PHYSICS

SCIENCE Paper – 1

(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 in reading the Question Paper.

The time given at the head of this Paper is the time allowed for writing the answers.

***Section I** is compulsory. Attempt **any four** questions from **Section II**.*

The intended marks for questions or parts of questions are given in brackets [ ].

SECTION – I (40 Marks)

*(Attempt **all** questions from this Section)*

Question 1.

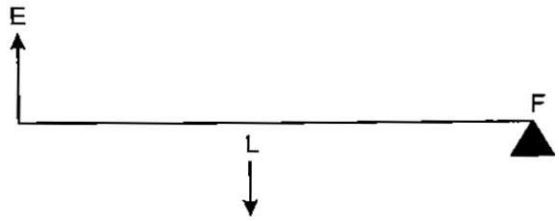
(a) *(i) State and define the S.I. unit of power.*

(ii) How is the unit horse power related to the S.I. unit of power ? **[2]**

(b) *State the energy changes in the following cases while in use :*

(i) An electric iron *(ii) A ceiling fan* **[2]**

(c) *The diagram below shows a lever in use :*



(i) To which class of levers does it belong ?

(ii) Without changing the dimensions of the lever, if the load is shifted towards the fulcrum what happens to the mechanical advantage of the lever ? **[2]**

(d) *(i) Why is the ratio of the velocities of light of wavelengths 4000 Å and 8000 Å in vacuum 1 : 1 ?* **[2]**

(ii) Which of the above wavelengths has a higher frequency ?

(e) *(i) Why is the motion of a body moving with a constant speed around a circular path said to be accelerated ?* **[2]**

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

Where K : kinetic energy, v : linear velocity.

Answer 1.

(a) **(i)** 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.

(ii) 1 H.P. = 746 watt.

(b) **(i)** Electrical energy changes to heat energy.

(ii) Electrical energy changes to mechanical energy.

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(c) **(i)** The load 'L' is in between effort 'E' and fulcrum 'F', so it is a class II lever.

(ii) If load is shifted towards the fulcrum, keeping the dimensions of the lever same, the load arm decreases.

Since, Mechanical advantage of a lever $= \frac{\text{Effort arm}}{\text{Load arm}}$

Hence, the mechanical advantage increases.

(d) **(i)** In vacuum, the velocity of light is always constant *i.e.*, 3×10^8 ms^{-1} and it does not depend on wavelength or frequency.

(ii) We know that,

$$c = \lambda\nu$$

$$\nu = \frac{c}{\lambda}$$

$$\therefore \quad \nu \propto \frac{1}{\lambda} \qquad \text{(As } c \text{ is always constant)}$$

Hence, lower wavelength *i.e.*, 4000 Å will have higher frequency.

(e) **(i)** 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.

(ii) $$\frac{2K}{v^2} = \frac{2 \times \frac{1}{2} mv^2}{v^2} = m$$

Hence, the physical quantity obtained is mass and its unit is kilogram (kg).

Question 2.

(a) *The power of a lens is – 5 D.*

(i) Find its focal length. *(ii) Name the type of lens.* **[2]**

(b) *State the position of the object in front of a converging lens if :*

(i) It produces a real and same size image of the object.

(ii) It is used as a magnifying lens. **[2]**

(c) *(i) State the relation between the critical angle and the absolute refractive index of a medium.*

(ii) Which colour of light has a higher critical angle ? Red light or Green light. **[2]**

(d) *(i) Define scattering.*

(ii) The smoke from a fire looks white.

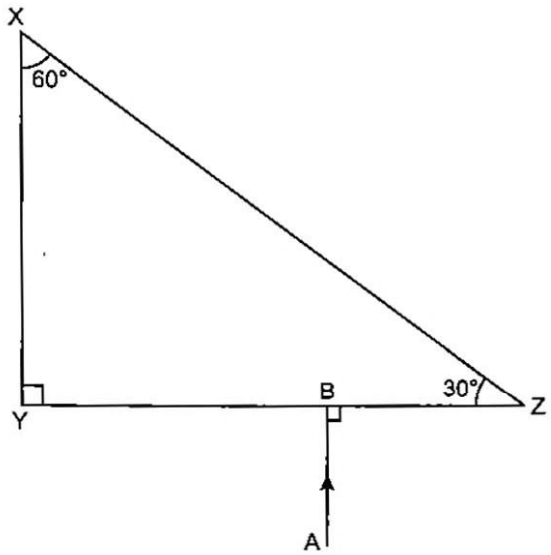
Which of the following statements is true ?

