceived highness or lowness of a sound, and *volume*, which refers to the loudness or softness of a sound.

2. A tuning fork is a type of instrument that is used to produce a specific pitch or frequency when struck or struck with an object. Tuning forks are often used in music to tune instruments and in physics to demonstrate the properties of sound waves. They are made of metal and have two prongs that vibrate at a specific frequency when struck, producing a pure tone that can be used as a reference pitch.

3. A sonometer is a scientific instrument used to measure the frequency and wavelength of sound waves. It consists of a string or wire that is stretched over a resonator, such as a wooden or metal frame, and is usually used to demonstrate the principles of waves and vibrations. The sonometer can be used to measure the frequency of a sound by measuring the number of vibrations of the string per second, and the wavelength can be determined by measuring the length of the string or wire.

4. Persistence of hearing is the phenomenon of a sound continuing to be heard in the absence of the physical source of the sound. For example, if you hear a ringing in your ears after a loud noise has stopped, this is an example of persistence of hearing.

5. Free or natural vibrations refer to the vibrations of a system when it is not subjected to any external force or disturbance.

For example, consider a simple mass-spring system. If the mass is displaced from its equilibrium position and then released, it will oscillate back and forth on its own, without the need for any external force. This is an example of free vibration.

6. There are several causes of vibration. Some common causes include:

a) Imbalance in rotating machinery, such as a misaligned fan or motor.

b) Loose or worn components in a system, such as loose bolts or bearings.

c) Excitation from external sources, such as wind or earthquakes.

d) Changes in the system's operating conditions, such as changes in temperature or load.

7.

a) **Damped vibrations**: Damped vibrations refer to oscillations that gradually decrease in amplitude over time. This is typically due to the presence of some form of resistance or friction that acts to oppose the motion of the vibrating system. Examples of damped vibrations include a swinging pendulum with air resistance, a car suspension system with dampers, or a speaker cone with a damper on the voice coil.

b) **Forced vibrations**: Forced vibrations refer to oscillations that are induced by an external force or disturbance. These vibrations can be periodic (occurring at regular intervals) or non-periodic (occurring randomly or irregularly). Examples of forced vibrations include a person pushing a swing, a wind turbine blade being hit by gusts of wind, or a speaker cone vibrating due to an audio signal.

c) **Resonance**: Resonance refers to the phenomenon where a system can amplify or reinforce vibrations at certain frequencies, known as resonant frequencies. This can occur when the natural frequency of the system matches the frequency of the external force or disturbance. Examples of resonance include a wine glass shattering due to a nearby singer hitting a resonant frequency, or a bridge collapsing due to a group of people marching in step across it, causing the bridge to vibrate at its resonant frequency.

8. Resonant vibrations occur when an object vibrates at its natural frequency in response to an external force. This can lead to the amplification of the vibration, which can be beneficial or detrimental depending on the situation.

9. A vibrating pendulum does produce sound, but the sound it produces may not be easily audible to the human ear. This is because sound is a type of mechanical wave that travels through a medium such as air, water, or solid materials. The frequency of a sound wave is an important factor in determining its pitch, or how high or low the sound appears to our ears.

10. Soldiers are asked to walk out of step while crossing bridges because the vibrations caused by their footsteps can cause the bridge to vibrate at its resonant frequency, potentially causing the bridge to collapse. By walking out of step, the soldiers create a mixture of frequencies that is less likely to match the bridge's resonant frequency and thus less likely to cause the bridge to vibrate.

11. Stringed musical instruments, such as guitars, are often provided with large sound boxes because the size of the sound box helps to amplify the sound produced by the strings. When the strings of the instrument vibrate, they cause the soundboard, which is typically made of wood, to vibrate as well. This vibration creates sound waves that are amplified by the air inside the sound box. The larger the sound box, the more air it contains, and therefore the more sound it can amplify. This is why guitars and other stringed instruments often have large sound boxes.

12. Sound waves require a medium through which to travel, such as a gas, liquid, or solid. On Earth, sound waves can travel through the air, water, and solid objects. However, the moon has no atmosphere, so there is no air to transmit sound waves. This means that it is not possible for sound to be audible on the moon's surface.

13. Rear view mirrors on motorcycles can start vibrating violently at a particular speed due to a phenomenon called resonance. When the natural frequency of the mirror matches the frequency of the vibrations being transmitted to it, the mirror will start to oscillate or vibrate more intensely.

There are several factors that can contribute to resonance in a rear-view mirror, including the size and shape of the mirror, the stiffness of the mounting system, and the type of surface that the motorcycle is traveling on.

14. When a tuning fork is held close to the ear, the vibrations of the fork are transmitted through the air and into the ear drum, causing a faint sound to be heard. When the tuning fork is placed on a table and its handle is in contact with the table, the vibrations of the fork are transmitted through the handle and into the table, causing the table to vibrate.

These table vibrations are then transmitted through the air and into the ear drum, causing a louder sound to be heard. The louder sound is produced because the table vibrations are more intense than the air vibrations, and because the handle of the tuning fork amplifies the vibrations of the fork when they are transmitted to the table.

15. When a note is struck by a piano, it produces sound waves that travel through the air. These sound waves can cause objects to vibrate if they are in the right frequency range. A wine glass is made of a thin, fragile material and has a relatively small mass. This means that it is more prone to vibrating in response to sound waves than heavier, more solid objects. If the frequency of the sound waves produced by the piano matches the natural frequency of the wine glass, the glass will start to vibrate and produce a sound. This phenomenon is known as resonance.

16. The pitch of a sound is determined by the frequency of the sound waves, which is measured in hertz (Hz). The timbre or tone colour of a sound, on the other hand, is determined by the specific shape of the sound waves, which is often referred to as the waveform. Different instruments produce sound waves with different waveforms, even when they are playing the same pitch. For example, a guitar and a piano may both play a note at the same pitch, with a frequency of 440 Hz, but the sound waves produced by the guitar and the piano will have different waveforms because of the differences in the way the instruments produce sound. This is why the qualities of sound for the same pitch can differ when emitted by different instruments.

17. When we hear a sound, our brains process the sound waves and use various characteristics of the sound, such as its frequency and intensity, to identify the source of the sound. Our brains are able to recognise the horn of our own car because we have become accustomed to the specific frequency and intensity of the sound produced by the horn.

18. Acoustic resonance occurs when a sound wave is amplified by the natural resonant frequency of an object or a system. When an object vibrates at its natural frequency, it absorbs the maximum amount of energy from the sound wave, causing the vibration to become more intense. This intense vibration can produce a loud sound.

19.

FREE VIBRATIONS	**DAMPED VIBRATIONS**
Vibrations that occur when a system is disturbed from its equilibrium position and then left to vibrate on its own, without any external force acting on it.	Vibrations that occur when a system is disturbed from its equilibrium position and then subjected to some form of damping force, which slows down the vibrations over time.
The amplitude of free vibrations decreases over time due to internal energy dissipation, but it never reaches zero.	The amplitude of damped vibrations decreases over time and eventually reaches zero, as the system comes to rest.
The frequency of free vibrations is constant and is determined by the natural frequency of the system.	The frequency of damped vibrations is generally lower than the natural frequency of the system, due to the damping force.

20.

Free Vibrations	**Forced Vibrations**
Vibrations that occur naturally in a system without any external excitation.	Vibrations that occur in a system due to external excitation, such as a force or displacement.
Depends on the natural frequency of the system and its characteristics (mass, stiffness, etc.).	Depends on the frequency of the external excitation and the natural frequency of the system.

May decrease over time due to energy loss (damping).	Can be increased or decreased by the magnitude and frequency of the external excitation.
Examples: A swinging pendulum, a vibrating string	Examples: A vibrating bridge, a car driving over a bumpy road

21.

Forced Vibrations	**Resonant Vibrations**
Vibrations that are caused by an external force, such as a person pushing a swing or a machine generating vibrations.	Vibrations that occur when the natural frequency of an object matches the frequency of an external force applied to it
The amplitude of the vibrations may be constant or may vary with time, depending on the strength and frequency of the external force.	The amplitude of the vibrations will increase over time until it reaches a maximum, at which point the system is said to be in resonance.
Examples: A person pushing a swing, a machine generating vibrations, a car driving over a bumpy road	Examples: A person singing and breaking a wine glass, a flag flapping in the wind

22. Factors on which the frequency of a stretched string depends are

i) **The tension of the string**: Increasing the tension of the string increases the frequency of the resulting vibrations.

ii) **The mass per unit length of the string**: The more mass per unit length the string has, the lower the frequency of the resulting vibrations.

iii) **The length of the string**: The longer the string, the lower the frequency of the resulting vibrations.

23. Resonance is a phenomenon that occurs when an oscillating system (such as a pendulum) is subjected to a driving force (such as a push) that has the same frequency as the natural frequency of the system. This causes the system to absorb more energy from the driving force and the amplitude of the oscillations to increase.

In order for resonance to occur, the natural frequency of the oscillating system must be close to the frequency of the driving force, the system must be able to vibrate freely without damping or friction, and the driving force must be applied at the point of maximum amplitude.

An example of resonance is the swinging of a pendulum.

24. Resonance is a phenomenon that occurs when the frequency of a vibrating system is in harmony with the natural frequency of a second system.

In the case of a radio set, resonance is used to tune the radio to a specific frequency by adjusting the frequency of the radio's oscillator circuit to match the frequency of the radio station being received.

This is done by adjusting a component called a tuning capacitor, which changes the frequency of the oscillator circuit. When the oscillator circuit is resonating at the same frequency as the radio station, the radio is said to be "tuned" to that station, and the signal can be received and amplified.

25.

a) The two frequencies associated with a body undergoing forced vibrations are the **natural frequency** of the body and the **frequency of the external force** causing the vibrations.

b) When these two frequencies are equal, a phenomenon known as resonance occurs. Resonance occurs when the natural frequency of the body and the frequency of the external force are the same, and it can lead to an amplification of the vibrations.

26. The medium through which a body is vibrating can affect the amplitude of the vibrations. Factors that can influence the amplitude include the stiffness, density, and viscosity of the medium.

A stiff, dense, or viscous medium may dampen the vibrations and reduce the amplitude, while a softer, less dense, or less viscous medium may allow the vibrations to continue at a higher amplitude.

The specific way in which the medium affects the amplitude will depend on the specific properties of the medium and the nature of the vibrations of the body.

27. The frequency of a sound produced by an air column, such as those produced by a flute or clarinet, is primarily determined by the length and diameter of the air column. The temperature and humidity of the air within the air column can also affect the frequency of the sound.

Other factors that can affect the frequency include the shape of the air column, the presence of resonating cavities within the air column, and the presence of any obstructions or openings within the air column.

28. The sound of escaping gas is caused by the gas flowing through the opening in the tap and moving through the air. The movement of the gas creates a sound that can be heard. The smell of gas, on the other hand, is caused by molecules of gas being released into the air. These molecules are much smaller than the gas itself and take longer to travel through the air. This is why the smell of gas often comes a few seconds after the sound of the gas escaping.

29. In the case of the person walking past the railway line, it is possible that the ringing sound is caused by the resonance of the vibrations from the rails being transmitted through the ground and into the air as sound waves.

These vibrations may be amplified by the person's own footsteps, which could be causing their body or the ground they are walking on to vibrate at the same frequency as the vibrations from the rails. This could create a resonance effect that enhances the perceived volume of the sound and makes it seem louder to the person.

30. Amplitude, Frequency and Distance can determine the loudness of sound.

31. The ceiling of a concert hall is typically made with a curved shape for a number of reasons related to sound. One reason is that a curved ceiling can help to diffuse sound waves more evenly throughout the space, reducing the potential for areas of excessive or insufficient sound levels. This can help to create a more balanced and uniform sound experience for listeners throughout the hall.

In addition, a curved ceiling can also help to reduce the amount of sound reflection and reverberation within the space. This is because the curve of the ceiling can scatter sound waves in different directions, rather than allowing them to bounce directly off the surface. This can help to reduce the echo and "boominess" that can sometimes be present in large, reverberant spaces, and can help to create a more natural and pleasant sound.

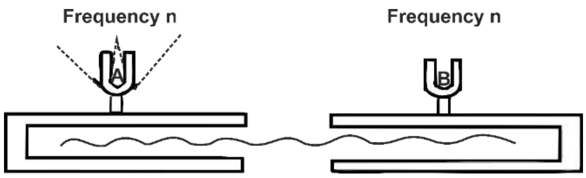
32.

i) **Law of diameter of string**: It states that the frequency of vibrations of stretched strings varies inversely as the diameter 'D' of the string.
$N \times \frac{1}{D}$

ii) **Law of density**: It states that the frequency of vibration of a stretched string varies inversely as the square root of the density of the material of string.
$N \times \frac{1}{\sqrt{\rho}}$

iii) **Law of mass per unit length**: It states that the frequency of vibrations of a stretched string varies inversely as the square root of its mass per unit length 'M'.
$N \times \frac{1}{\sqrt{M}}$

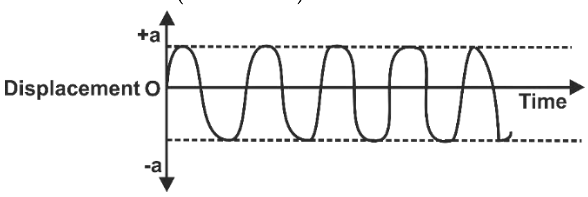
33. Resonance with Tuning forks



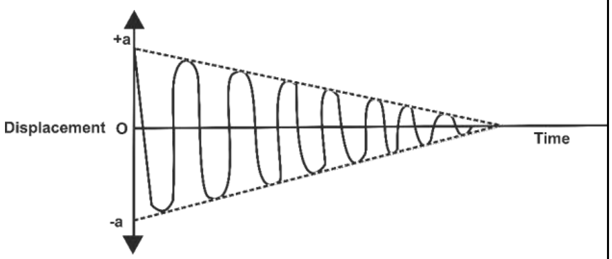
Take two sound boxes and place them with their open ends facing each other. Mount two identical tuning forks A and B of the same frequencies over the sound boxes as shown above. Set the tuning fork 'A' into vibrations.

After a few seconds, the tuning fork 'B' also sets into vibrations and a loud sound is heard. This is because of resonance. As the tuning fork A is set into vibrations, the air impulses act on the tuning fork B and set it into vibrations as their frequencies are the same.

34. i) Displacement: Time graph for free vibrations (in vacuum).



ii) Displacement: Time graph for damped vibrations.



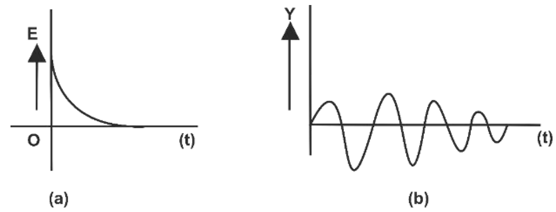
35. If the tension of a string is increased 4 times without changing its length, the frequency of its vibrations will also increase 4 times. This relationship between tension, length, and frequency is described by the equation:

$$f = \frac{1}{2l} \cdot \sqrt{\frac{T}{\mu}}$$

where tension is the force applied to the string, linear density is the mass per unit length of the string, and length is the length of the string. When the tension is increased while the length remains constant, the frequency of the vibrations will increase proportionally to the increase in tension.

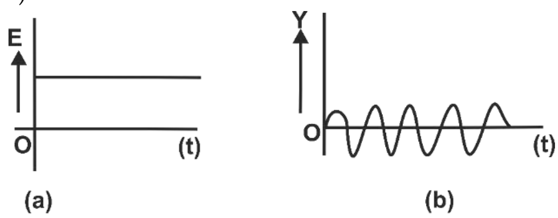
36.

a)



(Damped Vibrations)

b)



(Undamped Vibrations)

37. One characteristic that can help distinguish between a man's voice and a woman's voice is the **pitch** of the voice. In general, men tend to have deeper, lower-pitched voices, while women tend to have higher-pitched voices.

38. Amplitude, frequency, and quality.

39. The characteristics of sound are determined by the properties of the sound wave and the medium through which it travels.

i) **Frequency** is determined by the number of vibrations or cycles that a sound wave completes in a second. It is related to the speed at which the sound wave travels and the wavelength of the wave.

ii) **Amplitude** is determined by the strength or intensity of the sound wave. It is related to the amount of energy carried by the wave and the amount of pressure that it exerts on the particles of the medium through which it travels.

iii) **Quality** (Timbre) is determined by the spectral content of the sound wave, which is the distribution of energy across different frequencies. It is related to the shape of the waveform and the relative amplitudes of different frequencies within the wave.

40. Bel is a unit for measuring the intensity of sound. It is named in honour of Graham Bell who invented telephone.

II.

1. different
2. forced vibrations
3. resonance
4. louder
5. principle note, fundamental frequency
6. Temperature
7. Radio Detection and Ranging
8. forced vibrations
9. transverse waves

III.

1. True
2. True
3. False
4. True
5. False
6. True

PART 3

1. Natural vibrations of a body refer to the periodic motion of a body that occurs when it is subjected to a restoring force, such as a spring force or a gravitational force. This periodic motion is often referred to as the body's natural frequency or resonant frequency. Example: the oscillation of a simple pendulum.

2.

a) The frequency of sound emitted due to vibration in an air column depends on the length of the air column.

b) The frequency decreases as the length of the air column increases. Hence, we can say that they are inversely proportional to each other i.e., $f \propto 1 / L$

3.

a) Diagram showing the principle note is a)

b) Diagram which has the frequency four times that of the first is c)

c) The ratio of the frequency of vibrations in the diagram a) and b) is 1: 2

4. The difference is below:

DAMPED VIBRATIONS	**FREE VIBRATIONS**
Vibrations that occur when a system is disturbed from its equilibrium position and then subjected to some form of damping force, which slows down the vibrations over time.	Vibrations that occur when a system is disturbed from its equilibrium position and then left to vibrate on its own, without any external force acting on it.
The amplitude of damped vibrations decreases over time and eventually reaches zero, as the system comes to rest.	The amplitude of free vibrations decreases over time due to internal energy dissipation, but it never reaches zero.
The frequency of damped vibrations is generally lower than the natural frequency of the system, due to the damping force.	The frequency of free vibrations is constant and is determined by the natural frequency of the system.
Example: car with shock absorbers	Example: Swinging Pendulum

5. A loud sound is heard at resonance because the amplitude of the oscillation is at a maximum at resonance. When an object is in resonance, it is vibrating at its natural frequency, and the vibrations are able to build up and amplify each other, resulting in a larger overall amplitude. This increase in amplitude leads to a louder sound.

6.

a) No loud sound is heard with the tubes A and C, but a loud sound is heard with the tube B.

b) The reason for the difference in sound level is due to the different amounts of water in the test tubes. The water in test tube D has a higher level than the water in test tube C, which has a higher level than the water in test tube B, which has a higher level than the water in test tube A. The sound waves produced by the vibrating tuning fork are able to travel through the water, and the higher the water level, the more efficiently the sound waves are transmitted. This is because the higher water level provides more surface area for the sound waves to travel through.

c) The principle illustrated in this experiment is that the transmission of sound waves through a medium is more efficient when the medium has a higher level. This is because a higher level provides more surface area for the sound waves to travel through, allowing for more efficient transmission of the sound.

7. Stringed instruments like the guitar are provided with a hollow soundbox because it helps amplify the sound of the strings. When the strings of a guitar are plucked or strummed, they vibrate and produce sound waves. These sound waves then travel through the soundbox and are amplified, resulting in a louder sound. The shape and size of the soundbox can also affect the tone of the instrument, making it warmer or brighter.

8. Loudness is a measure of the intensity or strength of a sound. It is a subjective characteristic of sound, meaning that it is perceived differently by different people. Loudness is usually measured in decibels (dB), which are logarithmic units that represent the ratio of a physical quantity to a reference value. The reference value is typically a very small or faint sound, such as the sound of a whisper, and the physical quantity is the intensity of the sound being measured.

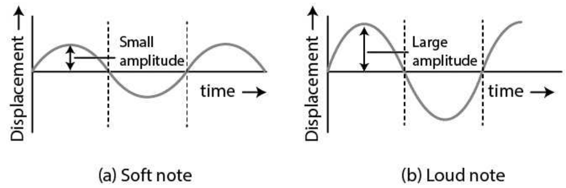
9. The loudness of sound heard by a listener depends on the following factors -

a) **Amplitude**: The amplitude of a sound wave refers to its strength or intensity. A sound wave with a higher amplitude will be louder than a sound wave with a lower amplitude.

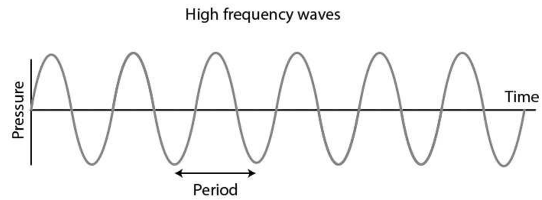
b) **Distance**: The distance between the source of the sound and the listener can also affect the loudness of the sound. As the distance between the source and the listener increases, the sound will become quieter.

c) **Frequency**: The frequency of a sound wave is also related to its pitch. Higher frequency sounds, such as those in the higher range of the human audible spectrum, will typically be perceived as louder than lower frequency sounds.

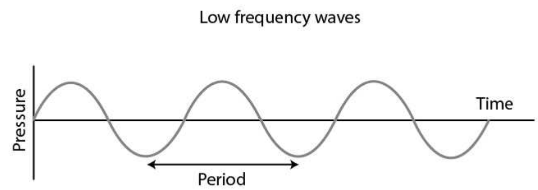
10.



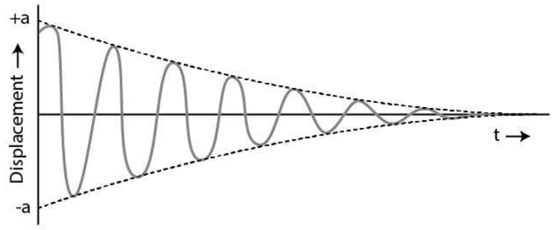
11. The diagram for high pitch note is



The diagram for low pitch note is



12. The displacement time graph of damped vibrations shown below



13.
a) Intensity/ amplitude of the sound wave
b) Frequency of the wave

14. c) A man.
When compared to the voices of a baby boy, baby girl, and woman, the voice of a man has a lower pitch. As the pitch of a man is low, which is proportional to the frequency of a sound, the man's voice is of minimum frequency as compared to others.

15.
a) Pitch (or Shrillness)
b) Pitch is that characteristic of sound by which an acute or shrill note can be distinguished from the grave or flat note.

16. Graph 'a' represents the male voice because the frequency of male voice is less than that of the female voice.

17. A tuning fork of frequency 256 Hz will resonate with another tuning fork of frequency 256 Hz.
Hint: Resonance occurs when the frequency of an externally applied periodic force on the body is equal to its natural frequency.

18. A stringed instrument is provided with the provision for adjusting the tension of the string. By varying the tension, we can get the desired frequency.

19. When a group of soldiers, also known as a troop, crosses a suspension bridge, it is typically recommended that they break their steps, or walk in a staggered formation rather than in a single file line. This is done to reduce the amount of stress that is placed on the bridge as the soldiers cross.

When soldiers walk in a single file line, their footsteps create a rhythmic vibration that can resonate through the bridge structure and potentially cause it to sway or oscillate. This can make the bridge feel unstable or even cause it to fail. By breaking their steps, the soldiers create a more random, irregular pattern of footsteps, which reduces the amount of vibration and helps to stabilize the bridge.

PART 4

1. (d) The vibrations with a constant frequency and constant amplitude.

2. (b) As graph B has highest frequency hence higher pitch.

3. (b) Pendulums A, B and D will also start vibrating but A and D will vibrate with the maximum amplitude.
Explanation: Since string PQ is flexible, it will also vibrate and hence A, B, D will also start vibrating. The lengths of pendulums A and D is same hence resonance will occur and hence amplitude increase.

4. c) A forced vibration, in which frequency of forced vibration is equal to the free vibrations of the body.

5.
a) When the natural frequency of vibration becomes equal to the frequency with which the object is vibrating, the object will have a maximum amplitude. This is called resonant vibrations.
b) Characteristic: Quality of Sound

According to Board Examiners

a) In the definition of resonant vibrations following glitches were observed
• keyword such as increase in amplitude was missing.
• natural frequency matching with forced vibration was written instead of frequency of forced vibration.
b) Many candidates wrote it correctly as Quality but quite a number of candidates also wrote as loudness, pitch, frequency.

6. Free vibrations of a body refer to oscillations that occur in a system when it is disturbed from its equilibrium position and then allowed to move freely, without any external force being applied.