(1) Molecules of the smoke are bigger than the wavelength of light.

(2) Molecules of the smoke are smaller than the wavelength of light. **[2]**

(e) *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.* **[2]**

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Answer 2.

(a) **(i)** Given : $P = -5$ D

We know that, $f = \frac{1}{P}$

$\Rightarrow$ $f = \frac{1}{-5}\text{ m} = -0{\cdot}2\text{ m} = -20\text{ cm}$

(ii) The negative power indicates that the lens is a concave lens.

(b) **(i)** The object is placed on the principal axis at a distance equal to twice the focal length of the lens (or At $2F_1$).

(ii) The object is placed between the first focal point (F_1) and the lens.

(c) **(i)** $\mu = \frac{1}{\sin C} = \text{cosec } C$

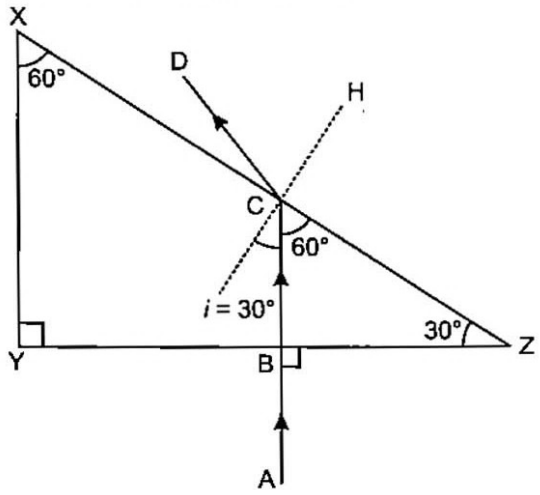
where 'μ' is the absolute refractive index of medium and 'C' is the critical angle.

(ii) Critical angle increases with the increase in wavelength of light, hence, red light having longer wavelength than green light has a higher critical angle.

(d) **(i)** The process of absorption and then re-emission of light energy is called scattering of light.

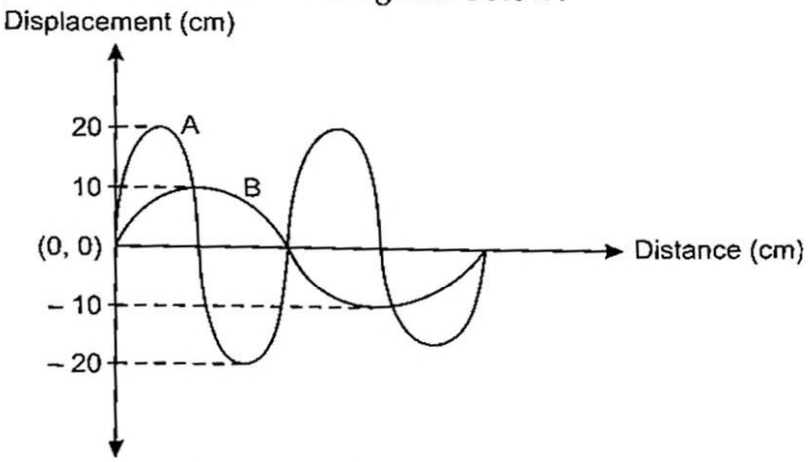
(ii) Molecules of the smoke are bigger than the wavelength of light is the correct statement.

(e) 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°.



Question 3.

(a) *Displacement distance graph of two sound waves A and B, travelling in a medium, are as shown in the diagram below.*



Study the two sound waves and compare their :

(i) Amplitudes *(ii) Wavelengths* **[2]**

(b) *You have three resistors of values 2 Ω, 3 Ω and 5 Ω. How will you join them so that the total resistance is more than 7 Ω ?*

(i) Draw a diagram for the arrangement.

(ii) Calculate the equivalent resistance. **[2]**

(c) *(i) What do you understand by the term nuclear fusion ?*

(ii) Nuclear power plants use nuclear fission reaction to produce electricity. What is the advantage of producing electricity by fusion reaction ? **[2]**

(d) *(i) What do you understand by free vibrations of a body ?* **[2]**

(ii) Why does the amplitude of a vibrating body continuously decrease during damped vibrations ?

(e) *(i) How is the e.m.f. across primary and secondary coils of a transformer related with the number of turns of coil in them ?*

(ii) On which type of current do transformers work ? **[2]**

Answer 3.