7.

a)

i) Loudness

ii) This is because the amplitude of vibration of a base drum is far greater than the amplitude of vibration of the side drum.

b) Given,

f = 4 vibrations, t = 1/f = 1/4 = 0.25 s,

for a frequency of 6 vibrations, time t = 0.25 × 6 = 1.5 s,

V = 340ms^{-1}

Using d = V × t/2

$\therefore d = \frac{340 \times 1.5}{2} = 225\ m$

c)

i) Free vibrations / damped vibrations

ii) Forced vibrations

iii) D vibrates with the same amplitude as C or C and D vibrate with maximum amplitudes alternately.

iv) Resonance

According to Board Examiners

(a) a) Some candidates answered it correctly as loudness but majority of them wrote pitch or quality. It seems candidates were unaware about base drums and side drums.
b) Very few could relate the answer to the surface areas of the two drums and therefore the difference in the loudness, but majority of the candidates wrote vague answers.
(b) Many candidates attempted it correctly but, in some scripts, following errors were noticed:
- could not calculate the time taken from the number of oscillations of the pendulum.
- formula applied $v=\frac{d}{t}$ in place of $v= \frac{2d}{t}$.
- did not write the unit.
- velocity of sound was substituted as 320 m s^{-1} instead of 340 m s^{-1}.

(c) a) Many candidates could identify it as free oscillations but some of them wrote it forced oscillations.
b) Several candidates answered it correctly as forced oscillation but some of them wrote it resonance. But for others conceptual understanding was missing between free and forced oscillations.
c) Many candidates failed to write about increased amplitude but talked about increase in frequency. Some also mentioned that oscillations remain the same. Some of them missed the keyword amplitude.
(iv) Almost all the candidates wrote correctly as resonance but some of them wrote it forced oscillations.

8.

a) $I_1/I_2 = (a_1/a_2)^2 = (1/3)^2 = 1/9$

$\therefore I_1 : I_2 = 1 : 9$

b) 1:1 (because pitch is same)

According to Board Examiners

Most of the candidates answered it correctly but some of the candidates made following errors in both the sub parts a) and b).
- expressed the same ratio.
- expressed the answer in the fractional form.
- wrote reverse ratio.

9. Closing the holes near the mouthpiece of a flute will increase the pitch of the note produced because it causes the air column inside the flute to vibrate at a higher frequency. The pitch of a note on a wind instrument is determined by the length of the air column that is set into vibration, and a shorter air column will vibrate faster and produce a higher pitch.

10.

a) Damped vibrations

b) The amplitude of vibrations decreases due to the frictional force. The energy of the vibrating body continuously dissipates in doing work against the force of friction. Hence, its amplitude gradually decreases.

c) After some time, it stops vibrating when it has lost all its energy.

11.

a) Forced vibrations

b) Resonance

c) Frequency of the tuning fork B matches the natural frequency of the stretched wire and vibrates with greater amplitude.

According to Board Examiners

Most candidates answered sub-parts a), b) and c) correctly, however a few candidates wrote: a) damped and forced or resonant vibrations. b) forced vibrations. c) that the frequency of the tuning fork B becomes more than the natural frequency of the stretched wire and vibrates with greater amplitude or vice versa or the explanation of increased amplitude was missing.

12.

a) The periodic vibrations of decreasing amplitude due to the presence of a resistive force are called as damped vibrations.

b) – A vibrating tuning fork in air
– Oscillations of a simple pendulum in air
– A slim branch of a tree pulled and released

13. Forced vibration or resonance.

14. Two ways of increasing the frequency of vibrations of a stretched string are -

a) By increasing the tension in the string

b) By decreasing the length of the string

15.

a) Resonance

b) Resonance is a particular case of forced vibration in which the frequency of forced vibrations is equal to the natural frequency of the body and the body begins to vibrate with increased amplitude.

16.

a) Pendulum B and D executes forced vibrations.

b) Pendulum C will be in a state of Resonance.

c) Natural frequency of B does not match with Natural frequency of A.
Natural frequency of C matches with that of A.

17. A body executes free vibrations in vacuum.

18.

Resonance	Forced Vibrations
Vibrations are of large amplitude.	Vibrations are usually small amplitude.
Frequency of an external applied periodic force is equal or an integer multiple to the natural frequency of the body.	Frequency need not be equal or integer multiple to the natural body frequency of the body.

19. Acoustic resonance occurs when a sound wave with a particular frequency causes an object to vibrate at the same frequency. This can cause the object to amplify the sound wave, making it louder.

For example, if you strike a drum, the drumhead will vibrate at a particular frequency, depending on its size and material. If you sing a note or play a note on an instrument that matches the resonant frequency of the drum, the drum will amplify the sound of your voice or instrument, making it louder. This is why certain notes or frequencies sound louder or clearer when played on certain instruments.

20.

a) A person is trying to adjust the radio set's frequency so that it matches the frequency of the radio station they want to listen to.

b) Electrical resonance

21.

a) The rattling sound that is sometimes heard when a vehicle is driven at a particular speed is called resonance. This occurs when the natural frequency of a system, in this case the vehicle and its components, matches the frequency of an external force, such as the vibration of the engine or the road surface. When this occurs, the vibrations can amplify and cause a resonant vibration, which can be heard as a rattling sound.

b) To stop the rattling sound, it may be necessary to identify and address the source of the vibration, or to add materials to absorb or dissipate the vibrational energy. Alternatively, changing the operating speed of the vehicle or modifying the natural frequency of the system may also be effective in stopping the resonance and the rattling sound.

Chapter 4 - Electricity & Magnetism

PART 1

1. a) Increases
2. a) Charge per unit area
3. b) CS^{-1}
4. b) Ohm m
5. c) 1/100 ohm
6. c) r/u
7. a) E/2
8. b) Neither the Ammeter nor the Voltmeter will be damaged
9. c) Nine- times
10. d) Ohmic conductors.
11. a) Is the same all over the surface
12. c) Carbon
13. c) ε
14. c) R = r
15. b) The current decreases
16. d) To provide a path for the flow of current
17. d) A zigzag line
18. d) Diamond
19. a) Electric current
20. a) Open circuit
21. d) Two parallel lines with a wavy line between them
22. a) Conductance is the reciprocal of resistance
23. d) Siemens
24. c) P = VI
25. a) Ohm's law
26. a) R = V/I
27. b) V = I/R
28. d) The voltage divider rule
29. a) I = V/R

PART 2

I.

1. The flowing charge through a conductor is called conventional current.

2. Current is defined as the rate of flow of charge.
SI unit of current is Ampere. It is measured in ampere (a).

3. The current due to moving electrons is called electronic current.

4. The flowing charge through a conductor is called current electricity. It is also called conventional current.

5. We have V × I = P or I = P/V = (40/250) A = 0.16 A, Current drawn = 0.16 A

6. Unit of electric charge is coulomb. 1 coulomb is equivalent to a charge of 6.25×10^{18} electrons.

7. Electric potential is the condition which determines the direction of flow of charge.

8. Potential difference between two points in an electric circuit is the amount of work done to move certain amount of charge from one point to another Point. It is measured in Volts.

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Amount of charge}}$$

$$V = \frac{W}{Q}$$

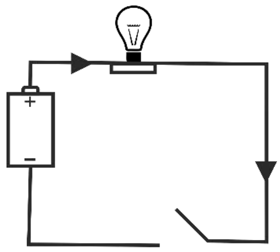
9. An electric cell is a device which maintains a constant potential difference across an electric circuit by converting chemical energy into electric energy.

10. Electromotive force is the potential difference across the terminal of a cell when it is not doing any external work. It is a content

quantity for a given cell. It is measured in Volts.

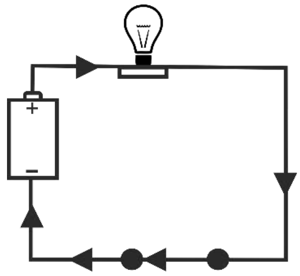
11. A continuous conducting path between the terminals of source of electricity (such as a battery) is called electric circuit.

12. An open electric circuit is a circuit in which there is a break or interruption in the path that the electric current is flowing through. In an open circuit, no current flows because the flow of charge is blocked by the break in the circuit.



Open Electric Circuit

13. A closed electric circuit is a circuit in which there is a complete path for the electric current to flow. In a closed circuit, the electric current flows through the conductors and devices in the circuit, allowing electrical energy to be used or transformed.



Closed Electric Circuit

14. The opposition or obstruction offered by a conductor to the passage of drifting electrons is called electric resistance.

15. The resistance offered by a connector of unit length and unit area of cross-section, such that current enters and leaves from its opposite ends is called specific resistance units- C.G.S – ohm-centimeter [Ω-cm]. S.I – ohm-metre (Ω-m).

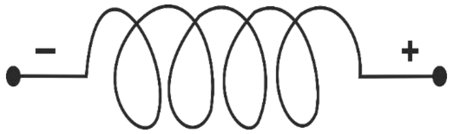
16. It is represented by zigzag line. The figure shows a fixed resistance wire or resistor. Two thick dots at the ends represent brass terminals in which this wire is fixed. The resistance wire is generally made from alloys like manganin, nichrome, constantan etc.

17. A resistance whose magnitude can be altered when desired is called variable resistance. Variable resistances are of two kinds.

a) **Rheostat**:
In this kind of resistance, its magnitude of resistance can be altered but change in resistance is not known.

b) **Resistance box**:
In this kind of resistance, the change in magnitude of resistance is known.

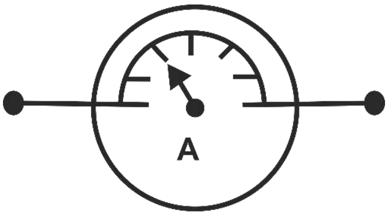
18.



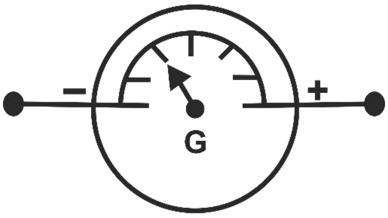
Solenoid is an insulated copper coil of large no. of turns. It behaves like a magnet on the passage of electric current through it.

19.

a) Voltmeter is a device used for measuring difference between two points in an electric circuit. It measures potential difference in volts.
b) Ammeter is a device used for measuring current in electric circuits in amperes.



c) Galvanometer is a device used for detecting the flow of current in electric circuit.



20. Electric conductance is a measure of the ability of a material to conduct electric current. It is the reciprocal of electric resistance and is expressed in units of siemens (S). The conductance of a material is directly proportional to the cross-sectional area of the material and the number of free electrons it contains, and inversely proportional to its length.

21. The opposition or obstruction offered by a conductor to the passage of drifting electrons is called electric resistance.
Unit of resistance:
Resistance is measured in 'Ohms' symbol Ω.

22.
a) Kilo – Ohm (K Ω) = 10^3 Ohms
b) Mega Ohm (M Ω) = 10^6 Ohm
c) Giga – Ohm (G Ω) = 10^9 Ohm

23.

E.M.F.	**P.D (Potential Difference)**
It is the potential difference between 2 definite points associated with a source.	Potential difference may exist between any two points in a closed circuit.
It exists even when the circuit is not closed.	It exists only when the circuit is closed.

24. Three laws of resistance are -

a) Resistance of conductor depends upon its nature.
b) Law of length: Resistance of a conductor is directly proportional to its length.
c) Law of area of cross section: resistance of a conductor is inversely proportional to its area of cross section $R\ X \frac{1}{a}$

25. When several resistors are connected end to end such that the tail of one resistor is connected to initial end of another resistor, so as to form a closed electrical circuit, then such a circuit is called a series circuit.

26. When several resistors are connected in such a way that they have common positive and common negative terminals, then the resistors are said to be connected in parallel. The circuit so obtained is called parallel circuit.

27.
a) Surface area of the electrodes in contact with the electrolyte.
b) Distance between the electrodes or plates.

28. Cell in series can give a large current only if their internal resistance is so small that it is negligible with respect to external resistance. It is for this reason that led acid accumulators are connected in series.

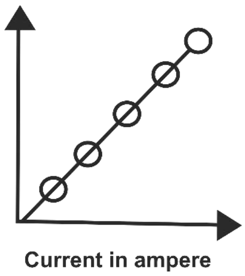
29. Cell can give maximum current in parallel only, if external resistance is very small and internal resistance is large.

30.
a) Ohmic resistance must be used.
b) Temperature should be kept constant.

31. Internal resistance of a cell is the resistance offered by the electrolyte of a cell.

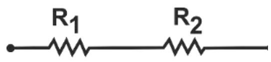
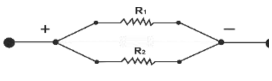
32. If a graph is plotted between potential difference and current, it is found to be a straight line. From the graph, it can be concluded:

$$V \times I \text{ or } V = IR \text{ or } I = \frac{V}{R}$$



33. The resistors which do not obey ohm's law such as a diode, a transistor, an electrolyte, all non-metal armature of fans and motors are non-ohmic resistances.

34.

Series combination	Parallel combination
	 Fig.18 (Parallel Circuit)
The current passing through each resistor has the same value.	The total current in the battery circuit is the sum of the current in each resistor.
In the combination potential difference across the combination equals the sum of the potential difference across each of the resistors.	Potential difference across the combination is equal to the potential differences across anyone.

35. If an Ammeter is connected in parallel, the resultant resistance of the circuit decreases and more current passes through the instrument. Hence the Ammeter is likely to burn out.

36. One ampere is defined as the amount of current when 1 coulomb of charge passes through a conductor in one second.

37.

a) Conductance of a material is an expression of the ease with which electric current flow through.

b) The reciprocal of resistance is called conductance.

38. The unit of conductance is $\frac{1}{Ohm}$ or $(ohm)^{-1}$
It is normally stated as Mho or Siemen 1 Mho = $(ohm)^{-1}$.

39. Electrical conductivity is the reciprocal of electrical resistivity.

40.

a) Good conductor X Temperature

b) Semiconductor X $\frac{1}{temp}$

c) Alloy →No change

41. When a given wire is stretched to double its length, its area of cross section will be halved, so the resistance of wire will become four times.

42. Resistivity will remain the same.

43.

a) The resistance offered by the electrolyte of a cell is called internal resistance to the flow of current.

b) Cathode to anode

44. The unit which is used for calculation of electric energy for domestic consumption is called BOT unit.

45. The opposition for resistance offered by a conductor to the passage of drifting electrons is called electrical resistance.

46.

a) Resistance × length of conductor

b) Resistance is inversely proportional to area of cross – section

c) Resistance depends upon the nature of material

d) Resistance × Temperature

47. Ohm-metre

48. Conductance × $\frac{1}{Resistivity}$

49.

a) An Ammeter is an instrument used to measure the current in a circuit. An ideal Ammeter should have zero resistance.

An Ammeter is always connected in series with the circuit. By keeping its resistance low, the inclusion on the Ammeter in the circuit does not affect the potential difference of the circuit.

50.

a) A voltmeter is an instrument used to measure potential difference between two points in an electric field. An ideal Voltmeter has infinite resistance.

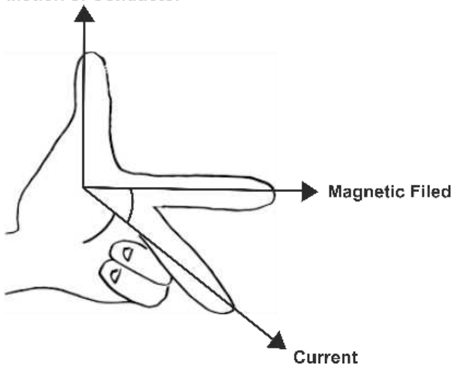
A Voltmeter is always connected in parallel with the circuit. By keeping its resistance high, the inclusion of Voltmeter in the circuit does not affect the potential difference of the circuit.

51. Newton ampere^{-1} metre^{-1} or weber metre^{-2}.

52. Circular

53. When the electric charge is in motion.

54. According to Lenz's law the direction of induced e.m.f is such that it always tends to oppose the cause which produces it.



55. If we stretch the thumb, the forefinger and the middle finger of our right hand are mutually at right angles to each other, such that fore-finger points in the direction of magnetic field and the thumb in the direction of motion of conductor, then the direction in which middle finger points, gives the direction of flow of induced current.

56. Yes, the direction gets reversed with the current getting reversed.

57. The direction of a magnetic field produced due to the flow of current can be determined by right hand thumb rule.
Right hand thumb rule – Imagine that you are holding the conductor in the right hand, such that the thumb is in the direction of the current and the other fingers are folded around the conductor. The direction in which the finger encircles around the wire, represent the direction of the field around the conductor.

58. He observed that a magnetic field is produced around a current carrying conductor.

59. Concentric circles

60. Electric motor is a device which converts electrical energy into mechanical energy.

61. When a magnetic compass is brought near a current carrying solenoid, its north pole will be attracted by one end of the solenoid and repelled by the other. Similarly, South Pole of the magnetic compass will be attracted by one end and repelled by the other end of the solenoid. This is why a current carrying solenoid behaves like a bar magnet with fixed polarities at its ends.

62. The electromagnet is a temporary magnet which can be magnetized in a very short time as per our requirements. In simplest form an electromagnet consists simply of a soft iron core around which a large number of turns of insulated wire are wound.

63. Soft iron is used as the core of an electromagnet because it is easily magnetized and demagnetized, making it suitable for use in applications where the magnet needs to be turned on and off frequently. Soft iron is also a good electrical conductor, which makes it efficient at conducting the magnetic field generated by the electromagnet.

64. A permanent magnet is a magnet made from steel such that once magnetized, it does not lose its magnetism easily.

Use: It is used in Galvanometer.

65. A moving charge in magnetic field not parallel to the field, experience a force called "LORENTZ FORCE" and since moving charge is called current then conductor carrying a current in magnetic field experiences force, F = BIL in other words. This force can be expressed as follows.
F × B (Magnetic field)
F × I (current)
F × L (length of conductor inside the field)
S.I unit of magnetic field B = $\frac{F}{IT} = \frac{N}{Am}$ = $NA^{-1}\ m^{-1}$
Or unit is tesla (T)

66.
a) The magnitude of the e.m.f induced is directly proportional to the rate of magnetic flux linked with the coil.
b) Whenever there is a change in magnetic flux linked with a coil an e.m.f is induced. The induced e.m.f lasts so long as there is a change in magnetic flux linked with coil.

67. It helps in setting up a strong magnetic couple.

68. It increases the magnitude of induced e.m.f.

69. It intensifies the magnetic field setup.

70.
a) At 92° and 270°
b) At 180° and 360°

71. Winding more coils on a soft iron core at an angle can increase the inductance and resistance to AC and DC current of the coil, depending on the specific circumstances and the purpose of the coil. The specific effects will depend on various factors such as the number of coils, the size and shape of the core, and the intended use of the coil.

72. If a right-handed corkscrew is rotated so that it moves in the direction of flow of current through the conductor, then the direction of the rotation of the thumb gives the direction of magnetic lines of force.

73. If a large current is passed through the galvanometer, it can damage the device in several ways. First, the large current may cause the needle to deflect too far, potentially causing it to become stuck or to break. Additionally, the large current may produce a magnetic field that is too strong, which could cause the coil to become overheated or even to burn out. Finally, the large current may cause the galvanometer's internal components to become damaged due to the excess heat or stress.

74. When an ammeter is connected in series with a circuit, it becomes part of the circuit and the current passing through the circuit also flows through the ammeter. This allows the ammeter to measure the current flowing in the circuit.

If an ammeter were connected in parallel with the circuit, it would not be able to accurately measure the current flowing in the circuit. This is because the current would be divided between the circuit and the ammeter, and the ammeter would only be able to measure the portion of the current that is flowing through it, rather than the total current flowing in the circuit.

75. In a galvanometer, a coil of wire is suspended in a magnetic field. When a current passes through the coil, the magnetic field created by the current interacts with the magnetic field of the galvanometer. This interaction causes the coil to rotate.

76. Concave cylindrical magnets produce a magnetic field:
a) Highly intensified
b) Uniform
Thus, it helps in producing a strong magnetic couple.

77. A pivoted type moving coil galvanometer is not well-suited for measuring alternating current (AC) because its high resistance would severely limit the flow of AC and cause inaccurate readings.

78. An Ammeter is a very low resistance instrument. Thus, when connected in series, it practically does not consume any current, but can measure its magnitude.

79. Voltmeter must measure potential difference between two points. Thus, it must be connected in parallel to these points. Furthermore, Voltmeter is a high resistance instrument. Thus, if connected in series, it will completely block the main current or alter its magnitude.

80. If the magnetic lines of force increase within the coil, it drives the free electrons (dipoles) in one direction. This gives rise to induced current and hence, Galvanometer shows deflection.

81.

Physical quantities	Nature of the physical quantity
Current	Scalar
Charge	Scalar
Potential difference	Scalar
Electromotive force	Scalar
Resistance	Scalar
Internal resistance	Scalar
Electrical energy	Scalar
Electric power	Scalar

82. Internal resistance of a cell depends on the following factors:

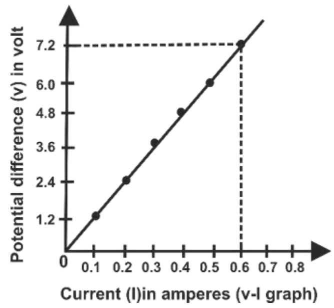
a) **The surface area of the electrodes**.
Larger the surface area, Smaller is the internal resistance.

b) **Concentration of the electrolyte**.
Higher the concentration of the electrolyte, Greater is the internal resistance.

c) **Distance between electrodes**.
More distance between electrodes, Greater is the internal resistance.

d) **Temperature of the electrolyte**.
Higher the temperature of the electrolyte, Smaller is the internal resistance.

83. The required graph is:



a) We observe that in the graph drawn, the potential difference v/s current is a straight line. This confirms the Ohm's law.

b) The slope of straight line on V- I graph gives the resistance of the resistor.

c) Resistance $= \frac{\Delta V}{\Delta I} = \frac{7.2-0}{0.6-0}$
$= \frac{7.2}{0.6} = 12\Omega$

84. Potential is that electrical state of conductors which determines the direction of flow of charge when two conductors are connected by a metallic wire.

85. The conductor having excess of electrons is said to be at a **negative or lower potential** while the conductor having deficit of electrons is said to be at **positive or higher potential.**

86. Nichrome is used for making wires to prepare heating coils. The reason is that its melting point and resistivity are very high.

87.

a) An insulator will have higher resistivity.

b) The resistance of connecting wires should be almost negligible. As a thick copper wire has small resistance and the resistivity is low, they are used as connecting wires.

88. We connect resistors in parallel when we want less resistance at a high potential.

89. We connect resistance in series when we want a large resistance and at the same time want to distribute potential.

90. a) 10^{-8}ohm m b) 10^{-5}ohm m c) 10^{10}ohm m

91. During the motion of electron through a conductor, the electron suffers collision with other electrons or the ions of the conductor. As a result, their motion is opposed. This opposition is the cause of resistance.

92. 1 V.

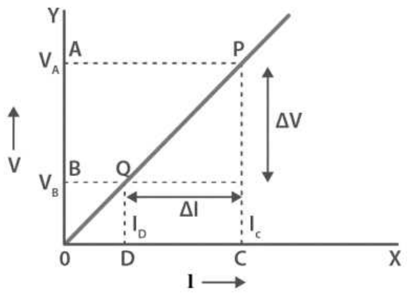
II.

1. greater
2. resistance
3. electrons
4. charge
5. opposite
6. same
7. heavy/different
8. temperature
9. Volt
10. Ohm Ω
11. lower
12. Ohm metre
13. Conductivity
14. decreases
15. less
16. current, resistance
17. 3000^0C.
18. charge of electron
19. 1.6×10^{-19}
20. 6.25×10^{-18}C.
21. NC^{-1}
22. 3.6×10^6J.
23. increase
24. Ω m
25. Potential
26. current
27. Low
28. High
29. Bar magnet
30. It is an instrument used to detect the position of direction.
31. A magnetic field
32. Current flowing in the coil

PART 3

1.

a) V-I graph for a conductor obeying Ohm's law is given below -



b) Slope of V-I graph for a conductor represents resistance.

2.

a) For wire of radius r_1

$R_1 = \varrho\ (l / A_1)$

$R_1 = \varrho\ (l / \pi r_1^2)$

For wire of radius r_2

$R_2 = \varrho\ (l / A_2)$

$R_2 = \varrho\ (l / \pi r_2^2)$

∴ R_1: R_2 will be

$\varrho\ (l / \pi r_1^2) : \varrho\ (l / \pi r_2^2)$

$= r_2^2 : r_1^2$

b) The resistivities of the two wires will be same because the material of the two wires is same. That is $\varrho_1 : \varrho_2 = 1 : 1$

3. Resistance of 220 V, 50 W lamp is

$R_1 = V^2 / P_1$

$R_1 = (220)^2 / 100$

$R_1 = 968$ ohm

Resistance of 220 V, 100 W lamp is

$R_2 = V^2 / P_2$

$R_2 = (220)^2 / 100$

$R_2 = 484$ ohm

Same current I pass through each lamp because the two lamps are connected in series.