(a) **For wave A :** Amplitude (a_1) = 20 cm, Wavelength (λ_1) = λ cm (say)

For wave B : Amplitude (a_2) = 10 cm, Wavelength (λ_2) = 2λ cm

(i) $$\frac{a_1}{a_2} = \frac{20}{10} = \frac{2}{1}$$

The amplitude of wave A is two times of the amplitude of wave B.

(ii) $$\frac{\lambda_1}{\lambda_2} = \frac{\lambda}{2\lambda} = \frac{1}{2}$$

The wavelength of wave A is half of the wavelength of wave B.

(b) 2 Ω, 3 Ω and 5 Ω have to be joined in series to obtain the total resistance more than 7 Ω.

(i)



(ii) $R_{eq.} = (2 + 3 + 5)\ \Omega = 10\ \Omega$

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(c) **(i)** Nuclear fusion is the process in which two light nuclei combine to form a heavy nucleus. In this process, huge amount of energy is released.

(ii) Nuclear fusion is not possible at ordinary temperature and ordinary pressure, but the advantage of fusion reaction over fission reaction is that the fusionable substance is not radioactive, so it does not give out any harmful radiations and the disposal of its waste is not difficult.

(d) **(i)** The periodic vibrations of a body in the absence of any external force on it, are called free (or natural) vibrations.

(ii) The amplitude of a vibrating body continuously decreases during damped vibrations because of the frictional (resistive) force due to the surrounding medium.

(e) **(i)**
$$\frac{E_s}{E_p} = \frac{N_s}{N_p}$$

where E_s and E_p are the e.m.f. across the secondary and the primary coils respectively.

N_s and N_p are the number of turns in the secondary and primary coils respectively.

(ii) A transformer works on alternating current (A.C.).

Question 4.

(a) *(i) How can a temperature in degree Celsius be converted into S.I. unit of temperature ?*

(ii) A liquid X has the maximum specific heat capacity and is used as a coolant in car radiators. Name the liquid X. **[2]**

(b) *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 ?* **[2]**

(c) *Identify the following wires used in a household circuit :*

(i) The wire is also called as the phase wire.

(ii) The wire is connected to the top terminal of a three pin socket. **[2]**

(d) *(i) What are isobars ?*

(ii) Give one example of isobars. **[2]**

(e) *State any two advantages of electromagnets over permanent magnets.* **[2]**

Answer 4.

(a) **(i)** The S.I. unit of temperature is Kelvin (K).

To convert temperature in degree Celsius to degree Kelvin 273·15 is added to Celsius.

$$T\,K = °C + 273{\cdot}15$$

(ii) The liquid 'X' is water because water has highest specific heat capacity.

(b) Given : $m = 150$ g, Power (P) = 100 W, Time (t) = 4 minutes = $4 \times 60 = 240$s

Heat energy supplied to melt the metal $= P \times t$

$= 100 \times 240$ J

Heat energy required by the metal to melt $= mL$

$= 150 \times L$ joule

If there is no exchange of heat energy with the surrounding, then

$$150 \times L = 100 \times 240$$

or

$$L = \frac{100 \times 240}{150} = 160 \text{ J g}^{-1}.$$

(c) **(i)** Live wire. **(ii)** Earth wire.

(d) **(i)** Isobars are atoms of different elements which have the same mass number A, but different atomic number Z.

(ii) $^{14}_{6}C$ and $^{14}_{7}N$ are isobars.

(e) The advantages of electromagnets over permanent magnets are :

(i) The strength of magnetic field of an electromagnet can easily be changed by changing the current or the number of windings in its solenoid.

(ii) The polarity of the electromagnet can be reversed by reversing the direction of current in its solenoid.

SECTION—II (40 Marks)

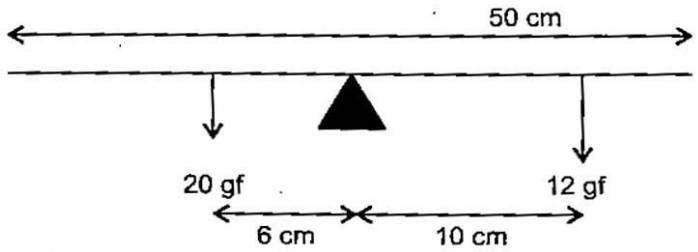
*(Attempt any **four** questions from this Section)*

Question 5.