Power consumed in 220 V, 50 W lamp is

$P_1 = I^2R_1$

Power consumed in 220 V, 100 W lamp is

$P_2 = I^2R_2$

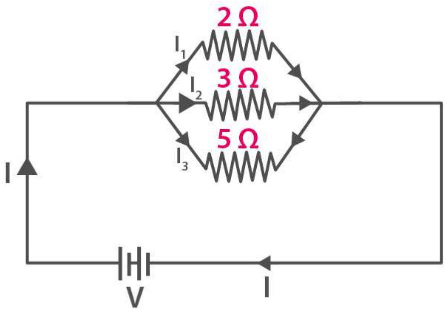
Here, $R_1 > R_2$

So, $P_1 > P_2$

Thus 50 W lamp consumes more power

4. Fleming's right-hand rule is the law which determines the direction of current induced in the conductor.

5. To get a total resistance less than 1 Ω, the three resistors should be connected in parallel.



Let the total resistance be R′

Then, 1 / R′ = 1 / 2 + 1 / 3 + 1 / 5

1 / R′ = (15 + 10 + 6) / 30

1 / R′ = 31 / 30 Ω or

R′ = 30 / 31

R′ = 0.97 Ω

6. According to Lenz's law, the direction of induced e.m.f. (or induced current) is such that it opposes the cause which produces it.

7. The potential difference between two points is said to be 1 volt when 1 joule of work is done in bringing 1 coulomb charge from infinity to that point.

8.

a) 1 – Earth, 2 – Neutral and 3 – Live

b) Terminal 1 is connected to the outer metallic case of the appliance.

c) The fuse is connected to live wire joined to 3 because in case of excessive flow of current, fuse melts first and breaks down the circuit to protect appliances.

9.

a) A cylindrical coil of diameter less than its length is solenoid.

b) Electromagnet is the name of the device obtained.

c) Electromagnet is used in electric relay.

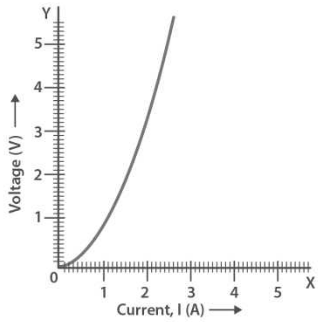
10. In most cases, a fuse is connected in the live wire, or "hot" wire, of the circuit. This is because the live wire carries the full electrical current to the circuit, and it is this current that the fuse is designed to interrupt if it becomes too high.

11.

Electromagnet	Permanent magnet
It is made of soft iron.	It is made of steel.
The polarity of an electromagnet can be reversed.	The polarity of a permanent magnet cannot be reversed.

12. The conductors that do not obey the Ohm's law are known as the non-ohmic resistors or non-linear resistances).

Examples: LED, solar cell, junction diode, etc.



V v/s I for non-ohmic conductors

13. Porcelain is an insulator of electricity. Hence, the fuse wire is fitted in a porcelain casing.

14.

a) The magnetic field lines become rarer on decreasing the current.

b) If the direction of current is reversed, the direction of the magnetic field is also reversed.

15. It is generally not safe to connect a switch in the neutral wire of an electrical circuit. The neutral wire is used to complete the circuit and return electrical current back to the source, and it is typically grounded to protect against electrical shocks. If a switch is connected in the neutral wire, it can interrupt the normal flow of electrical current and create a potential shock hazard.

16. The safe limit of current which can flow through the electrical appliance is I = P / V

Now,

Substituting 5 kW and 200 V in I = P / V, we get

I = P / V

I = 5000 / 200
I = 25 A
25 A is greater than 8 A.
Hence, such fuse cannot be used.

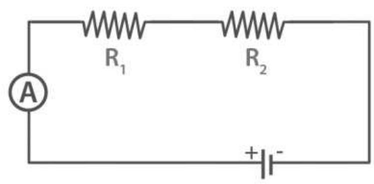
17.

a) The polarity at the end A is the north pole and at the end, B is the south pole.

b) The north pole of the compass needle will defect towards west.
Tip: End A of the coil behaves like north pole which repels the north pole of the compass needle towards the west.

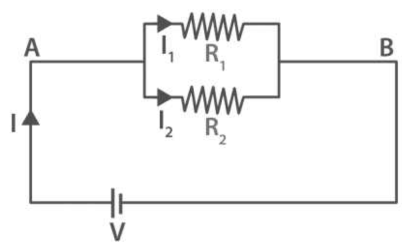
18.

a)



R_1 = 2 ohm
R_2 = 3 ohm
R = $R_1 + R_2$
R = 2 + 3; R = 5 ohm
V = 6 V
Now, I = V / R
I = 6 / 5; I = 1.2 A

b)



Here, R_1 and R_2 are connected in parallel.
$1 / R = 1 / R_1 + 1 / R_2$
1 / R = 1 / 2 + 1 / 3
1 / R = (3 + 2) / 6
1 / R = 5 / 6
R = 6 / 5; R = 1.2 ohm
V = 6 V
We know that,
I = V / R
I = 6 / 1.2; I = 5 A
Therefore, in series: 1.2 A and in parallel: 5 A

19. The three factors on which the resistance of wire depends are as follows -

i) Resistance of a wire is directly proportional to its length that is $R \propto l$.

ii) Resistance of a wire varies inversely as the area of cross section of the wire. The resistance will be less when the area of cross section of the wire is more and vice versa
$R \propto 1 / a$

iii) Resistance of a conductor increases with an increase in its temperature. As a result, the number of collisions increases.
Resistance depends on the nature of conductor since different substances have different concentration of free electrons. Substances which have a large concentration of electrons, offer less resistance and hence called good conductors and substances which have negligible concentration of free electrons offer very high resistance and are called insulators.

20. Given, Current, I = 0.2 A
Potential difference, V = 15 V
Time, t = 60 sec As V = IR

a) To calculate the resistance of the wire
R = V / I
R = 15 / 0.2
R = 75 ohm

b) To calculate the heat energy produced in 1 minute:
Heat energy, $H = I^2Rt$
$H = (0.2)^2 \times 75 \times 60$
H = 180 J

21. The safe limit of current for the kettle is I = 3000 / 250 = 12 A
Yes, this kettle can be used in a circuit which contains a fuse of current rating 13 A as the safe limit of current for kettle is 12 A.

22.

a) When a magnet is moved towards a coil having a galvanometer between its ends then mechanical energy changes to the electrical energy.

b) The phenomenon is known as electromagnetic induction.

PART 4

1. A straight line passing through origin
Explanation: For ohmic resistors, V – I graph is a straight line passing through origin.

2. (A) Given P = 440 W
V = 220 volts
P = V I
$I = \frac{P}{V}$
$= \frac{440}{220} = 2A$
(B) V = IR
$R = \frac{V}{I}$
$R = \frac{220}{2}$
R = 110 Ω

3. (A) When this bulb is put across 240 V supply, it will consume 100 J of energy per second.
(B) If line voltage drops to 220 V from 240 V the power consumed will also drop and bulb will glow less bright.
(C) $R = \frac{V^2}{P}$
$= \frac{240 \times 240}{100}$
= 576 Ω
(D) Energy = Power x time
= 100 x 10 x 60
= 60,000 J

4. (c) a live as well as neutral wire
Explanation: the main switch in the distribution board is double pole (DP) switch which connects and detaches both live and neutral wire simultaneously.

5. (d) earth wire is used to prevent electric shock.

6. (a) Factors on which the force experienced by a conductor carrying current, placed in a magnetic field depends are:
Magnitude of current in the conductor.
Magnitude of external magnetic field.
As magnitude of current or magnetic field is increased, force also increases.
(b) Fleming's Left Hand Rule

7. (a) Faraday's laws of electromagnetic induction describe how a changing magnetic field can induce an electric current in a circuit.
(b) One device that uses this principle is a transformer, which transfers electrical energy between two or more circuits through a common electromagnetic field.

8. Copper has low resistivity and high melting point whereas fuse wire has low melting point and high resistivity.

According to Board Examiners

Majority of the candidates wrote about resistance instead of resistivity. Some candidates wrote the reason for not using a copper wire as a fuse wire was the low melting point of copper/copper melts quickly/low specific heat capacity of copper. Some wrote the characteristics of a fuse only without comparing it with copper.

9. $R_1 = \frac{6 \times 3}{6+3}$

$\therefore R_1 = 2\Omega$

R = 2 + 5 = 7Ω

According to Board Examiners

Most of the candidates answered this part correctly. However, the following errors were also observed:
- In the parallel combination formula, substitution was incorrect.
- Calculation errors were common.
- Units were not written in the final answer.

10.
a) 0^o / zero or parallel (180, 360……)
b) (90^o or Perpendicular (270….)
Tip: When a current carrying conductor is placed in a magnetic field, it experiences a mechanical force, which can make the conductor move.

According to Board Examiners

This was answered correctly by most candidates. However, a few candidates answered this part of the question by keeping a coil in mind instead of a straight conductor. Some candidates were not able to write the angles between the magnetic field and the length of the conductor for the asked forces.

11.

a) Superconductors are materials that can conduct electricity with zero resistance. When a material becomes a superconductor, it can carry an electric current indefinitely without losing any energy to resistance. This property allows superconductors to be used in a variety of applications, such as in medical imaging, transportation, and energy storage.

b) $P = VI$

$110 = 220 \times I$

$I = 110/220 = 1/2 = 0.5$ A

c) Carbon/ silicon/germanium or a semiconductor

According to Board Examiners

a) Most of the candidates answered this part correctly but some candidates were confused between superconductors and semiconductors.
b) A large number of the candidates solved this problem correctly. However, following errors were noticed in many scripts:
- errors in copying the given data
- error in calculation
- unit not written
- incorrect unit given
c) Almost all candidates answered correctly, but some wrote random names such as, galvanized rubber, metals, copper, aluminium, tungsten, constantan, mangnanin, nichrome, which were incorrect.

12.

a) The specific resistance of a metal increases with the increase in the temperature.

b) The specific resistance of a semiconductor decreases with the increase in the temperature.

According to Board Examiners

a) Most of the candidates wrote the effect of an increase in the temperature on the specific resistance of a metal, increases which was a correct answer. But following answers were also observed that is the specific resistance of a metal does not change or decreases.
b) Most of the candidates answered it correctly but some candidates wrote that with the increase in temperature, the specific resistance of a semiconductor increases or remains the same.

13. $R_1 = \frac{9 \times 3}{9+3}$

$= \frac{27}{12} = \frac{9}{4}\Omega$

$\therefore R = 8 + \frac{9}{4} = \frac{32+9}{4} = \frac{41}{4} = 10.25\Omega$

14. $x < y$

Induced e.m.f. is directly proportional to the number of turns of the coil.

Tip: Factors affecting the magnitude of induced e.m.f.

According to Board Examiners

Almost all the candidates answered it correctly. But while giving reason some candidates wrote the statement which was not conveying the correct meaning.

15.

a) One advantage of connecting electrical appliances in parallel combination –
Each appliance will be working at the same potential so each appliance can operate independently.

b) A fuse wire has high resistivity and low melting point.

c) Earth wire

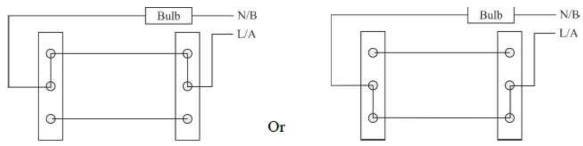
According to Board Examiners

a) Many candidates wrote one advantage of connecting electrical appliances in parallel combination correctly. However, some candidates supplied vague answers like
- advantages of series combination.
- current received is 220 volts.
- work on the same current in place of voltage.
- wrote about advantages of ring system of wiring.
- same thickness of wire can be used.
- monthly Power bill is reduced.

b) A large number of candidates wrote characteristics of a fuse wire correctly. Some candidates answered high melting point and low resistivity. Some even expressed about good conductance or low specific heat capacity which was irrelevant.
c) Many candidates answered correctly as Earth wire. It was also observed that some of the candidates had written about neutral and live wire and their combinations. Quite a few candidates had answered as fuse wire.

16.

a)



b) A – Live and B – Neutral

Tip: Live wire is always connected to the mains

According to Board Examiners

a) Several candidates copied the diagram of dual control switch circuit connected to a bulb correctly and also completed the circuit correctly but many of them kept the circuit incomplete or completed it incorrectly.
b) Some candidates answered correctly as A - live wire and B - neutral wire. Quite a few candidates interchanged this answer. Some candidates made careless errors by interchanging the markings A and B while copying the diagram.

17.

a) R= 5 + 0.5 = 5.5 Ω

b) $I = \frac{3.3}{5.5} = \frac{3}{5} = 0.6A$

c) $R_1 = \frac{5*5}{5+5} = 2.5\ \Omega$

d) ∴ R = 2.5 + 0.5 =3 Ω

$I = \frac{3.3}{3} = 1.1A$

According to Board Examiners

Some candidates solved this question correctly but many of them could not comprehend it properly. Candidates did not take into consideration the position of the key in the circuit. They did not realise that when the key is closed and when it is open, the resistance present in the circuit differs, so the resistance of the circuit is different in both cases and therefore, the current is also different in both the cases. Many candidates blindly wrote current is zero when the key k is open. The difference between open circuit and open key was not clear to the candidates. Some of the candidates did not write the units for the answers. It was also observed in some scripts that candidates were not trained in dealing with the internal resistance.

18.

a) Towards east

b) Magnetic effect of current

c) Deflection in the opposite direction / towards west

d) Electric Bell, Electromagnet

19.

a) Alternating current

b) 220V

20.

a)

i) $I = P/V = 5000/200 = 25A$

No, it cannot be used. Maximum current drawn by the appliance is greater than the fuse rating of 8A.

ii) M.C.B. Fuse, switch

b)

i) $R_1 = \frac{6\times3}{6+3} = 2\Omega$ or $R_2 = \frac{4\times12}{4+12} = 3\Omega$

R = 2 + 3 = 5 Ω

ii) No, it does not change.

Tip: Resistivity is the intrinsic property of the material that does not depend on the dimension of the material.

21.

a) E = P x t = 2 × 2 = 4 kW h [Correct substitution]
Cost for running it for a week
= 4 × 7 × 4.25 = Rs. 119

b) Power circuits draw large amount of current. Electric shock in this circuit is very fatal. Hence to avoid it, fuse is necessary in the power circuit/ to safeguard.

22.

a) North and South

Tip: Anticlockwise current means north and clockwise means south.

b) Increasing the strength of current through the coil can strengthen the magnetic field in the electromagnet.

c) The polarities at the two ends will be reversed.

23.

a) $P = i^2R = \frac{4}{10} \times \frac{4}{10} \times 500 = 80W$

b) $V = iR = \frac{4}{10} \times 500 = 200V$

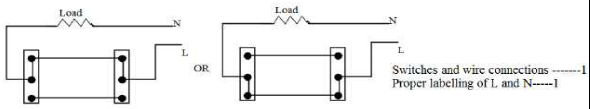
24.

a)

i) Green / Yellow

Tip: Earth wire is connected to the metallic body of an appliance.

ii)



b)

i) Electrons

ii) Earth wire

iii) Live wire

c) The "current rating" of a fuse is the maximum amount of electrical current that the fuse is designed to safely handle without breaking or "blowing." A fuse with a current rating of 5A (amperes) is designed to interrupt the flow of electrical current if the current flowing through it exceeds 5A. This helps protect electrical circuits and devices from damage that can be caused by excess current.

25. A represents the parallel combination. Resistance in parallel connection is less in comparison to series connection. A is less steep than B.
Tip: Graphical representation of Ohm's Law. The slope of V-I graph gives the resistance. More the resistance more the straight line becomes steeper. Here B is steeper than A means B has more resistance than A.

26.

a) R = V/I $\quad$ $R = 12 / 400 \times 10^{-3} = 30\Omega$

b) V = IR $\quad$ $V = (320 \times 10^{-3}) \times 30$

27. $H = i^2Rt$

$= 2.5 \times 2.5 \times 20 \times 300$

= 37500 J

28.

a) $R = R_1 + R_2$

$= 4\Omega + 6\Omega = 10\Omega$

$i = E / R + r$

= 12 / (10 + 2) = 1.0 A

Current in the circuit = 1.0 A

b) $T.V. = IR$

$T.V. = 1 \times (6 + 4)$

$T.V. = 10\ V$

c) V = I R

= 1 x 6 = 6.0 V

d) $W = I^2 R t$

= 1 x 1 x 4 x 60 = 240 J

29.

a) A current carrying freely suspended solenoid behaves like a bar magnet.

b) Geographic north south direction

30.

a) Ohm's Law

b) Resistance of the conductor

c) Copper / Aluminium

31.

a) $1 / R = 1 / R_1 + 1 / R_2$

= 1 / 9 + 1 / 4.5

= 1 / 3

R = 3 Ω

i = E / R + r

= 2 / (3 + 1.2 + 0.8)

= 0.4 A

Ammeter reading 0.4 A

b) V = E – ir

= 2 – 0.4 X 1.2

= 1.52 V

Or V = iR

= 0.4 x (3 + 0.8)

= 1.52 V

32.

a) Let

Electric current a) $= \frac{Total\ voltage\ diff.(V)}{Total\ resistance\ (R)}$

$$0.5 = \frac{6}{3 + R}$$

$R + 3 = \frac{60}{5}$; $\quad$ $R = 12 - 3$; $\quad$ $R = 9\Omega$

b) Let q = it

$= 0.5 \times 120$

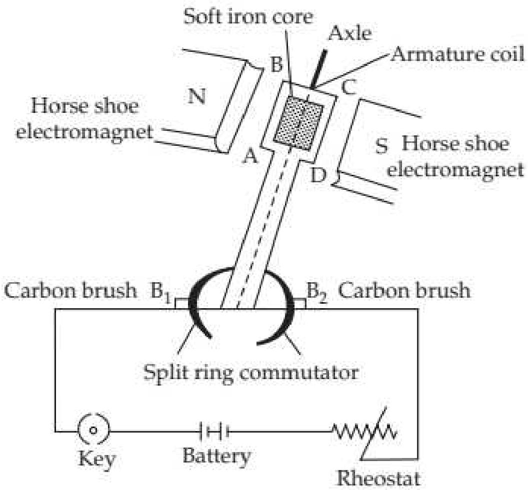
∴ Charge q = 60 coulomb

c) $P = V.I.$
$= I^2R$
$= (0.5)^2 \times 3 = 0.25 \times 3$

$\therefore P = 0.75$ watt.

33.

(i) Below is the diagram of d.c electric motor.



(ii) The split ring acts as a commutator in a d.c. motor. With the split ring, the direction of current through the coil is reversed after every half rotation of coil and thus the direction of couple rotating the coil remains unchanged and the coil continues to rotate in the same direction.
(iii) Advantage of a.c. over d.c. is that it is able to travel long distance without much power loss.

34.

i) Ohmic **Resistors**: The conductors who obey ohm's law are called the ohmic resistors or linear resistances. For such resistors, a graph plotted for the potential difference V against current I is a straight line.

ii)

Thin wire will have more resistance.

Since $R \propto l/a$

Specific resistance of both wire is same.

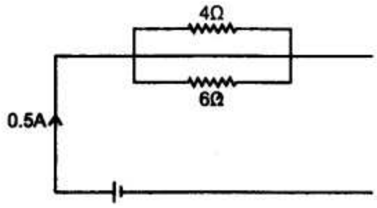
35.

a) The bulbs of set A are connected in series. Therefore, when one bulb fuses the current stops flowing. When the bulbs of set B are connected in parallel and when any one bulb fuses, then current flows through the other bulb.

b) Set B is preferred in parallel combination because in it the potential difference remains same.

36.

i)



ii) Let current through 4Ω resistance is *i* then current through 6Ω resistance is (0.5 – i)

$\therefore i \times 4 = (0.5 - i) \times 6$

$\Rightarrow 4i = 3 - 6i$

$\Rightarrow 10i = 3$

$\Rightarrow i = 0.3$ A

$\therefore$ Current through 4Ω resistance = 0.3 A

and current through 6Ω resistance = 0.5 – 0.3 = 0.2 A

37.

a) North pole

b) The magnetic field strength can be changed in electromagnet. But not in permanent magnet.

38.

a) **Ohm's Law**: The electric current flowing through a conductor wire is directly proportional to voltage difference across the conductor wire if there is no change in physical condition (temperature, length, area of cross section etc.) of wire.

b) Volume of metal wire remains same.

$A_1 l_1 = A_2 l_2$

$\frac{l_2}{l_1} = \frac{A_1}{A_2}$

$R_1 = \rho \frac{l_2}{A_2}$

New resistance,

$R_2 = \rho \frac{l_2}{A_2}$

$\frac{R_2}{R_1} = \frac{l_2}{A_2} \times \frac{A_1}{l_1} = \frac{l_2}{l_1} \times \frac{l_2}{l_1}$

$R_2 = \left(\frac{l_2}{l_1}\right)^2 R_1$ [$\because\ l_2 = 2l_1$(Given)]

$= \left(\frac{2l_1}{l_1}\right)^2 R_1$

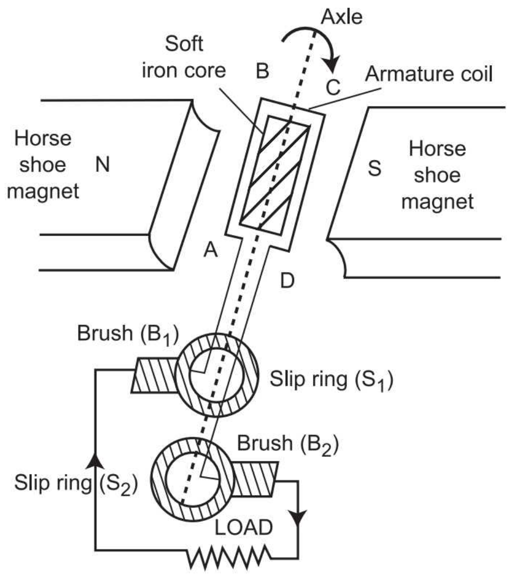
$R_2 = 4R_1 = 4 \times 6$ **= 24 Ω**

c) An electric shock may be caused either due to poor insulation of wires, or when the electric appliances are touched with wet hands.

d) To prevent electric shocks, the insulation of wires must be of good quality, and it should be checked from time to time particularly when they become old, so that no wire is left naked.

39.

i) Diagram of AC generator is shown below.



ii) The energy conversion is mechanical energy to electrical energy.

Chapter 5 - Heat

PART 1

1. b) Its material
2. a) J Kg^{-1} ° C^{-1}
3. a) Sublimation
4. b) Heat is absorbed
5. c) The total energy of all the molecules due to their random motion and mutual attraction
6. c) Small heat capacity
7. b) J Kg^{-1}
8. b) 0.42×10^3
9. a) Joules
10. a) Regelation

PART 2

I.

1. Heat is a form of energy which excites in the sensation of warmth.
Units of heat – Joule or Calorie
1 Calorie = 4.2 Joules

2. Heat energy is the form of energy that is associated with the movement of atoms and molecules within a substance. According to the kinetic model of matter, atoms and molecules are constantly in motion, and this movement is what gives a substance its temperature. The faster the atoms and molecules are moving, the higher the temperature of the substance will be.

3. A calorie is a unit of energy that is used to measure the amount of heat energy contained in a substance. The calorie is defined as the amount of energy needed to raise the temperature of 1 gram of water by 1 degree Celsius. This unit is often used to measure the energy content of food, as well as the energy expenditure of physical activity.

4.

a) Heat capacity is a measure of the amount of heat energy required to raise the temperature of a substance by a certain amount. It is defined as the ratio of the amount of heat energy absorbed or released by a substance to the corresponding temperature change. The unit of heat capacity is typically joules per degree Celsius (J/°C).

b) Specific heat capacity is a measure of the heat energy required to raise the temperature of a unit mass of a substance by a certain amount. It is defined as the ratio of the heat capacity of a substance to its mass. The unit of specific heat capacity is typically joules per gram degree Celsius (J/g°C).

5. Water has the highest specific heat capacity compared to other substances.
(1 cal g^{-1} $°C^{-1}$ or 4200 J Kg^{-1} $°C^{-1}$)

6. The relationship between heat capacity and specific heat capacity can be expressed mathematically as:
Heat capacity = specific heat capacity * mass

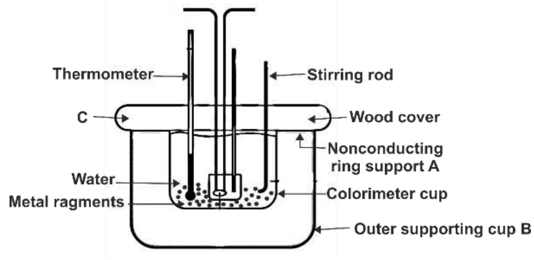
This equation shows that the heat capacity of a substance is equal to its specific heat capacity multiplied by its mass.

7. The water equivalent of a calorimeter is the mass of water that would absorb the same amount of heat as the calorimeter per unit temperature rise. It is a measure of the calorimeter's heat capacity, which is the amount of heat energy required to raise the temperature of the calorimeter by one degree.

The water equivalent is typically expressed in units of grams or kilograms.