(a) *(i) Derive a relationship between S.I. and C.G.S. unit of work.*

(ii) 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 θ to get the maximum positive work ? **[3]**

(b) *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 :*



(i) Which of the two forces acting on the rigid rod causes clockwise moment ?

(ii) Is the rod in equilibrium ?

(iii) The direction of 20 kgf force is reversed. What is the magnitude of the resultant moment of the forces on the rod ?* **[3]**

* **Mark is an error by the Council. We suggest you to use 'gf' instead of 'kgf'.**

(c) *(i) 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).*

(ii) The pulley system drawn lifts a load of 150 N when an effort of 60 N is applied. Find its mechanical advantage.

(iii) Is the above pulley system an ideal machine or not ? **[4]**

Answer 5.

(a) **(i)** The S.I. unit of work is joule (J) and C.G.S. unit is erg.

1 joule = 1 newton × 1 metre

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$= 10^5$ dyne $\times$ 100 cm

$= 10^7$ dyne cm

$= 10^7$ erg

or $1\ J = 10^7$ erg

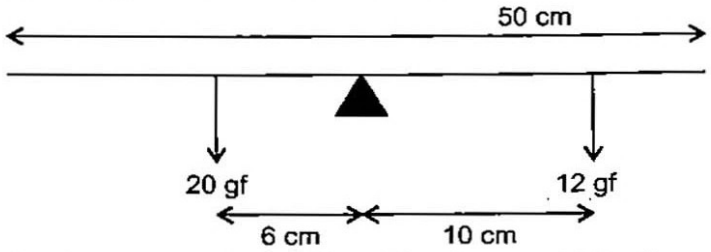
(ii) We know that, $W = FS \cos \theta$

For maximum positive work, $\cos \theta$ should be maximum.

Maximum value of $\cos \theta = 1$

$\therefore \quad \theta = 0°$.

(b) **(i)** The force of 12 gf causes a clockwise moment.



(ii) Clockwise moment = 12 × 10 gf cm = 120 gf cm

Anti clockwise moment = 20 × 6 = 120 gf cm

∵ Clockwise moment = Anti clockwise moment

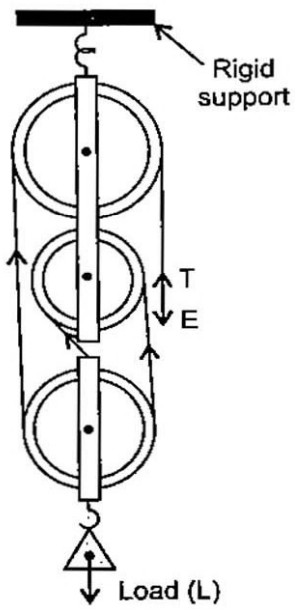
∴ The rod is in equilibrium.

(iii) 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

(c) **(i)** The diagram is shown below :



(ii) $$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{150}{60} = 2{\cdot}5$$

(iii) No, the pulley system is not ideal because M.A. < V.R.

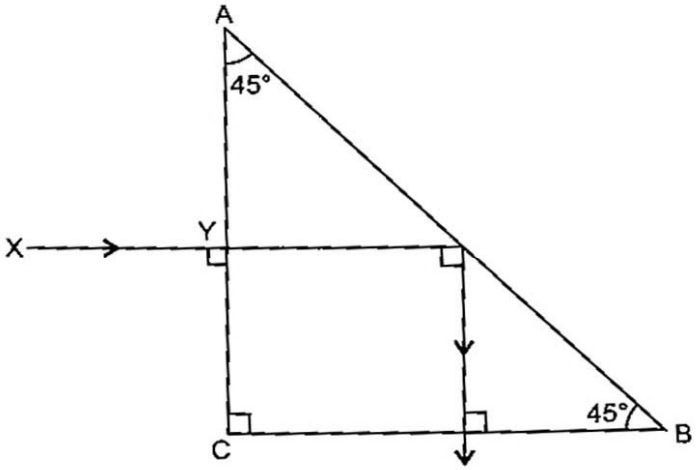
Question 6.