8.
i. The calorimeter should be cleaned and highly polished.
ii. Calorimeter should be insulated by placing it in a jacket of wool or wood.
iii. A very sensitive thermometer should be used.
iv. Water in the calorimeter should be slightly below room temperature.

9. A calorimeter is a cylindrical vessel which is used to measure the amount of heat lost or gained by a body when it is mixed with another body. The calorimeter is usually made of thin sheet of copper.



(CALORIMETER)

10.
a) Joule
b) Water
c) Ice
d) 120° C to 125 °C
e) 1gm of steam at 100°

11.
a) The process of changing of a substance from one state to another at constant temperature is termed as change of phase of a substance.
b) No, there is no change in temperature during the change of phase (or state)
c) Yes, a substance absorbs or liberates latent heat during the change of phase (or state).

12.
a) Impurities tend to lower melting point of solids. The melting point of ice decreases with an increase in pressure.
b) The effect of pressure on the freezing and melting points of a substance is known as freezing point depression and melting point depression, respectively. When the pressure on a substance is increased, its freezing or melting point is raised. When the pressure on a substance is decreased, its freezing or melting point is lowered.

Applications of these effects include the use of **antifreeze** to lower the freezing point of coolant in automobiles, and the purification of substances through **cryogenic distillation**.

13.

Boiling	**Evaporation**
It takes place at a fixed temperature.	It takes place at all temperatures.

It is a rapid process.	It is a slow process.
It does not cause cooling.	It always causes cooling.
It is a noisy process.	It is a silent process.
It requires an external source of heat.	It does not require any external source of heat.

14.

Melting (Fusion)	Regelation
The process of changing of a solid into liquid state, at constant temperature with the gain of heat energy from external sources is called melting.	The phenomenon due to which ice at 0°C, melts to form water below 0°C, on the application of pressure, and the water so formed refreezes to form ice on the removal of pressure is called regelation.

15. a)

Melting point	Boiling point
The temperature at which a solid change into liquid state is called melting point.	The temperature at which a liquid rapidly changes into gaseous state is called boiling point.

b)

Specific latent heat of fusion of ice	Specific latent heat of vaporization of steam
It is the amount of heat energy required to melt 1 kg of ice at 0°C to form 1 kg of water at 0°C, without any rise in temperature.	It is the amount of heat energy required to change 1 kg of water at 100°, into 1 kg of steam at 100°C, without any rise in temperature.

16.

a) **Sea Breeze**: A sea breeze is a wind that blows from the sea towards the land. It happens when the land is hotter than the sea, and the hot air above the land rises, creating a low-pressure area. The cooler air above the sea then flows towards the low-pressure area over the land, creating a sea breeze.

b) **Land breeze:** A land breeze is a wind that blows from the land towards the sea. It happens when the land is cooler than the sea, and the cool air above the land sinks down, creating a high-pressure area. The warmer air above the sea then flows towards the high-pressure area over the land, creating a land breeze.

17.

a) A mixture of ice and common salt or any other impurity (soluble in water) which has a temperature below zero degrees Celsius is called freezing mixture.

b) Uses of freezing mixture:
   i) For preserving biological specimens
   ii) For making ice-cream or kulfi

c) **Ethylene glycol** and **propylene glycol** are two freezing mixtures that do not use common salt as a cooling agent. They are commonly used as antifreeze and coolant in automobiles and other mechanical systems, and have lower freezing points than water, allowing them to prevent water-based solutions from freezing in cold temperatures.

18. Three factors on which the rate of evaporation of liquid depends are -

a) The nature of liquid
b) The area of exposed surface
c) The temperature of the liquid

19. 1 gm of steam at 100°C contains more heat.
Heat contained by 1gm of water
When heated from 0°C to 100°C

$= \frac{1}{1000} \times 4200 \times 100 = 420\text{ J}$

Heat Contained by 1gm of steam converted from 1gm water at 100°C

$= \frac{1}{1000} \times 2268 \times 10^3 = 2268\text{ J}$

II.

1. Putting strips of wet cloth on the forehead can help to reduce a high body temperature, also known as fever. When the cloth is wet, it has a cooling effect as the water evaporates. The evaporation of water from the cloth helps to lower the skin temperature and can provide a feeling of relief and comfort to the person with the fever.

2. It is common to feel cold after taking a bath or shower, especially if the water was cold or the air in the room is cool. The body's natural response to the sudden change in temperature can cause the blood vessels in the skin to constrict, which can make you feel cold.

3. Yes, because steam at 100°C gives out its latent heat of vaporization to condense into water at the same temperature of 100°C.

4. Fomentation is heating the swollen parts of body at a moderate temperature of about 50°C, as it brings lot of relief. We use hot water bottles for fomentation purpose, because water can store in large amount of heat energy at a low temperature, owing to its high specific heat capacity.

5. The rate of heat transfer between the skin and the ice cream is faster than the rate of heat transfer between the skin and water. This means that the ice cream will cool the skin more quickly, which can make it feel colder.

6. Land has a much lower specific heat capacity than water. This means that it takes less energy to raise the temperature of a unit of land by a certain degree, compared to a unit of water. As a result, land is more susceptible to temperature changes, and it cools more quickly when the air temperature drops.

7. Steam pipes are more effective at warming a building in cold countries because they have a higher heat transfer coefficient, higher temperature, better insulation, and release latent heat when they condense.

8. As the latent heat of vaporization of petrol is much lesser as compared to that of water, the petrol evaporates quickly than water.

9. Dogs often hang their tongues out in the summer to help regulate their body temperature. When a dog pants, the moisture on their tongue and the inside of their mouth evaporates, which helps to cool their body down. This is especially important for dogs because they do not have sweat glands on their skin like humans do, so panting is their primary means of thermoregulation.

10. Water is used as coolant in motor car radiators, as it can absorb large amount of heat energy from the engine of car, but itself does not rise to very high temperature.

11. Evaporation helps our body in maintaining the body temperature at about 37°C. When the atmospheric temperature rises the body perspires more profusely and the sweat produced gets evaporated. It takes the heat of evaporation from the body itself thereby cooling it and thus maintaining it at a constant temperature of 37°C.

12. Press letters, also known as type or typefaces, are traditionally cast in metal because it allows for precise and detailed designs. In the casting process, a mold is created from a design of the letter and then heated. Molten metal is poured into the mold, and as it cools and solidifies, it takes on the shape of the mold. Stamping, on the other hand, involves pressing a die into a sheet of metal to create the letter and does not require the same level of heat energy as the casting process.

13. The ice at 0°C is cooler than water because it has given up its latent heat of fusion before freezing to ice. So, it is more effective for cooling, as it can absorb more heat from the drink before it is re-transformed to water.

14. Shimla is situated at a high altitude as compared to Mumbai, so the atmospheric pressure is low at Shimla. Therefore, the water boils at a temperature lower than 100°C. So, the boiling point of water at Mumbai is greater than that at Shimla.

15. Watering the fields before a frost can help protect the crops by insulating them with water, which releases heat as it freezes, and by keeping the soil moist, which is less prone to freezing. This helps the plants survive the frost and continue to grow.

16. Ice skating involves gliding across a smooth, frozen surface (the ice) on special shoes called skates. The blades of the skates are made of a hard, sharp material like steel, and they are designed to cut into the ice and create minimal friction. This allows the skater to move smoothly across the ice without leaving any tracks behind. The smoothness and lack of tracks is due to the combination of the sharp blades, the pressure applied to the blades, and the maintenance of the ice rink to keep it at the right temperature.

17. Big tubs of water are kept in underground cellars for storing fresh fruit and vegetables in cold countries to regulate temperature and humidity, which helps to preserve their freshness and extend their shelf life. The underground location also provides natural insulation and protection from extreme weather conditions.

18. Wet soils have a higher water content, which means that they have more water molecules that need to be heated before the soil temperature increases. Additionally, wet soils have a higher thermal conductivity than dry soils, which means that heat energy is more easily conducted through wet soils, rather than being absorbed by the soil particles. These factors contribute to the slower heating of wet soils compared to dry, sandy soils.

19. Atmospheric temperature falls after a hailstorm because the hail stones, being made of ice, absorb heat from the surrounding air as they fall, causing the air temperature to drop.

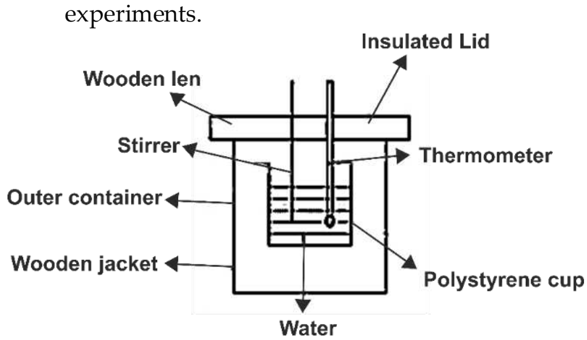
20. Evaporation is the process by which a liquid absorbs heat and changes into a gas. According to the kinetic theory, evaporation occurs when the molecules in a liquid gain enough energy to escape from the surface of the liquid and become a gas.

21. Wet khus-khus (also known as *vetiver* or *Chrysopogon zizanioides*) is used for cooling a room because it has a high evaporation rate and helps to increase the humidity in the air, which can make the air feel cooler.

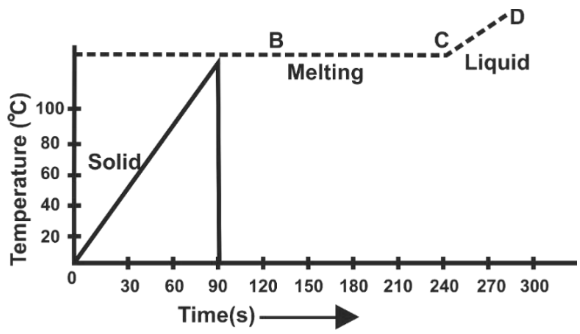
22. Weather becomes pleasant when it starts freezing in cold countries because freezing temperatures typically bring clear, dry weather, which is often more comfortable than the damp, cold weather that can occur at slightly higher temperatures. In addition, the low humidity and low temperatures can make the air feel very dry and refreshing.

III.

1. Calorimeters are often made of copper because it is a good conductor of heat, has a high mass per unit volume, and is relatively inexpensive. Copper's properties make it well-suited for accurately measuring the heat transfer between substances in calorimetry experiments.



2.



3.

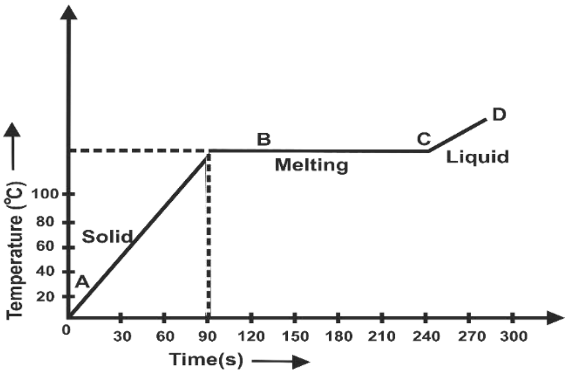
a) Boiling point of the substance is 150°C.

b) In the region DE, the substance undergoes a change of state from liquid to solid phase.

c) The region DE is shorter than the region BC because the latent heat of fusion is much less than the latent heat of vaporization.

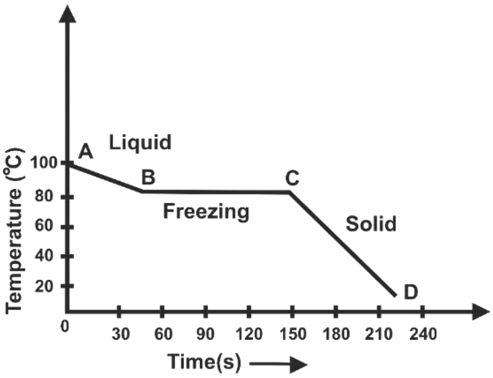
4.

a) Heating curve



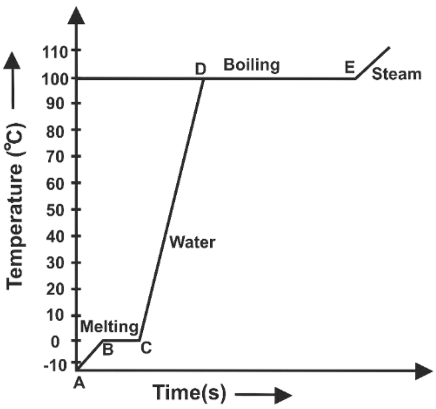
HEATING CURVE

b) Cooling curve

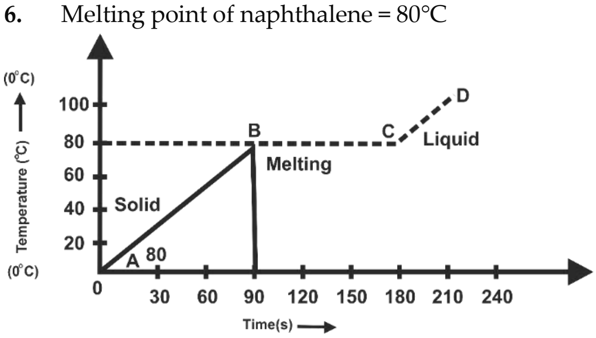


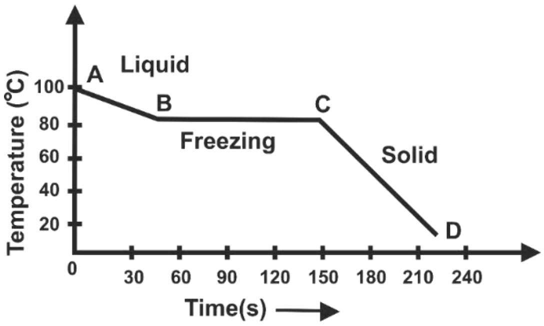
COOLING CURVE

5.



6. Melting point of naphthalene = 80°C





In the above diagram, CB part is parallel to the time axis. This part represents change in state of solid naphthalene without any rise of temperature to liquid state. This temperature in which naphthalene starts to melt is called **melting point.**

Similarly, in graph b), the part AB on graph indicates that the temperature of liquid naphthalene decreases continuously till it reaches B. The part BC indicates that the substance is solidifying and is solidifies of C. This temperature is called **freezing point.** Freezing point of naphthalene is 80°.

∴ Melting point is 80°C.

IV.

1. Temperature
2. Heat
3. Potential, Kinetic
4. Kinetic energy
5. endothermic
6. 4200
7. 2100
8. 336,000
9. 2268×10^3 J Kg^{-1} or 2268 Jg^{-1}
10. 4.2
11. Increases
12. decrease
13. effect of pressure on boiling point
14. Absorption
15. Water
16. Rapid process, slow
17. Impurities
18. Steam
19. 1Kg of ice at 0°C, 1 Kg of water at 0°C
20. 0°C, 0° C, regelation

PART 3

1. Heat energy absorbed by a body depends on three main factors -

a) **Temperature difference:** The heat energy absorbed by a body increases as the temperature difference between the body and its surroundings increases. For example, a body will absorb more heat energy if it is placed in a room with a higher temperature than if it is placed in a room with a lower temperature.

b) **Thermal conductivity:** The heat energy absorbed by a body also depends on its thermal conductivity, which is a measure of the ability of a material to conduct heat. Materials with high thermal conductivity, such as metals, will absorb more heat energy than materials with low thermal conductivity, such as insulating materials.

c) **Heat capacity:** The heat energy absorbed by a body also depends on its heat capacity, which is a measure of the amount of heat energy required to raise the temperature of a substance by a given amount. Materials with high heat capacity, such as water, will absorb more heat energy than materials with low heat capacity, such as air.

2. Heat capacity is a measure of a substance's ability to absorb heat energy. When the same amount of heat is supplied to two substances, the one with the lower heat capacity will have a greater rise in temperature because it takes less heat energy to raise its temperature by a given amount. Therefore, we can say that the heat capacity of A is less than that of B.

3. The principle of the method of mixture in calorimetry is that the heat gained or lost by a substance is equal to the heat gained or lost by the surroundings. This principle is based on the law of conservation of energy, which states that energy cannot be created or destroyed, only converted from one form to another.

4. Given,
Mass of copper m = 100 g = 0.1 kg

Change of temperature $\triangle t = (70 - 20)\ °C =$

$50°C$
Specific heat capacity of copper = 390 J kg^{-1} K^{-1}
Amount of heat required to raise the temperature of 0.1 kg of copper is

$Q = m \times \triangle t \times c$

$Q = 0.1 \times 50 \times 390$
$Q = 1950$ J

5. Let the final temperature of the water when all the ice has melted = T°C
Amount of heat lost when 200 g of water at 50°C cools to T°C = $200 \times 4.2 \times (50 - T)$
$= 42000 - 840T$
Amount of heat gained when 40 g of ice at 0°C converts into water at 0°C = 40×336 J
= 13440 J
Amount of heat gained when temperature of 40 g of water at 0°C rises to T°C = $40 \times 4.2 \times (T - 0)$
$= 168T$
We know that,
Amount of heat gained = amount of heat energy lost
$13440 + 168T = 42000 - 840T$
$168T + 840T = 42000 - 13440$
$1008T = 28560$
$T = 28560 / 1008$
$T = 28.33°C$

6. Heat energy = Power × time
Heat energy contained by water = $1000 \times 4.2 \times 75$
$1000 \times 4.2 \times 75 = 1250 \times$ time
time = $(1000 \times 4.2 \times 75) / 1250$
time = 315000 / 1250
time = 252 sec
time = 4 min 12 sec

7. Amount of heat energy gained by 100 g of ice at – 10°C to raise its temperature to 0°C = $100 \times 2.1 \times 10$

= 2100 J
Amount of heat energy gained by 100 g of ice at 0° C to convert into water at 0°C = 100 × 336
= 33600 J
Amount of heat energy gained when the temperature of 100 g of water at 0°C rises to 100°C = 100 × 4.2 × 100
= 42000 J
Total amount of heat energy gained is = 2100 + 33600 + 42000
= 77700 J
= 7.77×10^4 J

8. To attain the room temperature, ice cream absorbs heat energy as well as the latent heat while water absorbs only heat energy. Thus, ice cream absorbs more amount of energy from the mouth as compared to water. For this reason, ice cream appears colder to the mouth than water at 0°C.

9. Mass of copper vessel m_1 = 50 g
Mass of water contained in copper vessel m_2 = 250 g
Mass of ice required to bring down the temperature of vessel = m
Final temperature = 5°C.
Amount of heat gained when 'm' g of ice at 0°C converts into water at 0°C = m × 336 J
Amount of heat gained when temperature of 'm' g of water at 0°C rises to 5°C = m × 4.2 × 5
Total amount of heat gained = m × 336 + m × 4.2 × 5
Amount of heat lost when 250 g of water at 30°C cools to 5°C = 250 × 4.2 × 25
= 26250 J
Amount of heat lost when 50 g of vessel at 30°C cools to 5°C = 50 × 0.4 × 25
= 500 J
Total amount of heat lost = 26250 + 500
= 26750 J
We know that amount of heat gained = amount of heat lost
m × 336 + m × 4.2 × 5
= 26750
357 m = 26750
m = 26750 / 357
m = 74.93 g
∴ mass of ice required is 74.93 g

10. Specific heat capacity of material c = 960 J kg^{-1} K^{-1}

Change in temperature $\triangle T$ = (38 – 18) °C

= 20°C or 20 K
Power of heater P = 500 W

$\triangle Q = mc\triangle T$

$\triangle Q = 50 \times 960 \times 20$

Time taken by a heater to raise the temperature of material

$t = \triangle Q / P$

t = (50 × 960 × 20) / 500
t = 1920 seconds
t = 32 minutes

11. Mass of hot water (m_1) = 300 g
Temperature (T_1) = 50°C
Mass of cold water (m_2) = 600 g
Change in temperature of cold water ($T - T_2$) = 15°C
Final temperature = T°C
The specific heat capacity of water is c
$m_1c (T_1 - T) = m_2c (T - T_2)$
300 (50 – T) = 600 (15)
T = 6000 / 300
T = 20°C
Final temperature = 20°C
Change in temperature = 15°C
Initial temperature of cold water = 20°C – 15°C = 5°C

12. The high specific heat capacity of water helps to regulate temperature fluctuations in coastal areas by absorbing and releasing heat in response to changes in air temperature, resulting in a generally milder climate compared to inland areas.

13.
i) When a substance undergoes a rise in temperature, the energy of the molecules

increases due to an increase in the kinetic energy of the molecules or the absorption of heat from the surroundings.

ii) When a substance undergoes a change in phase without a change in temperature, the energy of the molecules remains the same but the phase of the substance changes. This process requires the latent heat of the substance, which is the energy needed to overcome the forces holding the molecules in their current phase.

14. Given,

Mass of ice, m_{ice}= 200 g

Time for ice to melt, t_1 = 1 min

= 60 s

Mass of water, m_w = 200 g

Temperature change of water, ΔT = 20°C

Rate of heat exchange is constant. So, power required for converting ice to water is the same as the power required to increase the temperature of the water.

$P_{ice} = P_{water}$

$E_{ice} / t_1 = E_{water} / t_2$

$m_{ice}L / t_1 = m_w c_w \Delta T / t_2$

$t_2 = (m_w c_w \Delta T \times t_1) / m_{ice}L$

$t_2 = (200 \times 4.2 \times 20 \times 60) / 200 \times 336$

$t_2 = 15$ s

15. Farmers may fill their fields with water on a cold winter night to protect crops from freezing temperatures, prevent soil erosion, and create temporary reservoirs for irrigation. The use of water can help to preserve the integrity of the field and support the growth and health of crops.

16. Cooking vegetables on hills and mountains can be more challenging due to the changes in altitude and atmospheric pressure that can affect the way that food cooks. At higher altitudes, water boils at a lower temperature, which can make it more difficult to cook food, especially vegetables, to the desired level of perfection. Additionally, the lower atmospheric pressure at high altitudes can cause food to cook more quickly or more slowly than it would at lower altitudes, which can make it difficult to gauge the cooking time.

17. Hot water bottles are often used for fomentation, which is the application of moist heat to a specific area of the body. The heat from the hot water bottle can help to increase blood flow to the area, which can help to reduce muscle tension and pain. It can also help to relax the muscles and improve circulation, which can promote healing and reduce inflammation. Hot water bottles are a convenient and easy way to apply heat to a specific area of the body, and the water inside the bottle helps to retain the heat for an extended period of time.

18. Since the whole block does not melt and only 2 kg of it melts, so the final temperature would be 0° C.

Amount of heat energy gained by 2 kg of ice at 0° C to convert into water at 0° C = 2 × 336000

= 672000 J

Let the amount of water poured = m kg

Initial temperature of water = 100°C

Final temperature of water = 0°C

Amount of heat energy lost by m kg of water at 100°C to reach temperature 0°C = m × 4200 × 100

= 420000 m J

We know that heat energy gained = heat energy lost

672000 J = m × 420000 J

m = 672000 / 420000

m = 1.6 kg

19. 1 g of water at 0°C has more heat than 1 g of ice at 0°C because it takes more heat to raise the temperature of water than it does to melt ice, and the specific heat capacity of water is higher than the latent heat of fusion of water.

20. A mass m_1 of a substance A of specific heat capacity c_1 at temperature T_1 is mixed with a mass m_2 of other substance B of specific heat capacity c_2 at a lower temperature T_2 and final temperature of the mixture becomes T.

Fall in temperature of substance A = $T_1 - T$

Rise in temperature of substance B = $T - T_2$

Heat energy lost by A = $m_1 \times c_1 \times$ fall in temperature = $m_1 c_1 (T_1 - T)$

Heat energy gained by B = $m_2 \times c_2 \times$ rise in temperature = m_2c_2 (T – T_2)
If no energy lost in the surrounding, then by the principle of mixtures,
Heat energy lost by A = Heat energy gained by B
m_1c_1 (T_1 – T) = m_2c_2 (T – T_2)
We get after rearranging this equation
T = (m_1c_1 T_1 + m_2c_2 T_2) / m_1c_1 + m_2c_2
We have assumed here that there is no loss of heat energy.

PART 4

1. (b) 67200 J
Explanation:
Given m = 200 g = 0.2 kg
L = 336000 J/kg
Q = mL
Q = 0.2 x 336000 J
= 67200

2. (c) 4 J g-1 °C^{-1}
Explanation:
Given Q = 4000 J
M = 1 kg
ΔT = 1°C
Q = mcΔT
4000 = 1 x c x 1
C = 4000 $\frac{J}{kg^{\circ}C}$ = $\frac{4J}{g^{\circ}C}$

3. (d) Its specific heat capacity is very high so it can cool the engine without greater increase in its own temperature.

4. Heat lost by metal piece = Heat gained by calorimeter + water
$\Rightarrow\ 420 \times C(80 - 30) = 80 \times 4.2(30 - 20) + 84 \times \frac{200}{1000} \times 10$
$\Rightarrow\ 420 \times 50 \times C = 80 \times 42 + 168$
C = 0.168 J g^{-1} $^{0}C^{-1}$

5. Heat transfer occurs more quickly through materials with high thermal conductivity and with low mass. Water has a low thermal conductivity and a high mass, so it takes longer to heat up and cool down compared to a stone, which has a higher thermal conductivity and a lower mass. This is why a stone lying in the sun will tend to heat up more quickly than water lying in the sun for the same duration of time.

According to Board Examiners

Almost all the candidates gave partially correct answers. They related it to the difference in the absorption of heat or to heat capacity instead of specific heat capacity of the stone and water. Some candidates wrote that the stone takes less time since it is a good conductor instead of writing about the specific heat capacity.

6. m_P = 2 m (say)
m_q = m
$\Delta t_p = \Delta t_q = \Delta t$ (say)
Heat given to the block P = Heat given to block Q
m_p x c_p x Δt = m x c_q x Δt
2 m x c_p x Δt = m x c_q x Δt (correct formula with substitution)
C_p / C_q = 1/2
C_p : C_q = 1:2

According to Board Examiners

Following errors were observed:
- Substitution for masses was incorrect.
- Some candidates compared heat capacities.
- Several candidates substituted for masses correctly but could not express the specific heat capacities in the ratio form.

7. The amount of heat energy absorbed to raise the temperature of a body by unit degree is called heat capacity. Its unit is: J K^{-1}

According to Board Examiners

a) Almost all candidates answered correctly barring a few, who wrote the definition of specific heat capacity. Instead, some candidates wrote the definition assuming the substance to be water. b) Most candidates answered correctly but a few wrote the unit of specific heat capacity. c) Some candidates wrote the relationship between heat capacity and specific heat capacity of a substance in the form of symbols without giving the meaning of the symbols.

8.

i) Specific heat capacity in liquid state is greater than specific heat capacity in solid state.

ii) Boiling point t_2 °C; Melting point t_1 °C

According to Board Examiners

a) Many candidates could not answer this question correctly. They related it with the time.
b) Most of the candidates answered correctly but a few wrote vague values such as, 100°C, 90°C, etc. Some also wrote BC, DE as answers. A few candidates interchanged the values of melting point and boiling point of the substance. Some answered assuming the substance to be water.

9. ml + mct = ∴ 60(336 + 4.2 × x) = 140 × 4.2 × (50 – x)

∴ 60 × 4.2 (80 + x) = 140 ×4.2(50 – x)

3(80 = x) = 7(80 – x) ∴ 240 + 3x = 350 – 7x

∴ 10x = 350 – 240 =110 ∴ = $\frac{110}{10}$ 11° C

According to Board Examiners

Majority of the candidates attempted this numerical correctly. However, the following errors were observed in other scripts:
– Not taking into consideration the heat absorbed by ice after melting to reach equilibrium temperature.
– Not substituting the change in temperature correctly.
– Not writing the unit for the final answer.

10. Substance B is a good conductor of heat. Because specific heat capacity of B is less than that of A and specific heat capacity is the heat energy required to raise the temperature of 1 kg of a substance by 1°C, so substance B gets heated faster.

According to Board Examiners

A large number of candidates did not name the good conductor of heat out of the two given substances. Also, many were unable to write the reason for naming one of the given substances as a good conductor of heat on the basis of their specific heat capacities.

11.

a) The specific heat capacity of a substance does not remain the same when its state changes from solid to liquid.

b) One example of this is water. The specific heat capacity of water is 4.18 J/gK in its solid state (ice) and 4.18 J/gK in its liquid state (liquid water). However, when water changes from its solid state (ice) to its liquid state, the specific heat capacity changes because the structure of the water molecules changes, leading to a change in the specific heat capacity.

According to Board Examiners

a) Most of the candidates answered it correctly but some of them made the following errors:
• wrote specific heat capacity remains the same.
• got confused with latent heat and specific heat capacity.
• got confused between specific heat capacity and specific resistance.
b) Some of them wrote example of water and ice but they did not mention the values. Those who said specific heat capacity remains the same on changing the state of a substance, validated the same even in examples. Several candidates made mistakes while stating the units of the values of specific heat capacities.

12.

a)

i) The measurement of the quantity of heat is called Calorimetry.

ii) Copper

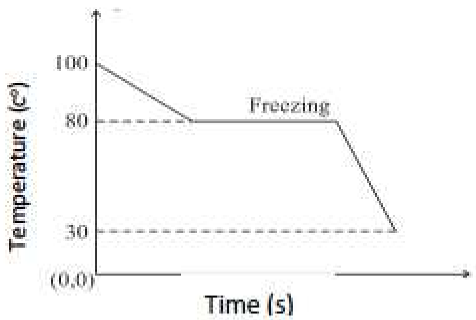
iii) A calorimeter is a device used to measure the heat of a chemical reaction or physical change. Thin sheets of copper are often used in the construction of calorimeters because copper is a good conductor of heat, which allows the calorimeter to accurately measure the heat transfer between the system being studied and the surroundings. Copper is also a relatively inexpensive and readily available material, which makes it a convenient choice for use in calorimeters.

According to Board Examiners

a) Several candidates in the definition of calorimetry wrote the key word study in place of measurement. In many scripts candidates stated the principle of calorimetry.
b) Almost all the candidates answered the name of the material used for making a Calorimeter correctly. Very few candidates gave options other than copper such as wood, mercury, iron and steel.
c) Many candidates answered this subpart of the question correctly. Some candidates wrote the answer as good conductor of electricity instead of good conductor of heat. They also missed the

keyword Heat capacity. They did not take into consideration the word thin sheet.

b)



According to Board Examiners

Majority of the candidates could not attempt this question correctly. The graph drawn was not correct. Some candidates drew the graph correctly. Some candidates have even shown the graph line being parallel to x-axis three times.

c) $m_{ice}L + m_{ice}c_w t = m_w c_w(t_i - t_f) + m_{cu}c_{cu}(t_i - t_f)$

m (336 + 4.2 × 10) = 104 × 4.2 × (30 - 10) + 42 × 0.4 × (30 - 10)

∴ m × 4.2 (80 + 10) = 4.2 × (104 + 4) × 20

∴ m = $\frac{108 \times 20}{90}$ = 24g

According to Board Examiners

A large number of the candidates solved this numerical correctly. However, following errors were noticed in many scripts:
• substitution errors
• substitution was correct but made mistakes in calculation.
• for ice considered only melting and not increase in the temperature thereafter.
• did not take into consideration the heat absorbed by the calorimeter.
• did not write unit for the final answer.

13.

a) Heat energy

b) 1 calorie = 4.2 J / 4.186 J / 4.18 J

According to Board Examiners

a) Most candidates named the physical quantity which is measured in calories correctly. But some wrote the physical quantity such as work or energy. Some of them even wrote as joule as they were confused between physical quantity and unit. b) Most of the candidates wrote the relation between calorie and the S.I unit of that quantity correctly but some of them reversed it and wrote it as 1 J = 4.2/4.186 calorie. Some even wrote 1 cal = 0.4 j/1J/41.8j/373K/336j

14.

a) $^{o}C + 273 = K$

b) Water

According to Board Examiners

a) Majority of the candidates could not express a temperature in degree Celsius in S.I. unit of temperature. Several candidates wrote $1^0C = 273$ K. Some candidates wrote t^0C-273 or T = 273 – t^0C or t = 273+K, 1^0C=1 K. b) Most of the candidates named the liquid X correctly. However, some candidates wrote hydrogen or kerosene, or petrol or diesel can be used as a coolant in car radiators.

15.

a)

i) Melting
ii) No
iii) Latent heat of melting/fusion

b)

i)

Heat capacity	Specific heat capacity
Heat absorbed by the mass of a body to raise its temperature by 1^oC.	Heat absorbed by unit mass of a body to raise its temperature by 1^oC.
Depends on mass and (specific Heat capacity/material)	Does not depend on mass (but depends on material)
S.I. Unit is J K^{-1}	S.I. unit is J kg^{-1} K^{-1}

ii) Heat capacity(C′) = mass of the body(m) x specific heat capacity (c)

c) $m_w c_w \theta_w = m_i L + m_i c_w \theta_w$

$170 \times 4.2 \times 45 = m_i[336 + 4.2 \times 5]$

$m_i = 90g$

16. Energy = P × t, Latent heat = mL, time = t = 4 min, m = 150g = 150 ×10^{-3} kg

P × t = mL

=> 100 × 4 × 60 = 150 ×10^{-3} × L

L= 1.6 × 10^{-5} J kg^{-1}

According to Board Examiners

Majority of the candidates used melting point 800 ^0C in their calculation. Most candidates substituted 150×800×l on one side of the equation. Some candidates solved the specific latent heat of fusion of the metal equation using incorrect expressions Q=mcΔt only or Q=ml only or using Q=ml + mcΔt. A few candidates wrote the incorrect unit.

17.

a)
i) Both (inner and outer) surfaces of calorimeter are highly polished.
ii) Metal B is the best option to make a calorimeter. B has the lowest specific heat capacity; hence it will absorb the least amount of heat.
b) Heat gained by ice = mL + mcΔT = m (330 + 4.2 × 5) = 351m J
Heat given out by water and calorimeter = (150 × 4.2 + 50 × 0.4) × (32 - 5)
= 17550 J
Mass of ice = $\frac{17550}{351}$
= 50g

18. Factors on which the heat energy liberated by a body depends on are –
i) Mass of the body
ii) Specific heat capacity of the body

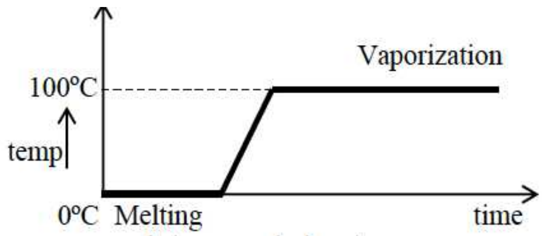
19. $m \times 336 = 300 \times 4.2 \times 40$

m = (300 × 4.2 × 40) / 336 = 150 g

20.
i) 60 J of heat energy is required to raise the temperature of a body by 1K.
ii) Lead requires 130 J of heat energy to raise the temperature of 1 Kg by 1K.

21.
– Directly proportional to the mass
– Directly proportional to change in temperature
– Directly proportional to the specific heat capacity.

22.
a)
i) According to principle of mixtures, heat lost by a hot body is always equal to the heat gained by a cold body provided no heat is lost to the surroundings.
ii) Principle of Calorimetry
iii) Law of conservation of energy
b)



Correct graph (Axes and Shape)
Melting marked
Vaporization marked

c) m c θ + m c θ = m$_I$ L + m$_i$ c θ
100 x 0.4 x 45 + 150 x 4.2 x 45 = m$_i$ (336 + 4.2 x 5)
m$_i$ = 84.45 g

23. There are a few possible reasons why water might boil at 115°C:
i) **Altitude**: At high altitudes, the atmospheric pressure is lower, which means that the boiling point of water is also lower. This means that water can boil at a lower temperature than usual at high altitudes.
ii) **Impurities in the water**: If the water contains impurities such as minerals or dissolved gases, it can affect the boiling point of the water. These impurities can lower the boiling point of the water, allowing it to boil at a lower temperature.
iii) **Type of container**: The type of container in which the water is being heated can also affect the boiling point. For example, a narrow container with a small surface area will allow the water to heat up faster, which could cause it to boil at a higher temperature.

24. Water is an effective coolant because it has a high specific heat capacity, meaning it can absorb a lot of heat without significantly increasing in temperature, and a high boiling point, making it suitable for use in high-temperature systems. It is also a good conductor of heat and relatively inexpensive, making it a practical choice for many cooling applications.

25.
a)
i) Water in lakes and ponds does not freeze at once due to the process of convection, which

keeps the surface water from freezing by circulating warmer water from the bottom to the top. As the temperature continues to drop, the water at the bottom will eventually cool enough to freeze, but this process takes longer than if the water were to freeze from the top down. This is because the surface water cools and becomes denser, causing it to sink to the bottom and be replaced by warmer, less dense water from the bottom.

ii) Calorimetry is the study of heat transfer and energy exchange that occurs during chemical reactions or physical changes. The basic principle of calorimetry is that the heat gained or lost by a system is equal to the heat gained or lost by its surroundings. This principle is known as the law of conservation of energy, which states that energy cannot be created or destroyed, only converted from one form to another.

iii) Law of conservation of energy.

iv) An increase in impurities in ice usually lowers the melting point of the ice. This is because impurities, such as salt or other substances, disrupt the hydrogen bonding that occurs between the water molecules in ice.

b) m c θ + m L + m c θ = P × t

100 × 4.2 × 20 + 100 × 336 + 100 × 2.1 × 10 = P × 35 × 60

44100 = P × 2100

P = 21 W

26.

a) Given: m = 100g, t = 2 minutes = 2 × 60sec.

Heat energy taken by ice at 0°C.

Q = mL = 100 × 336 = 33600 J

$\therefore \quad P = \frac{Q}{t} = \frac{33600}{2x60} = 280 J/S$

The heat energy required to convert water at 0°C to 20°C.

Q = mc Δt= 100 × 4.2 × 20 = 8400 J

Q = P × t

8400 = 280 × t

t = 30 sec = **0.5 min.**

b)

i) Substance B is a good conductor of heat.

ii) Because specific capacity of B is less than that of A.

27. Heat energy = mc ΔT + mL

= 5 × 4 – 2 × 20 + 5 × 336 = 420 + 1680 = 2100 Joule.

28.

a) The temperature of the surroundings decreases when the ice in a frozen lake starts melting because melting is an endothermic process, which means it absorbs heat from the surroundings. The heat energy from the surroundings is transferred to the ice, causing the temperature to decrease. Once the ice has completely melted and the water reaches room temperature, the temperature of the surroundings will start to rise again.

b) Heat capacity of a body is directly related to its specific heat capacity, with a higher specific heat capacity leading to a higher heat capacity for a given mass.

Heat capacity = mass (m) x specific heat capacity (L)

29.

a) A bottle of soda will cool faster when surrounded by ice cubes because the ice cubes have a larger surface area in contact with the air, which allows them to release more heat into the surrounding air as they melt. This helps to warm up the air around the bottle, which in turn slows down the cooling of the bottle. Additionally, the ice cubes can transfer more heat to the bottle due to the larger temperature difference between them.

b) Specific heat capacity = $\frac{Q}{m.\Delta T}$

Specific heat capacity α $\frac{1}{\Delta T}$

So, material X has a higher specific heat capacity.

30. Heat energy given by metal piece

= m . Δ T_1'

= 20 × 0.3 × (100 – 22)

= 468 Joule

Heat energy gained by water

= $m_w c_w$ × Δ T_2

= m_w × 4.2 × (22 – 20)

= m_w × 8.4 Joule

Heat energy gained by water

= m_c × c_c × Δ T_2

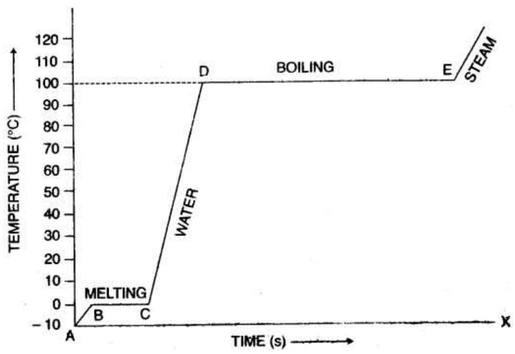
= 50 × 0.42 × (22 – 20)
= 42 Joule
By principle of Calorimetry
Heat lost = Heat gained
Heat energy given by metal = Heat energy gained by water + Heat energy gained by calorimeter
$468 = m_w \times 8.4 + 42$
$m_w = \frac{468 - 42}{8.4}$
= 50.7 gm

31. Heat gained = Heat Lost
150 × 4.2 × (25 - 20) = 60 × c × (100 – 25)
150 × 4.5 × 5 = 60 × c × 75
c = 0.7 $Jg^{-1}\,°C^{-1}$

32.
a)
i) ΔQ = mc Δt
where m —> mass, c —> specific heat capacity, Δt —> change in temperature.

ii) Since ΔQ ∝ Δt

Hence the corresponding rise in temperature of the body in Kelvin = 25K.
iii) Avg. kinetic energy of the molecules would remain same.
b)



c) Let mass of water used = m gm
Since Heat gained = Heat lost
$m_1 c\ \Delta t_1 = \text{mL} + m_2 c\ \Delta t_2$
m × 4.2 × (60 – 10) = 40 × 336 + 40 × 4.2 × (10 – 0)
m × 4.2 × 50 = 40 × 336 + 1680
$m = \frac{13340 + 1680}{42 \times 5} = \frac{15120}{210} = 72$ gm

33.

Heat	Temperature
It is a form of energy.	It the degree of hotness or coldness of a body.
Unit is Joule/Calorie.	Unit is °C, °F or Kelvin.

34. Let the final temperature be T °C.
Heat gained = Heat lost (H = mc Δ*t*)
200 × 4.2 × (80 – T) = 300 × 4.2 × (T – 10)
2(80 – T) = 3 (T – 10)
160 – 2T = 3T – 30
5T = 190
T = 38°C

35.
a)
i) Hailstorms typically occur during thunderstorms, which are accompanied by strong upward air currents. As the storm clouds rise, the air cools and the water droplets within the clouds freeze into hail. When the hail falls to the ground, it brings with it the cold temperatures from the upper levels of the atmosphere. This can cause the temperature to drop suddenly and significantly, leading to a feeling of coldness after the hailstorm.
ii) When the heat supplied to a substance causes no change in the temperature of the substance, the heat is being used to change the state of the substance rather than increase its temperature. This process is known as latent heat. For example, when water is heated and reaches its boiling point, the heat supplied to the water is used to convert the water from a liquid to a gas (steam), rather than increase the temperature of the water. Similarly, when a solid substance is heated and reaches its melting point, the heat supplied is used to change the solid into a liquid, rather than increase the temperature of the solid.
b)
i) When 1 g of ice at 0°C melts to form 1 g of water at 0°C, the latent heat is absorbed by the ice. Latent heat is the energy that is absorbed or released during a phase change, such as the transition from a solid to a liquid. In this case, the ice absorbs energy from its surroundings

in order to melt, and that energy is stored as latent heat.

ii) One example where the high specific heat capacity of water is used as a heat reservoir is in a thermal power plant. In a thermal power plant, water is used as a coolant to transfer heat from the steam produced in the power generation process to a cooling tower or a body of water. The high specific heat capacity of water allows it to absorb a large amount of heat without a significant change in temperature, making it an effective heat reservoir.

iii) One example where the high specific heat capacity of water is used for cooling purposes is in a cooling tower. A cooling tower is a device that is used to cool water by using evaporation to remove heat. The water is circulated through the cooling tower, where it comes into contact with air and is cooled by evaporation. The high specific heat capacity of water allows it to absorb a large amount of heat before its temperature rises significantly, making it an effective means of cooling.

c) Heat lost by ice = Heat gained by water + Heat gained by copper

Let the mass of ice needed be M Kg

$M \times L_f + Mc_f \,\Delta t = m_1c_w \,\Delta t + m_2c_2 \,\Delta t$

$M \times 336 \times 10^3 + M \times 4200 \times (5 - 0) = \frac{250}{1000} \times 4200 \times (30 - 5) + \frac{50}{1000} \times 400 \times (30 - 5)$

$M \times 336 \times 10^3 + M \times 21 \times 10^3 = 26250 + 500$

$M = \frac{26750}{357 \times 10^3} = 0.07492$ kg

= 74.9 gm

36.

a)

i) Specific Latent heat of fusion: It is the amount of heat required to convert unit mass of a substance from solid state to liquid state without change in temperature.

ii) Water.

iii) Two factors:
- The relative temperature of the body with respect to its surroundings.
- Mass of the body.

b)

i) The heat capacity of a substance is a measure of the amount of heat required to raise the temperature of that substance by a certain amount. If substance A shows a greater rise in temperature than substance B when the same amount of heat is supplied, it means that substance A has a lower heat capacity than substance B.

ii) (1) Kinetic energy changes
(2) Inter molecular space changes

c) Let the mixture reach a final temperature T °C.

Heat absorbed by ice to reach T°C

$= mL + mc\,\Delta t$

$= 50 \times 336 + 50 \times 4.2 \times T$

Heat released by liquid to come to T°C

$= mc\,\Delta t$

$= 300 \times 2.65 \times (30 - T)$

Heat gained = Heat lost

$50 \times 336 + 50 \times 4.2 \times T = 300 \times 2.65 \times (30 - T)$

$20.1\,T = 141$

$T = 7.01°C$

Chapter 6 - Modern Physics

PART 1

1. d) Any of (a) and (b)
2. d) Gamma decay
3. c) Alpha decay
4. d) remains same
5. b) Neutron
6. a) isotopes
7. b) Gamma
8. a) increases by one
9. b) cobalt
10. d) Delta

PART 2

1. Three constituents of an atom are electron, neutron, and proton.

Electrons:
Mass → 9.1×10^{-31} kg
Charge → -1.6×10^{-19} C

Neutrons:
Mass → 1.67×10^{-27} kg
Charge → Zero

Protons:
Mass → 1.6726×10^{-27} kg
Charge → 1.6×10^{-19} C

Distribution: In an atom, the protons and neutrons are found in the nucleus, which is at the centre of the atom. The electrons are found in energy levels or shells surrounding the nucleus. The distribution of electrons in an atom is described by the electron configuration, which specifies the distribution of electrons in the various energy levels. The number of protons in the nucleus determines the atomic number of the atom and the identity of the element to which the atom belongs. The number of neutrons in the nucleus can vary within certain limits, and atoms with the same atomic number but different numbers of neutrons are called isotopes.

2.

a) Atomic number is a measure of the number of protons in the nucleus of an atom. It is also referred to as the proton number. The atomic number of an element is unique to that element and is used to identify it in the periodic table. It is represented by the symbol Z.

b) Mass number is the total number of protons and neutrons in the nucleus of an atom. It is represented by the symbol A. The mass number is the sum of the number of protons and the number of neutrons in the nucleus of an atom. The mass number is often used to identify isotopes of an element, which are atoms that have the same atomic number but a different number of neutrons and therefore a different mass number.

3. The nucleus of an atom is the central region of the atom that contains most of its mass and is composed of protons and neutrons. The size of the nucleus is much smaller than the size of the atom as a whole. The radius of a nucleus is typically on the order of a few femtometers (1 femtometer is equal to 10^{-15} meters), while the radius of an atom is on the order of a few angstroms (1 angstrom is equal to 10^{-10} meters).

The number of neutrons in the nucleus can be calculated by subtracting the atomic number from the mass number. For example, if an atom has an atomic number of 6 and a mass number of 14, it must have 14 - 6 = 8 neutrons in its nucleus.

4. Isotopes are atoms of the same element that have the same number of protons in their atomic nucleus, but a different number of neutrons. This means that isotopes of a given element have the same atomic number, but a different atomic mass. An example of isotopes is carbon, which has three naturally occurring isotopes: carbon-12, carbon-13, and carbon-14.

5. Isobars are atoms or atomic nuclei that have the same mass number, but a different atomic number. This means that isobars have the same number of neutrons and protons, but a different number of protons and hence a different atomic number.

An example of isobars is the element chlorine and the element potassium. Both elements have an atomic number of 17 but have different atomic masses. Chlorine has an atomic mass of 35 and potassium has an atomic mass of 39. This means that they are isobars because they have the same number of protons and neutrons (17 protons and 18 neutrons), but a different number of protons and hence a different atomic number.

6. Atoms of a substance having the same atomic number, but different mass numbers are called isotopes. An example of such a substance is carbon, which has three isotopes: carbon-12, carbon-13, and carbon-14.

The structures of isotopes of a given element differ in the number of neutrons they contain. Carbon-12 has 6 neutrons, carbon-13 has 7 neutrons, and carbon-14 has 8 neutrons. All three isotopes of carbon have 6 protons, which gives them an atomic number of 6 and makes them all atoms of the element carbon. However, the differing number of neutrons in the isotopes leads to differences in their atomic masses. Carbon-12 has an atomic mass of 12, carbon-13 has an atomic mass of 13, and carbon-14 has an atomic mass of 14.

7. Radioactivity is the property of certain atomic nuclei to emit energetic particles and radiation spontaneously. This happens when the nucleus of an atom is unstable, meaning that it has too much energy or an excess of subatomic particles. As a result, the nucleus undergoes a process called radioactive decay, during which it releases this excess energy in the form of radiation.
Example: Uranium, Plutonium, Radon

8. Yes, radioactivity is a nuclear phenomenon. It occurs when the nucleus of an atom is unstable and undergoes radioactive decay, during which it releases energetic particles and radiation.

9.
a) Alpha, beta, and gamma
b) Alpha and beta radiations
c) Gamma radiations
d) Gamma radiations
e) Alpha radiations
f) Beta radiations

10. Alpha particles are the least ionizing type of radiation, followed by beta particles and then gamma rays.
- Alpha particles are made up of two protons and two neutrons and are relatively large, so they do not penetrate matter very far.
- Beta particles are made up of high-energy electrons or positrons and are smaller and more penetrating than alpha particles.
- Gamma rays are the most ionizing and penetrating of the three types of radiation and are electromagnetic radiation with no mass or charge.