(a) *A ray of light XY passes through a right angled isosceles prism as shown below :*

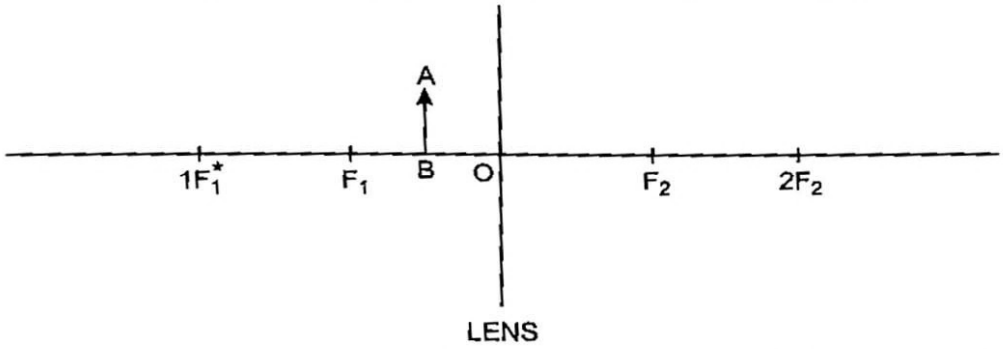
(i) What is the angle through which the incident ray deviates and emerges out of the prism ?

(ii) Name the instrument where this action of prism is put into use.

(iii) Which prism surface will behave as a mirror ? **[3]**



(b) *An object AB is placed between O and F_1 on the principal axis of a converging lens as shown in the diagram.*



* **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 the object AB. **[3]**

(c) *An object is placed at a distance of 12 cm from a convex lens of focal length 8 cm. Find :*

(i) the position of the image *(ii) nature of the image* **[4]**

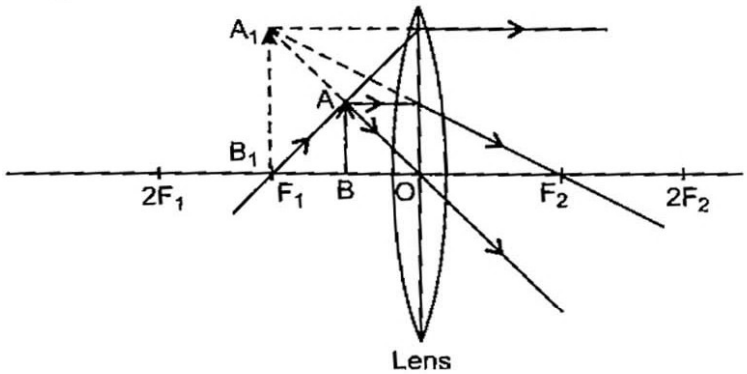
Answer 6.

(a) **(i)** The angle through which the incident ray deviates and emerges out of the prism is 90°.

(ii) Periscope.

(iii) The surface AB of the prism behaves as a mirror.

(b) A_1B_1 is the image formed.



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(c) **(i)** 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 $$\frac{1}{v} - \frac{1}{(-12)} = \frac{1}{8}$$

$$\frac{1}{v} + \frac{1}{12} = \frac{1}{8}$$

or $$\frac{1}{v} = \frac{1}{8} - \frac{1}{12} = \frac{3-2}{24} = \frac{1}{24}$$

or $$v = +24 \text{ cm}$$

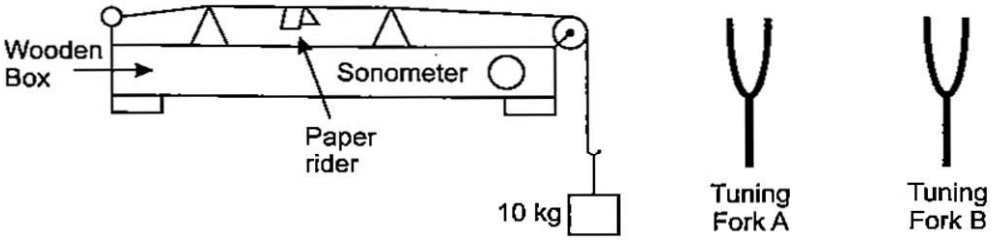
Therefore, the image is formed at a distance of 24 cm behind the lens (or on the other side).

(ii) The image is real, inverted and magnified.

Question 7.

(a) *Draw the diagram of a right angled isosceles prism which is used to make an inverted image erect.* **[3]**

(b)



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.

(i) Name the phenomenon when the paper rider just vibrates.