11. The penetrating range of α – particles is 3 cm to 8 cm of air of β particles is about 8 m of air and of ϒ – radiations is about 500 m of air. Thus, the penetrating range of α – particles is the least and of ϒ – radiations is the most.

12.
i) **Scale of the change**: Chemical changes involve the rearrangement or breaking of chemical bonds between atoms, while nuclear changes involve changes to the nucleus of an atom. Nuclear changes are much more significant and involve changes to the number of protons or

neutrons in the nucleus, which can lead to the creation of new elements.

ii) **Irreversibility**: Most chemical changes can be reversed through the use of chemical reactions, but nuclear changes are generally irreversible. Once a nuclear reaction has taken place, the atoms involved cannot be changed back to their original form.

13. Radioactivity is a property of an atomic nucleus and is not affected by chemical reactions. When an element undergoes a chemical change to form a compound, the arrangement of the atoms changes, but the atomic nuclei remain unchanged. As a result, the radioactivity of the element is not affected by the chemical reaction.

14.

a) Gamma radiations have zero mass.

b) Gamma radiations have the lowest ionizing power.

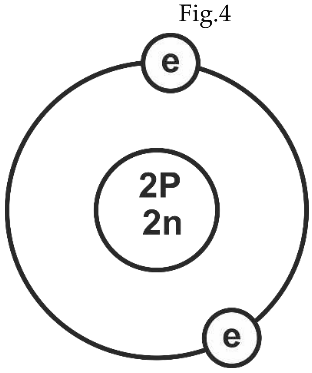
c) Alpha particles have lowest penetrating power.

d) Alpha particles have positive change equal to 3.2×10^{-19} C and rest mass equal to 4 times the mass of proton i.e., 6.68×10^{-27} kg

e) These radiations come from nucleus of the atom.

f) The gas is Helium.

Fig.4



15. Alpha and beta particles are deflected in electric or magnetic fields because they are charged particles and experience a force in these fields. Gamma rays are not deflected because they are not charged particles and do not experience a force in these fields. Gamma rays are instead a type of electromagnetic radiation composed of photons, which have no mass and no electric charge.

16. The isotopes of an element which exhibit the phenomenon of radioactivity are called radio isotopes. Radioisotopes find their use in the fields of medical, science, and industry.

17. Radioisotopes are atoms that have an unstable nucleus and emit radiation as they decay. The radiation emitted by radioisotopes can be harmful to living tissue and can cause damage to cells, leading to various health problems. Exposure to high levels of radiation can cause immediate illness, such as nausea and vomiting. Long-term exposure to radiation can increase the risk of cancer and other diseases, including leukemia, thyroid cancer, and cancer of the breast, lung, and liver.

18. There are several precautions that should be taken when handling a radioactive source –

(i) **Wear protective gear**: When handling a radioactive source, it is important to wear protective gear such as gloves, a lab coat, and goggles to minimize the risk of exposure to radiation.

(ii) **Use caution when handling the source**: Radioactive sources should be handled carefully to avoid accidents or spills.

(iii) **Store the source properly**: Radioactive sources should be stored in a secure, designated area away from people and animals.

(iv) **Use warning labels**: It is important to label the storage area and any equipment that has been in contact with the radioactive source with warning labels to alert others of the potential hazard.

(v) **Use shielding**: Radioactive sources should be shielded with materials that can absorb or block radiation, such as lead or concrete.

(vi) **Dispose of the source properly**: When disposing of a radioactive source, it is important to follow proper disposal procedures to ensure that the source is safely and securely disposed of.

19.

a) Becquerel rays are a type of ionizing radiation that is emitted during the radioactive decay of certain elements, such as uranium and radium. They have sufficient energy to ionize atoms and can penetrate matter, including solid objects and living tissue.

b) Four properties of Becquerel rays are:

i) **Ionizing radiation**: Becquerel rays have sufficient energy to ionize atoms, meaning they can remove tightly bound electrons from atoms and create ions.

ii) **Penetration**: Becquerel rays are able to penetrate matter, including solid objects and living tissue, to a certain extent.

iii) **Radioactive decay**: Becquerel rays are emitted during the radioactive decay of certain elements, such as uranium and radium.

iv) **Dangers**: Becquerel rays are harmful to living organisms and can cause cancer and other health effects if ingested or inhaled in large quantities. It is important to handle materials that emit Becquerel rays with caution and to use protective measures to minimize exposure.

20. Henri Becquerel

21. The first radioactive substance to be discovered was **uranium**, which was discovered in 1789 by Martin Heinrich Klaproth, a German chemist. Klaproth was studying the mineral pitchblende, which is a type of ore that is rich in uranium, and he was able to extract a small amount of pure uranium from it. The discovery of uranium was the beginning of the study of radioactivity, and it led to the discovery of other radioactive elements, such as radium, which was discovered in 1898 by Marie Curie and her husband Pierre.

22. Radioactivity is caused by the instability of the nucleus of an atom, which is the central part of the atom that is made up of protons and neutrons. The nucleus of an atom is held together by a strong nuclear force, but some types of nuclei are unstable and tend to break down, or decay, into more stable configurations. This process is called radioactive decay, and it is what gives rise to radioactivity.

23. When an alpha particle is emitted from the nucleus of an atom, the atomic number of the element decreases by two. This is because an alpha particle is made up of two protons and two neutrons, and the emission of an alpha particle reduces the number of protons in the nucleus by two.

24.

a) $< \beta < \alpha$

b) $\alpha < \beta < \Upsilon$

25. Speed of α radiation – 10^7 ms^{-1}
Speed of β radiation – 2.7×10^8 ms^{-1}
Speed of ϒ radiation – 3×10^8 ms^{-1} (in vacuum)

26.

b) Singly ionized helium H_e^+

c) Neutral helium atom

27.

a) **Alpha (α) radiation** is made up of alpha particles, which are clusters of two protons and two neutrons bound together. Alpha particles have a positive charge and are relatively large and massive compared to other types of radiation.

Beta (β) radiation is made up of beta particles, which are high-energy electrons or positrons. Beta particles have a negative charge and are smaller and lighter than alpha particles.

Gamma (ϒ) radiation is made up of gamma rays, which are high-energy electromagnetic radiation. Gamma rays do not have a charge and are even smaller and lighter than beta particles.

b) α radiation has the least penetrating power.

28. Beta particle, ${}_{-1}^{0}e$ or ${}_{-1}^{0}\beta$

29.

a) When an **alpha particle** is emitted, the atomic number of the element decreases by 2 and the mass number decreases by 4. An alpha particle is made up of two protons and two neutrons, so when it is emitted from an atom, the atomic number decreases by 2 (because the atom loses two protons) and the mass number decreases by 4 (because it loses two protons and two neutrons).

b) When a **beta particle** is emitted, the atomic number of the element increases by 1 and the mass number remains unchanged. A beta particle is made up of an electron or a positron, so when it is emitted from an atom, the atomic number increases by 1 (because the atom gains a proton or loses a neutron, depending on whether the beta particle is an electron or a positron) and the mass number remains unchanged (because the mass of the electron or positron is much smaller than the mass of the nucleus).

c) Gamma **radiation** is a type of electromagnetic radiation, not a particle, so it does not affect the atomic number or mass number of an element. Gamma radiation is simply a high-energy form of light that is emitted during certain types of radioactive decay.

30. The following changes occur during:

a) **Alpha decay**: The nucleus emits an alpha particle (a type of ionized helium nucleus) and the atomic number decreases by two, the atomic mass decreases by four. Example: Radon-222 (atomic number 86, atomic mass 222) becomes polonium-218 (atomic number 84, atomic mass 218) after emitting an alpha particle.

b) **Beta decay**: The nucleus emits a beta particle (a high-energy electron or positron) and the atomic number increases by one if a beta particle is emitted, or decreases by one if a positron is emitted. Example: Carbon-14 (atomic number 6, atomic mass 14) becomes nitrogen-14 (atomic number 7, atomic mass 14) after emitting a beta particle.

c) **Gamma decay**: The nucleus emits a gamma ray (a high-energy photon) and the atomic number and atomic mass remain unchanged. Example: Cesium-137 (atomic number 55, atomic mass 137) remains cesium-137 (atomic number 55, atomic mass 137) after emitting a gamma ray.

31.

a) After emitting an alpha particle, the composition of nucleus B will depend on the identity of nucleus A.

An alpha particle is made up of two protons and two neutrons, so if nucleus A emits an alpha particle, it will lose two protons and two neutrons. The resulting nucleus, nucleus B, will have a total of 84 - 2 = 82 protons and 128 - 2 = 126 neutrons.

b) Gamma radiation is a type of electromagnetic radiation, and it is not composed of matter. Therefore, emitting gamma radiation does not change the composition of the nucleus in the same way that emitting an alpha or beta particle would.

32.

a) ${}_{x+1}^{a}Q$

b) ${}_{2}^{4}He$

c) ${}_{90}^{234}Q$, ${}_{91}^{234}R$, ${}_{94}^{234}S$

d) ${}_{z-2}^{A-4}X_1$, ${}_{z-2}^{A-4}X_2$, ${}_{z}^{A-4}X_3$

e) ${}_{71}^{176}X_2$, ${}_{73}^{180}X_1$, ${}_{72}^{180}X$

33. Alpha particles are not used in radio therapy because they are not very effective at penetrating matter and reaching deep tissues in the body.

34. Gamma rays are often used as radioactive tracers in medical science because they are able to penetrate matter, can be detected with high sensitivity, and are emitted at a constant energy level.

35.

a) ${}_{6}^{14}C$ b) ${}_{15}^{32}P$ c) ${}_{19}^{40}K$

Reason: The number of neutrons exceeds the number of protons.

36. In terms of biological damage, alpha radiation is the least harmful, followed by beta radiation, and then gamma radiation.

Explanation:

This is because alpha particles are relatively large and have a positive charge, which makes them relatively easy to block.

Beta particles are smaller and more energetic than alpha particles, and they have a negative

charge. They can penetrate the skin to a limited extent.
Gamma radiation is the most energetic and penetrating form of radiation, and it can penetrate the skin and is highly ionizing, meaning it can cause damage to cells and tissues if the body is exposed to a high enough dose.

37. An atomic nucleus becomes radioactive when it is unstable, meaning that it has an excess of energy or an excess of protons and neutrons. This excess energy or mass can cause the nucleus to emit particles or electromagnetic radiation, such as alpha particles, beta particles, or gamma rays, as a means of stabilizing itself and reaching a more stable, lower-energy state.

38. Radioactive substances can be harmful to humans if they are ingested, inhaled, or absorbed through the skin. When a radioactive substance is touched, some of the radioactive particles may transfer to the skin, which can then be absorbed into the body. This can cause harmful effects, such as radiation sickness. In addition, some radioactive substances emit ionizing radiation, which can damage cells and tissues in the body.

39. Radioactivity is used in medicine in a number of ways. One common use is in the treatment of cancer, where radioactive isotopes are used to kill cancer cells or shrink tumors.

40. Isotopes of a given element have the same number of protons in their atomic nucleus, which determines the element's atomic number and its chemical properties. The number of neutrons in the nucleus can vary, however, which means that isotopes of the same element can have different atomic masses. Despite having different atomic masses, isotopes of the same element still have the same number of protons and the same atomic number, and therefore have the same chemical properties.

41. Isobars are atoms that have the same atomic mass, but are made up of different elements. Because they are made up of different elements, isobars have different atomic numbers and therefore different chemical properties.

For example, carbon-12 and nitrogen-14 are both isobars because they have the same atomic mass (12 atomic mass units), but carbon-12 is an isotope of carbon (atomic number 6) and nitrogen-14 is an isotope of nitrogen (atomic number 7).

Because they are made up of different elements, carbon and nitrogen have different chemical properties.

42. Alpha particles are massive and charged particles that lose energy as they pass through matter, especially dense materials. As they travel through air, they collide with atoms and transfer energy, which causes them to slow down and eventually stop.

43. Gamma radiation is made up of high-energy photons, which have no charge and a very small mass. They are not significantly affected by electric fields and do not lose much energy when passing through matter. As they travel through air, they may collide with atoms but are not significantly slowed down as a result. This is why gamma radiation is able to travel through a long distance in air.

44.

a) Atomic number and mass number of mediums are 88 and 229 respectively.

b) $^{229}_{88}Ra \longrightarrow {}^{0}_{-1}\beta + {}^{229}_{89}X$

45.

a) $^{218}_{84}Po \longrightarrow {}^{214}_{82}X + {}^{4}_{2}He$
Mass number of X = 214
Atomic number of X = 82

b) $^{230}_{90}Th \xrightarrow{\alpha-particle} {}^{226}_{88}Y + {}^{4}_{2}He$
Mass number of Y = 226 and atomic number = 88

46.

a) Thermionic emission is the process by which electrons are emitted from the surface of a hot conductor, due to the thermal energy of the conductor exceeding the work function of the material.

b) The rate of emission of thermions depends on the -

i) Temperature: The higher the temperature of the conductor, the more energetic the electrons will be, and the more likely they are to be emitted

ii) Material: A rough surface can increase the rate of thermionic emission, as it provides more points of emission.

47. The mass number of Al = 27 – 0 = 27 and its atomic number is 12 – (–1) = 13.

48.

a) When an element emits an alpha particle, it decays into a new element that is two places to the left in the periodic table. An alpha particle is made up of two protons and two neutrons, and when it is emitted, the resulting nucleus has two fewer protons. This means that the atomic number of the new element is lower than the atomic number of the original element, which causes it to be located two places to the left in the periodic table.

b) On the other hand, when an element emits a beta particle, it decays into a new element that is one place to the right in the periodic table. A beta particle is an electron or positron, and when it is emitted, the resulting nucleus has one more proton. This means that the atomic number of the new element is higher than the atomic number of the original element, which causes it to be located one place to the right in the periodic table.

49.

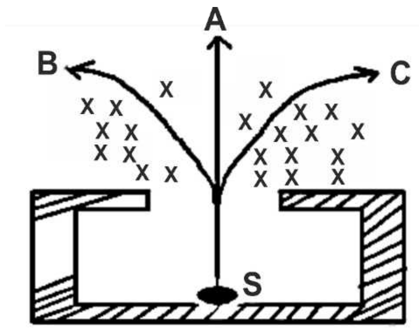
a) Three types of radiations are α – particles, β – particles and ϒ – rays

b) Negatively charged β – particles

c) Gamma (ϒ) radiation

d) Helium $^{4}_{2}He$

50. Radiations labelled A, B and C are α, β and ϒ respectively



a) Radiation labelled A is gamma radiation because they have no change and hence under action of magnetic field, they go undeflected.

b) Radiation β is alpha radiation because its mass is large, and it would be deflected less in comparison to beta radiation. The direction of deflection is given by Fleming's left-hand rule. Also, directions of deflection of alpha and beta radiations are opposite as they have opposite charges.

51. Gamma radiations are produced through the process of radioactive decay, in which an atomic nucleus undergoes a transformation and emits high-energy photons. These photons are called gamma rays, and they have very high frequency and energy, making them very penetrating and potentially harmful to living tissue.

Two common properties:

a) **Wavelength**: Both gamma radiations and visible light have a wavelength, which is the distance between consecutive peaks or troughs in a wave.

b) **Frequency**: Both gamma radiations and visible light also have a frequency, which is the number of cycles of a wave that pass a fixed point in a given period of time.

52. Background radiation refers to natural sources of ionizing radiation that are present in the environment. These sources include cosmic rays, which are high-energy particles that originate from outside the solar system, and radioactivity present in the Earth's crust.

It is not possible to completely eliminate exposure to background radiation. However, it is generally a very low level of radiation and the amount of radiation a person is exposed to can be reduced by taking certain precautions.

For example, it is possible to reduce exposure to cosmic rays by living at lower altitudes, as the Earth's atmosphere absorbs some of the radiation. Similarly, it is possible to reduce exposure to radioactive substances in the environment by avoiding certain areas or by using protective measures such as lead shielding.

53. $E = mc^2$ is Einstein's mass energy relation.

54. While establishing a nuclear power plant to generate electricity, following precautions must be taken:

a) **Site selection**: The site of the nuclear power plant should be carefully chosen based on factors such as geology, seismicity, and proximity to population centres.

b) **Emergency planning**: Nuclear power plants should have comprehensive emergency plans in place to deal with potential accidents or incidents. These plans should include measures such as evacuation procedures, emergency shutdown procedures, and off-site emergency response plans.

c) **Security**: Nuclear power plants should have robust security measures in place to protect against sabotage, terrorism, and other threats.

55. Nuclear waste is the material that is produced as a byproduct of nuclear reactions, such as those that occur in nuclear power plants or during the production of nuclear weapons. Nuclear waste can be highly radioactive and may remain hazardous for thousands of years. One way to safely dispose of nuclear waste is to bury it deep underground in a specially designed storage facility. This method allows the waste to be isolated from the environment and prevents it from contaminating the air, water, or soil.

56. Nuclear energy is the energy that is released when the nuclei of certain atoms are split or fused together. Nuclear reactions release a tremendous amount of energy, which can be harnessed to generate electricity or to power other processes. The energy is released when the strong nuclear force that holds the nuclei of atoms together is overcome, either by the impact of a neutron or by the fusion of two nuclei.

57. Einstein's mass-energy equivalence relation is an equation that describes the relationship between mass and energy. It is usually written as:

$E = mc^2$

Where E is the energy, m is mass and c is the speed of light in vacuum.

58.

a) The mass of atomic particle is expressed in terms of atomic mass unit (a.m.u).
1 a.m.u of mass is equivalent to 931 MeV of energy.
1 a.m.u = 931 MeV

b) Mass of proton = 938.3 MeV = 1.00727 a.m.u
Mass of neutron = 939 MeV = 1.00865 a.m.u
Mass of electron = 0.511 MeV = 0.00055 a.m.u

59.

a) *Scientific uses of radioisotopes:*
Medical imaging: Radioisotopes are commonly used in medical imaging to visualize the internal structure and function of the body. For example, radioisotopes can be used in PET (positron emission tomography) scans to visualize the metabolism of tissues in the body.

b) **Studying chemical reactions**: Radioisotopes can be used to study chemical reactions by introducing a radioisotope into a chemical reaction and measuring the radioactivity of the products. This can provide information about the mechanisms of chemical reactions and the rates at which they occur.

c) **Tracing the movement of elements through a system or organism**: Radioisotopes can be used to trace the movement of elements through a system or organism by introducing a small amount of the radioisotope into the system and following its progress over time. This can be useful for understanding the metabolism of an organism or the flow of materials through an ecosystem.

60.

a) *Industrial uses of radioisotopes*
Non-destructive testing: Radioisotopes can be used to test the quality and integrity of materials without damaging them. For example, radioisotopes can be used to test welds, castings, and other structural components for defects.

b) **Environmental monitoring**: Radioisotopes can be used to monitor environmental conditions, such as the movement of pollutants through soil or water.

c) **Sterilization**: Radioisotopes can be used to sterilize medical equipment and other items that need to be free of contaminants.

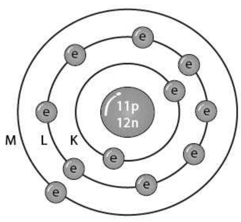
61.

a) $^{3}_{2}He + ^{2}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{1}H$ + energy

b) $^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n$ + energy

PART 3

1. The atomic number Z = 11
The mass number A = 23
Number of neutrons A – Z = 12
Its atomic model is



$^{23}_{11}$Na Sodium

2.

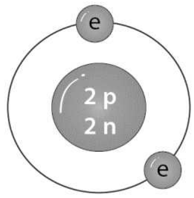
a) The radiation which has zero mass are gamma radiations.

b) Gamma radiations has the lowest ionizing power.

c) Alpha radiation has the lowest penetrating power.

d) Alpha particles have positive charge = 3.2 × 10^{-19} C and rest mass = 4 times the mass of proton i.e., 6.68 × 10^{-27} kg

e) The name of the gas is helium



f) These radiations come from the nucleus of an atom

3. This statement is generally true. Radioactivity is the emission of particles or electromagnetic radiation from the nucleus of an atom due to the instability of the nucleus. It is a phenomenon that occurs at the nuclear level and is caused by the arrangement and stability of the protons and neutrons within the nucleus. Radioactivity can be natural, occurring naturally in certain elements, or it can be artificially induced, for example through the bombardment of a stable nucleus with particles or by synthesizing a new element in a laboratory.

4. A particle that leaves its mass number unchanged but increases its atomic number by one is a beta particle. The symbol of the β particle is given by

$^{0}_{-1}e$ **or** $^{0}_{-1}\beta$

5.

a) The radiations labelled as A, B and C are γ, α and β respectively.

b) The radiation labelled as A is gamma radiation as they have no charge and thus under the action of the magnetic field, they go undeflected.
The radiation labelled as B is alpha radiation since its mass is large and it would be deflected less in comparison to beta radiation. Fleming's left-hand rule determines the direction of deflection. As the alpha and beta have opposite charges, hence the direction of deflection of alpha and beta radiations are also opposite.

6. Radioisotopes are isotopes of an element that are radioactive and emit radiation as they decay. One example of a radioisotope is carbon-14, which is used in carbon dating.

Radioisotopes have many important uses in a variety of fields, including medicine, industry, and scientific research. In medicine, radioisotopes are used in diagnostic imaging tests such as PET scans and in the treatment of cancer and other diseases.

7. The atoms of a substance having the same atomic number, but different mass number are known as isotopes.
Example: Hydrogen has three isotopes namely protium, deuterium and tritium. Each isotope structure differs by the number of neutrons in its nuclei.

8.

a) The atomic number of an element is the number of protons in the nucleus of an atom of that element. It is also equal to the number of electrons in a neutral atom of that element. The atomic number is unique to each element and determines the element's place in the periodic table.

b) The mass number of an atom is the total number of protons and neutrons in the nucleus of the atom. It is usually denoted by the symbol "A" and is equal to the sum of the number of protons and neutrons in the nucleus.

9. Radiation can come from various parts of an atom. When an atom is unstable, it can release energy in the form of radiation in order to become more stable. This process is known as radioactive decay.
There are three main types of radiation that can be emitted by an atom: alpha particles, beta particles, and gamma rays.
In summary, radiation can come from the nucleus or outer shell of an atom, depending on the type of radiation being emitted.

10.

$$^{234}_{90}Q,\ ^{234}_{91}R,\ ^{234}_{92}S$$

11.

a) **Radioactive decay is a random process**: The decay of any particular atom is completely unpredictable, and the rate at which a particular isotope decays is constant over time.

b) **Radioactive decay is a continuous process**: An isotope will continue to decay until it reaches a stable state, which may be a long time depending on the isotope. This means that there is always some level of radioactivity present in an isotope, even if it is very small.

12.

a) Alpha particles do not penetrate very far into matter. They are stopped by a few centimeters of air or a few millimeters of low-density material, such as tissue. This means that alpha particles cannot reach the deeper tumors that are sometimes targeted in radiation therapy.

b) Alpha particles are highly ionizing, which means they can cause a lot of damage to cells and DNA when they interact with living tissue. While this can be beneficial for killing cancer cells, it also means that alpha particles can cause significant damage to healthy tissue.

13.

a) **Alpha (α) radiation** is made up of alpha particles, which are positively charged and made up of two protons and two neutrons. Alpha particles are relatively large and heavy, and they have a relatively low penetration power.

b) **Beta (β) radiation** is made up of beta particles, which are high-energy, high-speed electrons or positrons. Beta particles are smaller and lighter than alpha particles and have a higher penetration power.

c) **Gamma (γ) radiation** is a form of electromagnetic radiation, similar to X-rays. Gamma rays are very high-energy and have a very high frequency and a very short wavelength. Gamma rays are the most penetrating of the three types of radiation, and they are produced by the decay of atomic nuclei.

14. Gamma rays are a type of electromagnetic radiation, similar to X-rays and visible light. They are produced by the decay of atomic nuclei, as well as through the interaction of high-energy particles with matter. One common property of gamma rays and visible light is that they are both forms of electromagnetic radiation, meaning they travel through space at the speed of light and have properties of both waves and particles.

15.

a) If an alpha particle captures one electron, it can change into a neutral atom of a different element. For example, if an alpha particle captures an electron from a lithium atom, it can change into a neutral helium atom.

b) If an alpha particle captures two electrons, it can change into a negative ion of a different element. For example, if an alpha particle captures two electrons from a beryllium atom, it can change into a negative beryllium ion.

16.

(i) **Atomic number**: When an alpha particle, beta particle, or gamma radiation is emitted, the atomic number of the nucleus does not change.

(ii) **Mass number**: When an *alpha* particle is emitted, the mass number of the nucleus decreases by 4, because an alpha particle consists of two protons and two neutrons.

When a *beta* particle is emitted, the mass number remains the same, but the atomic number increases by 1, because a beta particle is a high-energy electron or positron.