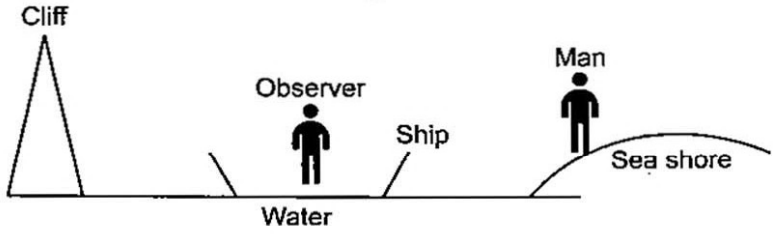
(ii) Name the phenomenon when the paper rider flies off.

(iii) Why does the paper rider fly off when the stem of tuning fork B is touched to the box ? **[3]**

(c) *A person is standing at the sea shore. An observer on the ship which is anchored in between a vertical cliff and the person on the shore fires a gun. The person on the shore hears two sounds, 2 seconds and 3 seconds after seeing the smoke of the fired gun. If the speed of sound in the air is 320 ms^{-1} then calculate :*

(i) The distance between the observer on the ship and the person on the shore.

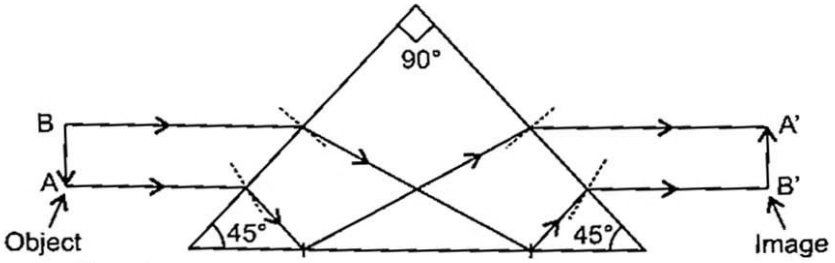
(ii) The distance between the cliff and the observer on the ship. **[4]**



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Answer 7.

(a) The diagram is shown below :



(b) **(i)** Forced vibration. **(ii)** Resonance.

(iii) The paper rider flies off when the stem of the tuning fork B is touched to the box because the frequency of vibration of tuning fork B is equal to the natural frequency of vibration of the stretched wire holding the paper rider and resonance occurs.

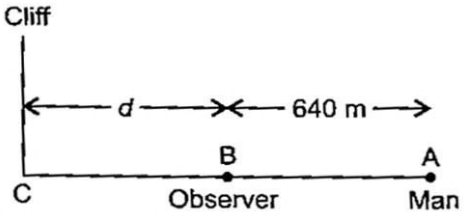
(c) **(i)** The person on the shore hears the first direct sound after 2 s from the observer.

$\therefore$ Distance between observer on ship and man on shore

$$= v \times t_1$$
$$= 320 \times 2 = 640 \text{ m}$$

(ii) Let the distance between the cliff and the observer be d metre.

Therefore, the second sound heard by the man on the shore travels a total distance of



$$(d + d + 640) \text{ m} = (2d + 640) \text{ m}$$

Time taken, $t_2 = 3$ s

$$\therefore \quad \text{Speed of sound} = \frac{\text{Total distance travelled}}{\text{Time}}$$

$$\text{or} \quad 320 = \frac{2d + 640}{3}$$

$$\text{or} \quad 960 = 2d + 640$$

$$2d = 960 - 640 = 320$$

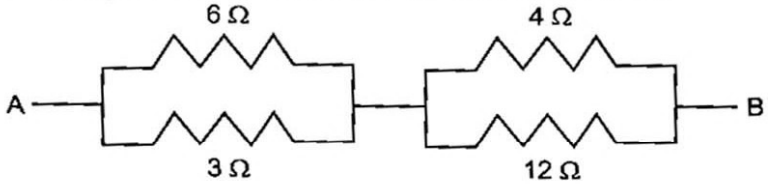
$$\therefore \quad d = \frac{320}{2} = 160 \text{ m}$$

Question 8.

(a) *(i) A fuse is rated 8 A. 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. **[3]**

(b) *(i) Find the equivalent resistance between A and B.*



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(ii) State whether the resistivity of a wire changes with the change in the thickness of the wire. **[3]**

(c) *An electric iron is rated 220 V, 2 kW.*

(i) If the iron is used for 2h daily find the cost of running it for one week if it costs ₹ 4·25 per kWh.

(ii) Why is the fuse absolutely necessary in a power circuit ? **[4]**

Answer 8.

(a) **(i)** Given : Power (P) = 5 kW = 5000 W, V = 200 volt

$$\therefore \quad \text{Current (I)} = \frac{P}{V}$$

$$= \frac{5000}{200} = 25 \text{ A}$$

The 8 A fuse cannot be used with the above appliance because it draws a current of 25 A and the fuse will blow off.

(ii) (1) Fuse, (2) Switch.

(b) **(i)** 6 Ω and 3 Ω resistances are connected in parallel,

$$\frac{1}{R_1} = \frac{1}{6} + \frac{1}{3}$$

$$= \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}$$

or $R_1 = 2\ \Omega$

4 Ω and 12 Ω resistances are connected in parallel,

$$\frac{1}{R_2} = \frac{1}{4} + \frac{1}{12}$$

$$= \frac{3+1}{12} = \frac{4}{12} = \frac{1}{3}$$

or $R_2 = 3\ \Omega$

Now, R_1 and R_2 are connected in series.

∴ Equivalent resistance between A and B = (2 + 3) Ω = 5 Ω.

(ii) Resistivity of a substance is its characteristic property and it does not change with the change in the thickness of the wire.

(c) **(i)** Electrical energy consumed daily = Power × Time = 2 kW × 2 h = 4 kWh

Electrical energy consumed in one week = 4 kWh × 7 = 28 kWh

∴ Total cost for running it for one week = ₹ 4·25 × 28 = ₹ 119

(ii) Fuse is necessary in power circuits to limit threats to human life and property damage due to excessive current or faulty appliance that may get connected to the power circuit.

Question 9.

(a) *(i) Heat supplied to a solid changes it into liquid. What is this change in phase called ?*

(ii) During the phase change does the average kinetic energy of the molecules of the substance increase ? **[3]**

(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. **[3]**

(c) *The temperature of 170 g of water at 50°C is lowered to 5°C by adding certain amount of ice to it. Find the mass of ice added.* **[4]**

Given : Specific heat capacity of water = 4200 J kg^{-1} $°C^{-1}$ and Specific latent heat of ice = 336000 J kg^{-1}.

Answer 9.

(a) **(i)** The change from solid state to a liquid state at a constant temperature is called melting.

(ii) Since, temperature remains constant during change of phase the average kinetic energy does not change.

(iii) The energy absorbed during phase change is called latent heat.

(b) **(i)** Difference between heat capacity and specific heat capacity :

Heat Capacity	Specific Heat Capacity
1. It is the amount of heat energy required to raise the temperature of entire body by 1°C (or 1 K).	1. It is the amount of heat energy required to raise the temperature of unit mass of body by 1°C (or 1 K)
2. Its S.I. unit is JK^{-1}.	2. Its S.I. unit is $Jkg^{-1}K^{-1}$.

(ii) Heat capacity of a body = Mass of the body × Specific heat capacity

or $C' = m \times c$

$$c = \frac{C'}{m}$$

But $$C' = \frac{Q}{\Delta t}$$

$\therefore$ $$c = \frac{Q}{m \times \Delta t}$$

(c) Given :

For hot body :

170 g water at 50°C changes to water at 5°C.

$m = 170\ g = \frac{170}{1000}\ kg$, $c = 4200\ J\ kg^{-1}\ °C^{-1}$, $\Delta T = (50 - 5) = 45°C$

$\therefore$ Heat lost by water $= mc\Delta T$

$$= \frac{170}{1000} \times 4200 \times 45\ J = 32130\ J$$

For cold body :

Let mass of ice be x kg.

x kg ice at 0°C changes to water at 5°C.

Mass $(m) = x$ kg, $L = 336000\ J\ kg^{-1}$, $c = 4200\ J\ kg^{-1}\ °C^{-1}$, $\Delta T = (5 - 0) = 5°C$

$\therefore$ Heat gained by ice $= mL + mc\Delta T$

$= (x \times 336000 + x \times 4200 \times 5)$ J

$= (336000\,x + 21000\,x)$ J

$= 357000\,x$ J.