When *gamma* radiation is emitted, the mass number and atomic number of the nucleus do not change, because gamma radiation is a type of electromagnetic radiation and does not involve the emission of any particles.

17.

a) Alpha (α) radiation: 5,000 to 15,000 meters per second.

b) Beta (β) radiation: 20,000 to 70,000 meters per second.

c) Gamma (γ) radiation: 299,792,458 meters per second.

18.

a) The particle emitted is an alpha particle.

b) The atomic number is decreased by 2 and the mass number is decreased by 4. This happens when an alpha particle is emitted.

c)

$$^{238}_{92}P \longrightarrow {}^{234}_{90}Q + {}^{4}_{2}\alpha$$

19. Nuclear waste refers to the materials that are left over after the use of nuclear fuel in nuclear power plants or other nuclear processes. These materials are highly radioactive and must be carefully managed to protect human health and the environment.

20.

a) This is allowed.

b) This is not allowed because mass number is not conserved.

PART 4

1. b) α-radiation

2. c) Carbon

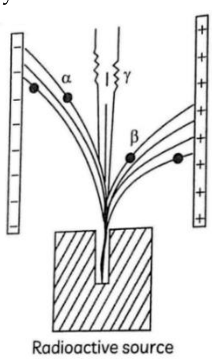
3. a) γ

4. d) Alpha

5.

a) In ascending order of ionizing power, the rays would be arranged as follows: β rays, α rays, γ rays

b) Of the three types of rays, only β rays will be undeviated if subjected to an electric field. This is because β rays are composed of fast-moving electrons, which are charged particles that will be affected by an electric field.



c) If a β ray is emitted and passes undeviated through an electric field, there will be no change in the nucleus of the atom. This is because the β

ray is simply a stream of electrons that are emitted from the nucleus and do not interact with the nucleus itself. The β ray may interact with other atoms or molecules that it encounters as it travels, but it will not affect the nucleus of the atom that it was emitted from.

6.

i) The composition of B is
No. of protons = 82
No of neutrons = 126

ii) The composition of C is
No. of protons = 83
No. of neutrons = 125

iii) Mass number of the nucleus A = 212

iv) No, the composition of a nucleus does not change if it emits gamma radiation.

According to Board Examiners

This part of the question was well attempted by most candidates. Some of the common mistakes made in the subparts are as follows:
a) A few candidates did not write number of neutrons. Some forgot to add the number of protons and neutrons to get the mass number. They subtracted 4 from the neutron number and 2 from the proton number instead of subtracting 4 from the mass number.
b) Some candidates used neutrons as atomic mass for beta emission. For candidates who made mistakes in the first part, the second part also went incorrect, since the second part was related to the first part.
c) Most of the candidates answered correctly but some forgot to add the number of protons and neutrons and some wrote only the number of protons as mass number.
(iv) A few candidates answered this subpart as Yes, which was incorrect.

7. One safety precaution in the disposal of nuclear waste is to store it in a secure, underground facility that is designed to isolate the waste from the environment for a very long period of time. This is typically done by encasing the waste in multiple layers of protective materials, such as steel and concrete, and burying it deep underground in a geologically stable location.

8. **(i) Nuclear Fission -** In nuclear fission, when neutrons are bombarded a heavy nucleus, it splits in two nearly equal light fragments. It can be controlled.

Nuclear Fusion - In nuclear fusion, two light nuclei combine to form a heavy nucleus at a very high temperature and high pressure. It cannot be controlled.

(ii) For disposal of nuclear waste, they must be first kept in thick casks and then buried in specially constructed deep underground stores and also while handling nuclear waste, we should wear special lined lead aprons and lead gloves.

According to Board Examiners

(i) A number of candidates answered correctly. Some candidates mixed up the definitions of fission and fusion. The words bigger and smaller were used in place of heavier and lighter, respectively. Vague statement was written by a few candidates such as, large energy is given out during nuclear fusion without comparing the quantity of nuclear material.
(ii) Some candidates gave precautions to be taken while handling the radioactive substances.

9. No, it is not possible for a hydrogen (^1_1H) nucleus to emit an alpha particle. An alpha particle is a type of radioactive decay in which a nucleus emits a helium nucleus, consisting of two protons and two neutrons. The hydrogen (^1_1H) nucleus, on the other hand, consists of only one proton and no neutrons. Therefore, it does not have the necessary mass or number of protons and neutrons to emit an alpha particle.

According to Board Examiners

Most of the candidates wrote first part correctly as 'No' barring some of them who wrote 'Yes'. But they found it difficult to give reason for the same. Various reasons were observed such as Hydrogen is not a radioactive substance, after Alpha emission atomic number decreases by 2 and mass number decreases by 4, Hydrogen has one proton and one neutron or hydrogen has one proton and one electron. Some candidates gave irrelevant explanation. Very few candidates attempted it to explain with a nuclear reaction.

10.

i) Isobars are nuclides that have the same atomic number (i.e., the same number of protons) but different atomic masses (i.e., different numbers of neutrons). They are therefore isotopes of different elements that have the same number of protons and the same atomic number but differ in the number of neutrons they contain.

ii) For example, the nuclides carbon-14 and nitrogen-14 are isobars, as they both have an atomic number of 7 (i.e., they both have 7 protons) but different atomic masses (14 and 14, respectively).

According to Board Examiners

Many candidates answered sub-parts a) and b) correctly. However, some common errors made by a few candidates were as follows: confused between isotopes and isobars. wrote examples with incorrect mass number and atomic number. Wrote the elements without atomic number and mass numbers. Gave examples of isotopes.

11. The nucleus of an atom can be radioactive if it contains an unstable combination of protons and neutrons. This can happen if the nucleus has too many or too few neutrons relative to the number of protons, or if it has an excess of energy.

12. $^{Z}S_{A} \rightarrow {}^{85}R_{222}$

A = 222+8 = 230

Z = 85 + 4 – 1 = 88

13. There will not be any change in the nature of the radioactivity of the substance as a result of oxidation. Radioactivity is a property of the atomic nucleus, and it is not affected by chemical reactions that involve the loss or gain of electrons, such as oxidation.

14.

i) $\alpha<\beta<\gamma$

ii) $\gamma<\beta<\alpha$

iii) $\alpha<\beta<\gamma$

15.

i) ${}_{0}^{1}n \rightarrow {}_{(+)1}^{1}P + {}_{-1}^{0}e$

ii) Isobars

iii) The nucleus of an atom can be radioactive if it contains an unstable combination of protons and neutrons. This can happen if the nucleus has too many or too few neutrons relative to the number of protons, or if it has an excess of energy.

16. Two precautions to be taken while handling radioactive substances are –

a) Wear protective equipment when handling radioactive substances.

b) Follow proper handling techniques to avoid accidents.

17.

i) ${}_{11}Na^{24} \rightarrow {}_{12}Mg^{24} + {}_{-1}e^{0}$

ii) The number 24 is mass number and 11 is atomic number.

iii) They are isobars. Because ${}_{12}Mg^{24}$ and ${}_{11}Na^{24}$ have same mass number but different atomic number.

Tip: Isobars have same mass number but different atomic number.

18. ${}_{72}X^{180} \xrightarrow{\beta} {}_{73}X_{1}^{180} \xrightarrow{\alpha} {}_{71}X_{2}^{176} \xrightarrow{\alpha} {}_{69}X_{3}^{172}$

Mass number of X = 180

Atomic number of X = 72

19.

i) All types of radioactive radiation can potentially cause genetic disorders if they are present in high enough levels. This is because radioactive radiation can damage DNA and other genetic material, which can lead to mutations and other genetic changes.

ii) Only charged particles, such as alpha particles and beta particles, can be deflected by an electric field. Alpha particles are positively charged and beta particles are negatively charged, so they can be affected by electric fields. Gamma rays and x-rays, on the other hand, are not charged and are not affected by electric fields.

20. There are several sources of background radiation, which is naturally present in the environment. Two important sources are **cosmic radiation**, which originates from outside the Earth's atmosphere, and **terrestrial radiation**, which originates from within the Earth's crust.

21.

i) β particle

ii) $^{14}_{6}X \rightarrow ^{14}_{7}Y + ^{0}_{-1}e$

22. One use of radioactivity is in medicine. Radioactive isotopes can be used in a variety of medical procedures, including imaging tests such as PET scans and radiation therapy to treat cancer.
One harmful effect of radioactivity is radiation sickness, which occurs when a person is exposed to high levels of ionizing radiation over a short period of time. Symptoms of radiation sickness can include nausea, vomiting, diarrhea, fatigue, and skin irritation.

23. In the case of the element P disintegrating by alpha emission and the new element suffering two further disintegrations by beta emission to form element Q, both P and Q are isotopes of the same element because they have the same number of protons in their nucleus.
The alpha and beta emissions represent the emission of particles (alpha particles and beta particles) from the nucleus of the atom, which changes the number of neutrons in the nucleus and therefore the atomic mass of the atom. However, the number of protons in the nucleus remains the same, so both P and Q are isotopes of the same element.

24.

i) An alpha particle absorbs one electron to become a neutral atom.

ii) An alpha particle absorbs two electrons to also become a neutral atom.
Explanation: The absorption of electrons by an alpha particle is a process called electron capture. This process can occur when an alpha particle is in close proximity to a negatively charged electron and is able to capture the electron, adding it to its own electron cloud and neutralizing its overall charge.

25.

a) $^{12}_{6}C$

b) $^{30}_{15}P$

c) $^{39}_{19}K$

Reason: Radioisotopes are isotopes of an element that are radioactive, meaning that they are unstable and will decay over time, emitting radiation in the process. The atomic number of an element represents the number of protons in the nucleus, and the mass number represents the total number of protons and neutrons. Radioisotopes with a higher atomic number and a lower mass number are generally more radioactive because they have a higher ratio of protons to neutrons, which makes them more unstable.

26.

a)

(i) Atomic number of an element decreases by 2 when an alpha particle is emitted out.

(ii) Atomic number of the element increases by 1 when a beta particle is emitted.

b) Alpha particles, beta particles, and gamma rays are all types of ionizing radiation that differ in their properties and behavior.
Alpha particles are made up of two protons and two neutrons and are positively charged. They are relatively large and heavy, and they are deflected in electric and magnetic fields due to their charge and mass.
Beta particles are high-energy electrons or positrons and are also charged. Like alpha particles, they are deflected in electric and magnetic fields.
Gamma rays are electromagnetic radiation and do not have a charge, so they are not affected by electric fields. They are also much lighter than alpha or beta particles, so they are not significantly affected by magnetic fields. As a result, gamma rays are not deflected in electric or magnetic fields.

ANSWERS TO LATEST SPECIMEN PAPER

SECTION A

1.

i) (b) Nm

Explanation: Moment = Force x Perpendicular distance

∴ S.I. unit of moment = Nm

ii) (d) $K = \frac{1}{2}m(v^2 - u^2)$

Explanation: Consider a body of mass m kg be initially moving with velocity u. After some time, velocity changes to v.

Initial K.E. $= \frac{1}{2}mu^2$

Final K.E. $= \frac{1}{2}mv^2$

∴ Change in K.E. $= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$= \frac{1}{2}m(v^2 - u^2)$

iii) (a) Kinetic to potential

Explanation: At mean position P.E. = 0 and K.E. is maximum. At extreme position velocity becomes zero hence K.E. = 0 and P.E. becomes maximum.

(iv) (a) Alpha

Explanation: Alpha particles have least penetrating power and can be stopped by paper or skin.

(v) (d) In the glass block, speed of orange light > speed of indigo light.

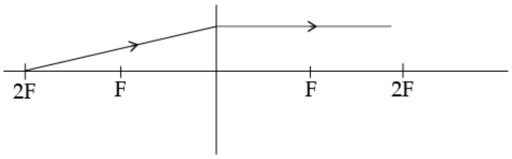
Explanation: Let refractive index be represented by n

$n_V > n_I > n_B > n_G > n_Y > n_O > n_R$

Speed in inversely proportional to refractive index

$v_V > v_I > v_B > v_G > v_Y > v_O > v_R$

(vi) (a) The correct diagram is



(vii) (b) Amplitude

Explanation: More the amplitude of vibration of source of sound, more sound energy is produced at a given point and hence higher the intensity.

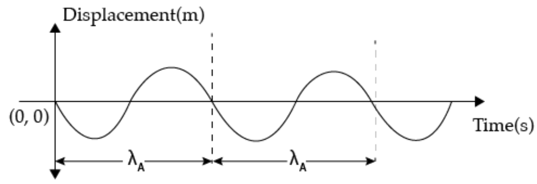
Caution

Don't get confused with the option loudness. Loudness is subjective in nature and depends on other factors also like response of ear etc.

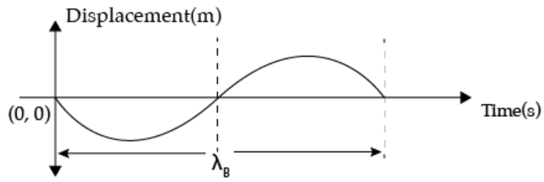
(viii) (b) 1 : 2

Explanation:

(A)



(B)



Clearly from diagram $2\lambda_A = \lambda_B$

$= \frac{\lambda_A}{\lambda_B} = \frac{1}{2}$

(ix) (c) $R_C > R_B > R_A$

Explanation: The more the V-I graph inclined towards V-axis, more is the resistance of that conductor.

(x) (c) Live : Brown

Neutral : Blue

Earth : Yellow

(xi) (b) Fleming's left hand rule.

Explanation: M

(xii) (d) is directly proportional to the specific latent heat of the substance.

Explanation: During change of phase of a substance, heat absorbed is given by latent heat absorbed = mL

where m = mass of substance

L = specific latent heat

(xiii) (a) Liquid P with specific heat capacity 4000 J $Kg^{-1} K^{-1}$

Explanation: Higher the specific heat capacity more suitable is the liquid for radiators in cars.

(xiv) (c) $\angle i > \angle r$

Explanation: While entering from medium A to medium B, if light shows down then $n_A < n_B$ i.e. light is entering from a rarer medium to

denser medium. Therefore light bends towards the normal.
$\therefore \angle i > \angle r$

(xv) (b) Total internal reflection.

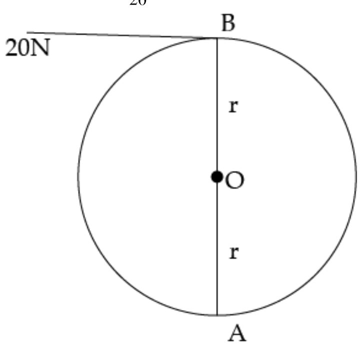
2.

i) (a) 2
Block and tackle system with velocity ratio 5 has five pulleys in all. Number of pulleys in upper fixed block are either equal to or 1 more than the number of pulleys in movable block. Hence fixed block has 3 pulleys and movable block has 2 pulleys.
(b) Yes
Daughter nucleus gets one position right to the parent nucleus in periodic table as neutron converts into proton, increasing its atomic number.
(c) Positive Plate
As beta particles (electrons) are themselves negatively charged, they are attracted towards positive plate.

ii) Moment of force A about O, 10 x $\frac{4}{100}$ Nm = 0.4 Nm
Moment of force B about O, 12 x $\frac{2.5}{100}$ Nm = 0.3 Nm
Moment of force C about O, 12 x $\frac{2}{100}$ Nm = 0.24 Nm
(a) Force A produces maximum moment about O.
(b) Moment of force A about O is 0.4 Nm.

iii) Two factors that affects the centre of gravity of the body are:
(a) Shape of the body.
(b) Distribution of mass of the body.

(iv) Moment of force F = 20 N about O is 6 Nm
$\Longrightarrow$ 6 = 20 x r
$\Longrightarrow$ r = $\frac{6}{20}$ m



Now moment of force F about A
M = F x AB
= 20 x 2r
= 20 x 2 x $\frac{6}{20}$ Nm
= 12 Nm

(v) Given, K = 40 J
$\frac{1}{2}$mv² = 40 …a)
If velocity is doubled
K = $\frac{1}{2}$ m $(2v)^2$
= $\frac{1}{2}$ m x $4v^2$
= 4 x $\frac{1}{2}$ mv^2
…b)
= 4 x (40) J
= 160 J
Important
Kinetic energy ∝ $(velocity)^2$
If velocity increases by K times, K.E. increases to K^2 times.

(vi) (a) natural vibration.
(b) By increasing the length of string of pendulum.

(vii) Let radius of wire A = 2r
radius of wire B = r
Area of wire A = $\pi(2r)^2 = 4\pi r^2$
Area of wire B = $\pi r^2 = \pi r^2$
(a) $R_B > R_A$ As $R \propto \frac{1}{A}$
(b) Both will have some resistivity.
As resistivity depends on nature of material and temperature which are same.

3.

i)
(a) Convex lens.
(b) Yes, when object is placed between focus and centre of curvature.

ii)
(a) It is generally not possible to switch off an appliance by placing the switch in a neutral wire. The neutral wire is a conductor that carries current back to the source of electricity, typically a power plant or utility company. It is not intended to control the flow of electricity to an appliance.
(b) Current can flow between a neutral wire and an earth wire under certain circumstances. The most common situation in which this can occur is if there is a fault in the electrical system that causes the neutral wire to become energized. This can happen if the neutral wire becomes damaged or if there is a break in the insulation surrounding the wire. When this happens, the current flowing through the

neutral wire can take an alternative path to the earth wire, which is typically grounded to the earth through a metal rod or other conductor.

iii) Factors affecting the strength of an electromagnet are:

(a) Number of turns of coil.

(b) Amount of current flowing in the coil.

Important:

One can also increase the strength of electromagnet by placing a magnetic material in the care of electromagnet.

(iv) m = 200 g, f = 336 J/g

c = 4.2 J/g

Heat absorbed during melting of ice = mL

Q_1 = 200 x 336 J

Q_1 = 67,200 J

Heat absorbed by water to change temperature $0^{\circ}C$ to $60^{\circ}C$ is given by

Q_2 = mc Δ T

= 200 x 4.2 x 60

= 50,400 J

Total heat absorbed = $Q_1 + Q_2$

= 67,200 + 50,400

= 117,600 J

= 117.6 KJ

(iv) Background radiations are the radioactive radiations (α, β or γ) emitted by radioactive isotopes of elements present in earth crust and atmosphere.

SECTION B

4.

i) (a) Angle of minimum deviation = 30°

Angle of incidence corresponding to angle of minimum deviation = 46

(b) $I_1 + I_2 = A + \delta$

where $I_1 = 40, I_2 = x, A = 62^{\circ}, \delta = 51^{\circ}$

⟹ 40 + x = 62° + 51°

⟹ x = 73°

Important

At angle of minimum deviation

$2_i = A + \delta_m$

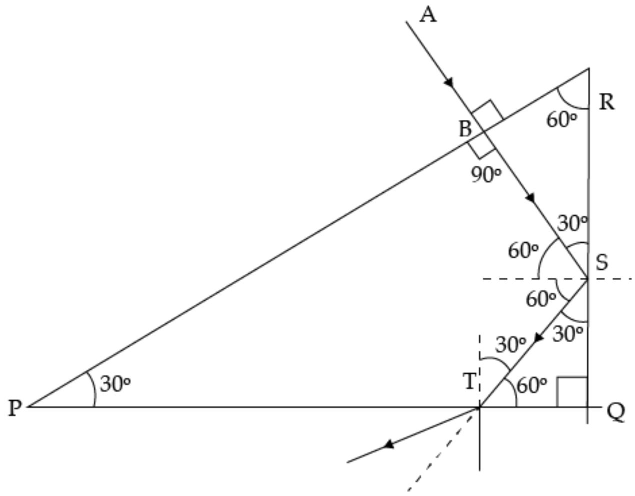
⟹2 x 46 = 62 + δ_m

⟹92 – 62 = δ_m

⟹δ_m = 30°

Hence angle of minimum deviation is 30°

ii) At S, angle of incidence is 60°. Hence total internal reflection occurs (critical angle = 42°). At T angle of incidence = 30° which is less than critical angle = 42°, hence ray of light travels to another medium (away from the normal).



iii) (a) Refraction:

When ray of light passes from one transparent medium to another transparent medium with different refractive index, it bends from its path. This phenomenon is called refraction.

(b) (1) X increases

(2) X decreases

5.

i) Given h_0 = 20 cm,

u = -50 cm, v = -15 cm

(a) Concave lens

Virtual and diminished image is the characteristics of concave lens only.

(b) $\frac{1}{v} = \frac{1}{u} = \frac{1}{f}$

$\Longrightarrow \frac{1}{-15} - \frac{1}{-50} = \frac{1}{f}$

$\Longrightarrow \frac{-1}{15} + \frac{1}{50} = \frac{1}{f}$

$\Longrightarrow \frac{-10+3}{150} = \frac{1}{f}$

$\Longrightarrow \frac{-7}{150} = \frac{1}{f}$

$\Longrightarrow f = \frac{-150}{7}$

= -21.4 cm

ii)

(a) X : Violet

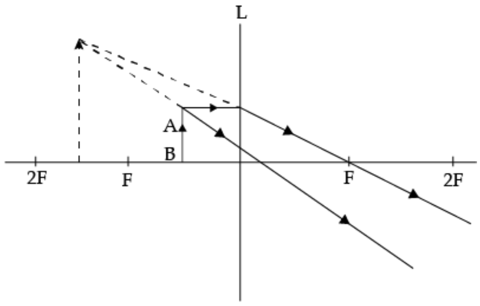
Y : Red

(b) All colours have same seed in vacuum.

iii)

(a) Convex lens

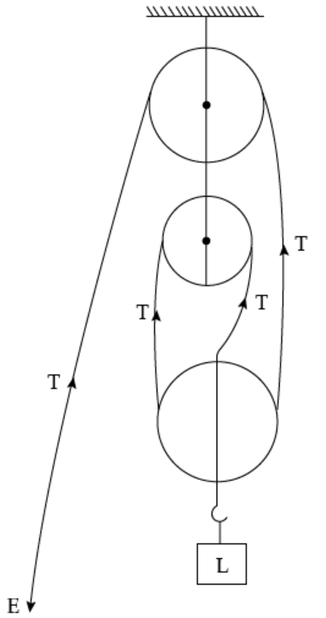
(b)



(c) Magnifying glass/simple microscope.

6.

i) (a)



(b) For three pulley system, V.R. = 3

Given efficiency η = 80% = 0.8

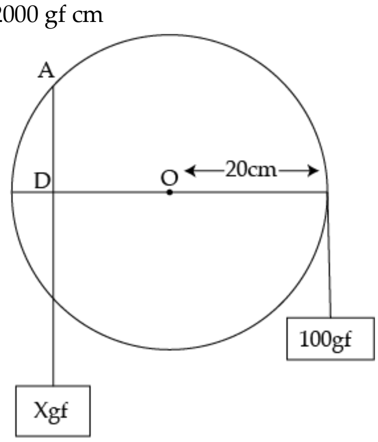
∴ Mechanical advantage = η x V.R.

M.A. = 0.8 x 3 = 2.4

ii) (a) Clockwise moment

= 100 gf x 20 cm

= 2000 gf cm



(b) X > 100 gf

(c) Anticlockwise moment

(X) = (OP) gf cm

As wheel is rotating anticlockwise

∴ (X) x (OP) > 100 x 20

As OP < 20 cm

∴ X > 100 gf

iii) (a) Given m = 450 g = $\frac{450}{1000}$ kg

h = 80 m.g. = 10 ms^{-2}

P.E. = mgh

= $\frac{450}{1000}$ x 10 x 80

= 360 J

K.E. = 360 J

(b) The principle involved is law of conservation of energy.

7.

i) (a) t = 3 s

v = 336 ms^{-1}

Let the distance of the person from the cliff be d

∴ 2d = v x t

2d = 336 x 3

d = 504 m

(b) Let the distance moved by man = x

New distance of man from cliff = (504 – x)

New time to hear echo = 1.5 seconds

∴ 2(504 – x) = 336 x 1.5

⟹ 1008 – 2x = 504

⟹ 504 = 2x

⟹ x = 252 m

ii) (a) Isotopes

$${}^{A}_{Z}X \xrightarrow{\alpha} {}^{A-4}_{Z-2}X_1 \xrightarrow{\beta} {}^{A-4}_{Z-1}X_2 \xrightarrow{\beta} {}^{A-4}_{Z}Y$$

X & Y have same atomic number but different mass number.

(b) 80 (Isotopes)

(c) 185

$${}^{189}_{80}X \xrightarrow{\alpha} {}^{185}_{78}X_1 \xrightarrow{\beta} {}^{185}_{79}X_2 \xrightarrow{\beta} {}^{185}_{80}Y$$

iii) (a) Resonance

It is a special case of forced vibrations. When the frequency of the externally applied force on a body is equal to its natural frequency, the body readily begins to vibrate with an increased amplitude.

(b) Frequency of channel = 93.5 MHz

= 93.5 x 10^{6} Hz

= 9.35 x 10^{7} Hz

8.

i) (a) 60 w, 220 v represents on appliance which when applied across 220 v, consumes 60 J/S.