When no heat energy is lost to the surroundings,

Heat gained = Heat lost

or $357000\,x = 32130$

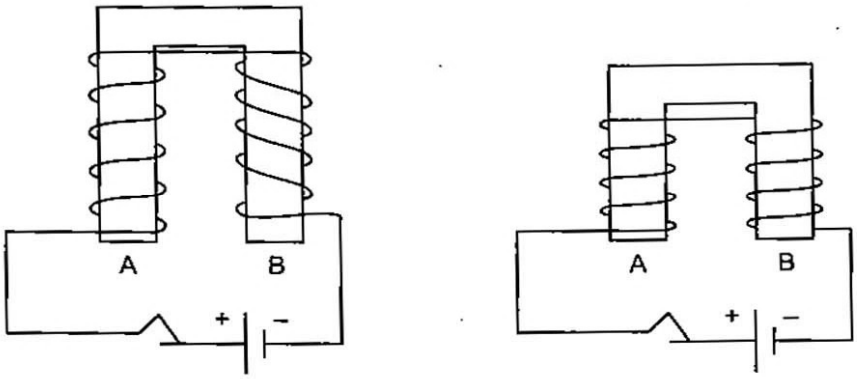
$\therefore \quad x = \frac{32130}{357000}$ kg $= 0{\cdot}09$ kg $= 90$ g.

$\therefore$ Mass of ice added = 90 g.

Question 10.

(a) *The diagram shows a coil wound around a U shape soft iron bar AB.*

Wrong Diagram* ***Correct Diagram***



*** Mark is an error by the Council. We suggest you to use 'Correct Diagram' instead of 'Wrong Diagram.'**

(i) What is the polarity induced at the ends A and B when the switch is pressed ?

(ii) Suggest one way to strengthen the magnetic field in the electromagnet.

(iii) What will be the polarities at A and B if the direction of current is reversed in the circuit ? **[3]**

(b) *The ore of uranium found in nature contains $_{92}U^{238}$ and $_{92}U^{235}$ Although both the isotopes are fissionable, it is found out experimentally that one of the two isotopes is more easily fissionable.*

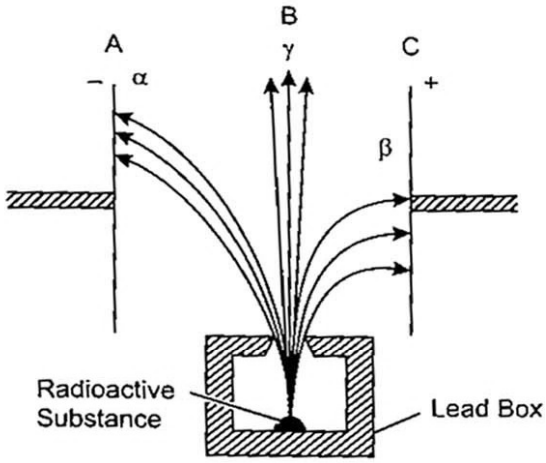
(i) Name the isotope of uranium which is easily fissionable.

(ii) Give a reason for your answer.

(iii) Write a nuclear reaction when Uranium 238 emits an alpha particle to form a Thorium (Th) nucleus. **[3]**

(c) *Radiations given out from a source when subjected to an electric field in a direction perpendicular to their path are shown below in the diagram. The arrows show the path of the radiation A, B and C. Answer the following questions in terms of A, B and C.*

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(i) Name the radiation B which is unaffected by the electrostatic field.

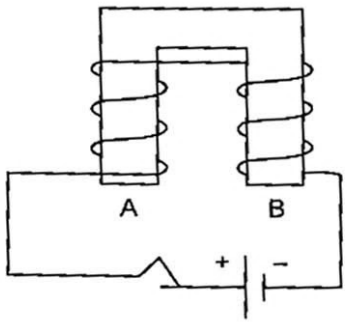
(ii) Why does the radiation C deflect more than A ?

(iii) Which among the three causes the least biological damage externally ?

(iv) Name the radiation which is used in carbon dating. **[4]**

Answer 10.

(a) (i) Polarity induced at end A is south pole (S) and at end B is north pole (N).



(ii) The strength of magnetic field can be increased by increasing the current or by increasing the number of windings in the electromagnet.

(iii) If direction of current is reversed, the polarities at A and B will also be reversed. End A will become north pole (N) and end B will become south pole (S).

(b) (i) $_{92}U^{235}$ is more easily fissionable than $_{92}U^{238}$.

(ii) Fission of $_{92}U^{238}$ is possible only by fast neutrons whereas the fission of $_{92}U^{235}$ can be achieved even by slow neutrons.

(iii) $_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_{2}He^{4}$ [$_{2}He^{4}$ is an alpha particle]

(c) (i) γ - radiation.

(ii) The deflection of radiation C (or β-particle) is more than the radiation A (or α-particle) because β-particles have less mass than α-particles.

(iii) Radiation A (or α-radiations) causes least biological damage.

(iv) The radiation which is used in carbon dating is radiation C (or β-radiation).

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