(b) Live wire

(c) Main switch connects and disconnects live and neutral wire simultaneously from the circuit.

ii) (a) $^{222}_{86}Rn \longrightarrow {}^{218}_{84}Po + {}^{4}_{2}$

(b) α-particles are positively charged. In an electric field it will bend towards positive plate.

iii) (a) 5 Ω and 3 Ω resistance are in series

∴ Effective resistance of this branch = 8 Ω

Now 2 Ω and 8 Ω resistance are in parallel

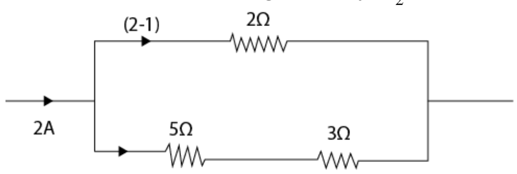
$\frac{1}{R} = \frac{1}{2} + \frac{1}{8}$

$\frac{1}{R} = \frac{4+1}{8} = \frac{5}{8}$

R = $\frac{8}{5}$ Ω = 1.6 Ω

Total resistance of circuit = 1.6 Ω + 0.4 Ω = 2 Ω

(b) Net current through battery = $\frac{4}{2}$ = 2 A



In parallel circuit, potential difference remains same i.e.

Si = 2(2 – i)

8i = 4 – 2i

10i = 4

i = 0.4 A

9.

i) Let thermal capacity of metal piece be C

Fall in temperature of metal piece

= (120 – 40)°C

ΔT_m = 80°C

Mass of water = 200 g

Rise in temperature of water ΔT_W

= (40° – 30°) = 10°C

Mass of calorimeter = 80 g

Rise in temperature of calorimeter = 10°C

Heat lost by metal piece

$Q_1 = C_m \times 80$

Heat gained by calorimeter and water

$Q_2 + Q_3 = 80 \times 0.4 \times 10 + 200 \times 4.2 \times 10$

= 320 + 8400 = 8720 J

Heat lost by hot body

= Heat gained by cold body

$C_m \times 80 = 8720$

$C_m = 109\ JC^{-1}$

ii) (a) Condensation temperature = 150°C

Freezing temperature = 60°C

(b) Temperature range in which the substance is in liquid state is 60° to 150°

(c) Ice absorbs latent heat of fusion from a drink to melt and convert to water at 0°C in addition to heat absorbed by ice cold water. Hence it better cools the drink.

iii) (a) At Q ⟶ South pole

At R ⟶ South pole

(b) Electromagnetic Induction

(c) Lenz's law

ICSE 2024 EXAMINATION
SAMPLE PAPER 1
PHYSICS
(SCIENCE PAPER - 1)

Maximum Marks: 80
Time allowed: Two hours
Answers to this paper must be written on the paper provided separately.
You will not be allowed to write during the first 15 minutes.
This time is to be spent reading the question paper.
The time given at the head of this Paper is the time allowed for writing the answers.

Section A *is compulsory. Attempt* ***any four*** *questions from Section B.*
The intended marks for questions or parts of questions are given in brackets []

Question 1

Choose the correct answers to the questions from the given options: - [15]

(i) If a body is pivoted at a point and a force of 20 N is applied at a distance of 20 cm from the pivot, then the moment of the force about the pivot is:

(a) 4 Nm (b) 3 Nm (c) 5 Nm (d) 2 Nm

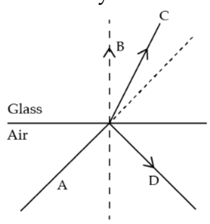
(ii) Work done is positive when ____________.

(a) distance is positive
(b) maximum distance is travelled along the direction of force applied
(c) displacement is in the direction of force applied
(d) distance is negative

(iii) Mechanical advantage is the ratio of:

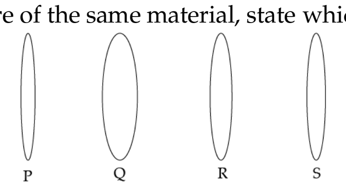
(a) effort to load (c) load arm to effort arm
(b) load to effort (d) none

(iv) In the diagram shown below, identify the refracted ray:



(a) A (b) B (c) C (d) D

(v) Assuming all lenses shown below are of the same material, state which lens had the maximum power.



(a) R (b) P (c) Q (d) S

(vi) A lens which always forms an upright diminished image is:
(a) concave lens
(b) convex lens
(c) plano concave lens
(d) none of these

(vii) The energy conversion, when an oscillating pendulum moves from mean to an extreme position is:
(a) Kinetic to potential
(b) Potential to kinetic
(c) Potential to kinetic to potential
(d) Kinetic to potential to kinetic

(viii) To increase the loudness of a sound, we should increase its:
(a) frequency (b) intensity (c) pitch (d) amplitude

(ix) 1C charge means a deficit of _________ electrons.
(a) 1 (b) 10^{19} (c) 6.25×10^{18} (d) 1.6×10^{-19}

(x) Fuse wire is always fitted in a porcelain casing because porcelain is:
(a) Insulator (b) Conductor (c) Looks bright (d) Flexible

(xi) In the earth's magnetic field alone, the needle rests along the:
(a) north-south direction
(b) east-west direction
(c) in any direction
(d) rotates continuously

(xii) Free vibrations are:
(a) The vibrations under the influence of a periodic force
(b) The vibrations with larger amplitude
(c) The vibrations when the frequency continuously decreases
(d) The vibrations with a constant frequency and constant amplitude

(xiii) Which of these is not associated with the nucleus?
(a) Electron (b) Quantum (c) Proton (d) Neutron

(xiv) 400 g of water at 80°C is mixed with 1 kg of water at 20°C. If the specific heat capacity of water is 4200 J/kg K, find the final temperature of the mixture.
(a) 23.25°C (b) 41.44°C (c) 18.52°C (d) 37.14°C

(xv) When the resistance of the combination is to be decreased, they are connected in the:
(a) series (b) mixed (c) parallel (d) in any of the way

Question 2

(i) From α, β, ϒ name the one: [3]
(a) Which has the maximum penetrating power?
(b) Which has the maximum ionising power?
(c) Which travels with the speed of light?

(ii) With reference to the terms Mechanical Advantage, Velocity Ratio and Efficiency of a machine name and define the term that will not change for a machine of a given design. [2]

(iii) A brass ball is hanging from a stiff cotton thread. Draw a neat, labelled diagram showing the forces acting on the brass ball and the cotton thread. [2]

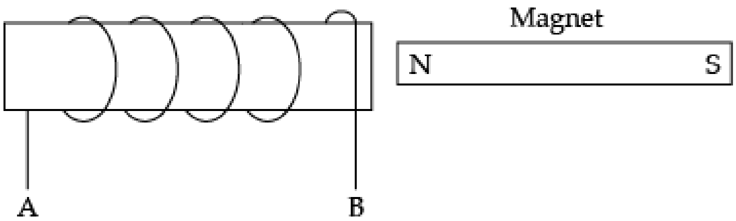
(iv) A mechanic can open a nut by applying 120 N force while using a lever of 50 cm in a length. How long handle is required if he wishes to open it by applying a force of 40 N only? [2]

(v) Answer the following [2]
(a) What do you understand by the free vibration of a body?
(b) Why does the amplitude of a vibrating body continuously decrease during damped vibration?

(vi) In the following diagram and arrow shows the motion of the coil towards the bar magnet. [2]

(a) State in which direction the current flows, A to B or B to A?

(b) Name the law which is used here to conclude.



(vii) It is easier to turn a steering wheel of a large diameter than that of a small diameter. Why? [2]

Question 3

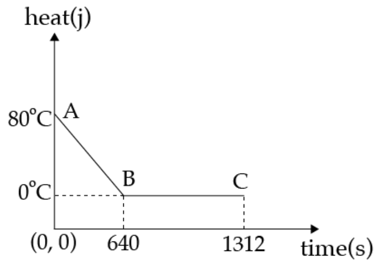
(i) Two lenses have the power of (A) + 2D (B) – 4D. What is the focal length of each lens? [2]

(ii) Explain how local earthing is done. [2]

(iii) State two ways by which the strength of an electromagnet can be increased. [2]

(iv) The diagram below shows a cooling curve for 200 g of water. The heat is extracted at the rate of 100 Js^{-1}. Answer the questions that follow: [2]

(a) Calculate the specific heat capacity of water. (b) Heat released is the region BC.



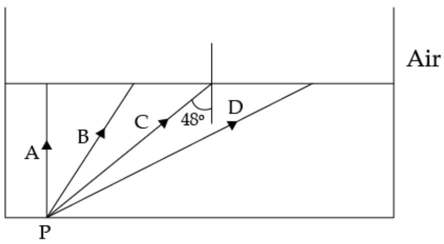
(v) Show the position of the centre of gravity by point G for a circular ring, triangular lamina, rectangle, parallelogram, square lamina, rod and cylinder. [2]

Section B

(Attempt any 4)

Question 4

(i) The diagram below shows a point source P inside a water container. Four rays A, B, C, and D starting from source P are shown up to the water surface. [3]



(a) Show in the diagram the path of these rays after striking the water surface. The critical Angle for the water-air surface is 48°.

(b) Name the phenomenon which rays B and D exhibit.

(ii) It has been observed that water in a pond appears to be three-quarters of its actual depth. [3]

(a) Mention the property of light that is responsible for this observation.

(b) Elaborate your answer with the help of a suitable diagram.

(iii) State the Law of conservation of energy. Give examples where needed. [4]

Question 5

(i) Answer the following: [3]

(A) Suggest one way in each case by which we can detect the presence of:

(a) Infrared radiation (b) Ultraviolet radiations

(B) Give one use of infrared radiation.

(ii) A converging lens is used to obtain an image of an object placed in front of it. The inverted image is formed between F2 and 2F2 of the lens. [3]

(a) Where is the object placed?

(b) Draw a ray diagram to illustrate the formation of the image obtained.

(c) If the object is placed at 40 cm and the focal length of a convex lens is 10 cm. Find the image distance.

(iii) Answer the following questions. [4]

(a) Write a relationship between the angle of incidence and angle of refraction for a given pair of media.

(b) When a ray of light enters from one medium to another having different optical densities it bends. Why does this phenomenon occur? Write one condition where it does not bend when entering a medium of different optical densities.

Question 6

(i) Answer the following questions. [3]

(a) Draw a diagram to show a block and tackle pulley system having a velocity ratio of 3 marking the direction of load (L), effort (E) and tension (T).

(b) The pulley system drawn lifts a load of 150 N when an effort of 60N is applied. Find its mechanical advantage.

(c) Is the above pulley system an ideal machine or not?

(ii) A uniform metre rule can be balanced at 60 cm mark if 100 gm is hung at 80 cm mark. [3]

(a) Draw the diagram of the arrangement.

(b) Find the mass of metre rule.

(c) In which direction the rule will tilt if 100 gm mass is shifted from 80 cm to 85 cm?

(iii) An engine can pump 30,000 litres of water to a vertical height of 45 metres in 10 minutes. Calculate the work done by the machine and the power. [4]

[Density of water = 10^3 kg/m^3 ; 1000 litre = 1 m^3, g = 9.8 ms^{-2}]

Question 7

(i) Answer the following questions. [3]

(a) What are damped vibrations?

(b) Give one example of damped vibrations.

(c) Name the phenomenon that causes a loud sound when the stem of a vibrating tuning fork is kept pressed on the surface of a table.

(ii) Answer the following questions. [3]

(a) What is meant by Radioactivity? (b) What is meant by nuclear waste?

(c) Suggest one effective way for the safe disposal of nuclear waste.

(iii) Answer the following questions. [4]

(a) Name the phenomenon involved in tuning a radio set to a particular station.

(b) Define the phenomenon named by you in part (A) above.

(c) What do you understand by the loudness of sound?

(d) In which units are the loudness of sound measured?

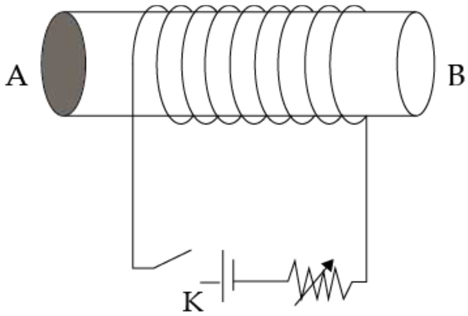
Question 8

(i) Answer the following questions: [3]

(a) What is the purpose of a switch in a circuit? (b) Why is the switch put in the live wire?

(c) What precautions do you take while handling a switch?

(ii) The diagram below shows an insulated copper wire wound around a hollow cardboard cylindrical tube. Answer the questions that follows: [3]



(a) What are the magnetic poles at A and B when the key K is closed?

(b) State two ways to increase the strength of the magnetic field in this coil without changing the coil.

(c) If we place a soft iron bar at the centre of the hollow cardboard and replace the DC source with an AC source then will it attract small iron pins toward itself when the current is flowing through the coil?

(iii) Select the pairs of Isobars and isotopes from the following nuclei. [4]

${}^{14}_{6}C$, ${}^{13}_{7}N$, ${}^{14}_{7}N$, ${}^{16}_{8}O$, ${}^{13}_{6}C$, ${}^{30}_{15}P$, ${}^{17}_{8}O$, ${}^{24}_{11}Na$, ${}^{31}_{15}P$, ${}^{18}_{8}O$, ${}^{22}_{11}Na$, ${}^{23}_{11}Na$, ${}^{23}_{12}Mg$

Question 9

(i) How much heat energy is gained when 0.5 kg of water at 20°C is brought to its boiling point? [Specific heat capacity of water = 4200 J Kg^{-1} $°C^{-1}$] [3]

(ii) 0.50 kg of lead at 327°C is cooled at 27°C when it gives off 22500 calories of energy. Calculate the specific heat of lead in: [3]

(a) Calories (b) Joules

(iii) Answer the following. [4]

(A) On what factors does the force experienced by a straight conductor placed in a magnetic field depend?

(B) Fleming stated two laws involving the left hand and right hand. Which law is applicable when:

(a) Electric energy change into mechanical energy? (b) Mechanical energy change into electric energy?

For solutions of this sample paper, scan this QR code on your smartphone.

ICSE 2024 EXAMINATION
SAMPLE PAPER 2
PHYSICS
(SCIENCE PAPER - 1)

Maximum Marks: 80
Time allowed: Two hours
Answers to this paper must be written on the paper provided separately.
You will not be allowed to write during the first 15 minutes.
This time is to be spent reading the question paper.
The time given at the head of this Paper is the time allowed for writing the answers.

***Section A** is compulsory. Attempt **any four** questions from **Section B**.*
The intended marks for questions or parts of questions are given in brackets []

Section A

*(Attempt **all** questions from **Section A**)*

Question 1 [15]

1. In situations wherein the displacement is in the same direction as the force. When this occurs, work is said to be?
a) Zero b) Positive c) Negative d) Finite

2. Red + _________ + Blue = White.
a) Green b) Yellow c) Violet d) Orange

3. The centrifugal force is
a) Real force
b) The force of reaction of centripetal force
c) A fictitious force
d) Directed towards the centre of the circular path

4. What is a point in a lens at which a ray of light suffers no refraction called?
a) Focal point
b) Optical centre
c) Spectrum
d) None

5. Which of the following is not an example of *damped* vibration?
a) The vibration of a simple pendulum in air.
b) The vibration of the tuning fork in the air.
c) The vibration of stringed instruments in the air.
d) The vibration is produced in the diaphragm of a gramophone.

6. What is the refractive index of water?
a) 2.40 b) 1.31 c) 2.42 d) 1.33

7. If a wire is stretched to make its length three times, its resistance will become.
a) Three times
b) One - third
c) Nine - times
d) One - ninth

8. An external resistance R is connected to a cell of internal resistance 'r'. The current in the circuit is maximum when ________.
a) $R > r$ b) $R < r$ c) $R = r$ d) $R = 2r$

9. The change from solid to vapour directly is called as
a) Sublimation b) Condensation c) Regulation d) Vaporisation

10. Heat is measured in

a) Joules b) Calorie c) Kilocalorie d) Watt

11. Isotopes of an element have different numbers of

a) Proton b) Neutron c) Electron d) atom

12. Which of the following decay emits electromagnetic radiation?

a) Alpha decay c) Beta minus decay

b) Beta plus decay d) Gamma decay

13. Pitch of a note increases with an ____________.

a) Increase in frequency c) Independent of frequency

b) Decrease in frequency d) Increase in amplitude

14. The S.I unit of specific heat capacity is:

a) J Kg^{-1} ° C^{-1} b) Calorie g^{-1} c) Joule $°C^{-1}$ d) Kilocalorie ° C^{-1}

15. The direction of the centrifugal force is:

a) radially outwards c) tangentially

b) radially inwards d) none of these

Question 2

(i) Answer the following questions. [3]

(a) A thorium isotope $^{233}_{90}$Th undergoes an α- decay and changes to radium. What are the atomic number and mass number of radium produced?

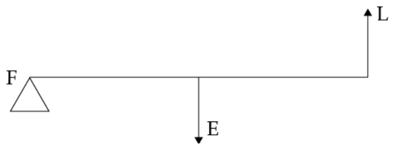
(b) If the radium undergoes further disintegration and emits two β- particles, represent the reaction in the form of an equation.

(c) What is the source of energy released during the decay?

(ii) Answer the following. [2]

(a) Identify the class of the lever shown in the diagram below.

(b) How is it possible to increase the M.A. of the above letter without increasing its length?



(iii) Answer the following. [2]

(a) Define 1 kilogram-force (1 kgf). (b) How is it related to the S.I unit of force?

(iv) What is the centre of gravity of the following objects situated? [2]

A. Ring B. Rhombus C. Scalene triangle D. Cylinder

(v) Calculate the change in the kinetic energy of a moving body if its velocity is reduced to $\frac{1}{3}$ rd of its initial velocity? [2]

(vi) A bucket kept under a running tap is getting filled with water. A person sitting at a distance is able to get an idea when the bucket is about to be filled. [2]

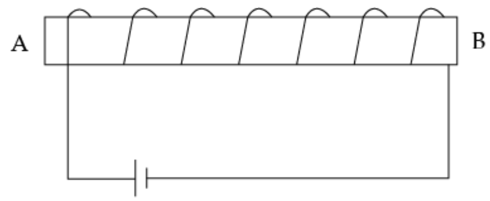
(a) What change takes place in the sound to give this idea?

(b) What causes the change in the sound?

(vii) You have been provided with a solenoid AB. [2]

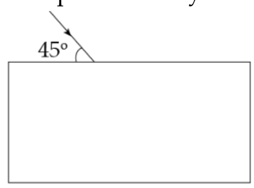
(a) What is the polarity at end A?

(b) Give one advantage of an electromagnet over a permanent magnet.



Question 3

(i) Draw the diagram below and clearly show the path taken by the emergent ray. [2]



(ii) What is an electromagnet? [2]

(iii) The specific heat capacity of substance A is 3800 $Jkg^{-1}K^{-1}$ and that of substance B is 400 $Jkg^{-1}K^{-1}$. Which of the two substances is a good conductor of heat? Give a reason for your answer. [2]

(iv) An element $_{Z}S^{A}$ decays to $_{85}R^{222}$ after emitting 2 α particles and 1 β particle. Find the atomic number and atomic mass of the element S. [2]

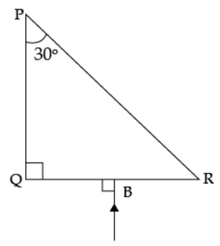
(v) Name the material used for the heating element of a room heater and why? [2]

Section B

*(Attempt **any four** Questions)*

Question 4

(i) Complete the path of the ray AB through the glass prism in PQR till it emerges out of the prism. Given the critical angle of the glass as 42°. [3]



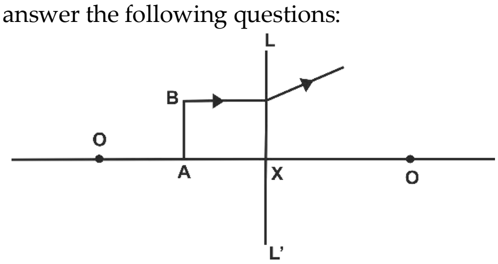
(ii) Jatin puts a pencil into a glass container having water and is surprised to see the pencil in a different state. [3]

(a) What change is observed in the appearance of the pencil?

(b) Name the phenomenon responsible for the change.

(c) Draw a ray diagram showing how the eye sees the pencil.

(iii) Study the diagram below and answer the following questions: [4]



(a) Name the lens LL^{1}.

(b) What is the points O and O^{1} called?

(c) Between which points will the image of the object AB be formed?

(d) What is the nature of the image?

Question 5

(i) A coin is placed at the bottom of a beaker appears to be raised by 4.0 cm if the refractive index of water is $\frac{4}{3}$ find the depth of the water in the beaker. [3]

(ii) Give reasons for the following: [3]

(a) Infrared radiations are used for photography in fog.

(b) Ultraviolet bulbs have a quartz envelope instead of glass.

(c) Microwaves are used in reader communication.

(iii) A lens of focal length 20 cm forms an inverted image at a distance of 60 cm from the lens. [4]

(a) Identify the lens.

(b) How far is the lens present in front of the object?

(c) Calculate the magnification of the image.

Question 6

(i) Answer the following questions. [3]

A block and tackle system has V.R. = 5.

(a) Draw a neat, labelled diagram of a system indicating the direction of its loads and effort.

(b) Rohan exerts a pull of 150 Keg. What is the maximum load he can raise with this pulley system if its efficiency = 75%?

(ii) A body of mass 10 kg is kept at a height of 5 m. It is allowed to fall and reach the ground. [3]

(a) What is the total mechanical energy possessed by the body at the height of 2 m assuming it is a frictionless medium?

(b) What is the kinetic energy possessed by the body just before hitting the ground? Take g = 10 m/s^2

(iii) A uniform half-metre rule balances horizontally on a knife edge at the 29 cm mark when a weight of 20 gf is suspended from one end. [4]

(a) Draw a diagram of the arrangement.

(b) What is the weight of the half-metre ruler?

Question 7

(i) Answer the following questions. [3]

Rohit playing a flute and Anita playing the piano emit sounds of the same pitch and loudness.

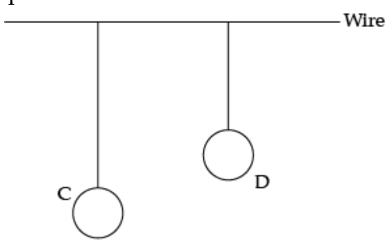
(a) Name one characteristic that is different for waves from the two instruments.

(b) If now the loudness of the sound from the flute becomes four times that of the sound from the Piano, then write the value of the ratio $A_F : A_P$. (A_F –amplitude of sound wave from the flute. A_F -amplitude of sound wage from the piano)

(c) Define the `Pitch' of sound.

(ii) State three uses of X-rays. [3]

(iii) Two pendulums C and D suspended from a wire as shown in the figure given below. Pendulum C is made to oscillate by displacing it from its mean position. It is seen that D also starts oscillating. [4]



(a) Name the type of oscillation, C will execute.

(b) Name the type of oscillation, D will execute.

(c) If the length of D is made equal to C then what difference will you notice in the oscillations of D?

(d) What is the name of the phenomenon when the length of D is made equal to C?

Question 8

(i) Answer the following questions. [3]

(a) A fuse is rated 8 A. Can it be used with an electrical appliance rated 5KW, 200 V? Give a reason.

(b) Name two safety devices which are connected to the live wire of a household electric circuit.

(ii) A nucleus ${}^{A}_{Z}X$ emits an alpha particle followed by ϒ-emission; thereafter it emits two β-particles to form X_3. [3]

(A) Copy and complete the values of A and Z for X_3.

$${}^{A}_{Z}X \xrightarrow{-\alpha} X_1 \xrightarrow{-\gamma} X_2 \xrightarrow{-2\beta} X_3.$$

(B) Out of alpha (α), beta (β) and gamma (γ) radiation.

(a) Which radiation is the most penetrating?

(b) Which radiations are negatively charged?

(iii) Answer the following: [4]

(a) How is the direction of a magnetic field at a point determined?

(b) Mention two important properties of the magnetic field lines.

Question 9

(i) Specific heat capacity of substance A is 3.8 $Jg^{-1} K^{-1}$ whereas the specific heat capacity of substance B is 0.4 $J g^{-1} K^{-1}$. [3]

(a) Which of the two is a good conductor of heat?

(b) How is one led to the above conclusion?

(c) If substances A and B are liquids then which one would be more useful in car radiators?

(ii) Answer the following: [3]

(a) An iron ball requires 5000 J heat energy to raise its temperature by 10°C. Calculate the heat capacity of the iron ball.

(b) 1g mass of the ball is 1.1 kg, find the specific heat capacity of iron.

(iii) A compass needle is placed near a current-carrying wire. State your observation for the following cases and give a reason for the same in each case: [4]

(a) Magnitude of electric current in the wire is increased.

(b) The compass needle is displayed away from the wire.

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