

# ICSE 2025 EXAMINATION

## Sample Question Paper - 6

### Physics

Time: 2 Hours.

Total Marks: 80

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#### General Instructions:

1. Attempt **all** questions from **Section A** and **any three** questions from **Section B**.
  2. The intended marks of questions or parts of questions are given in brackets [ ].
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#### SECTION A

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

##### Question 1

Choose the correct answers to the questions from the given options. (Do not copy the questions, write the correct answer only.)

- i) The moment of a force of 5N about a point is 2Nm. Calculate the distance of the point from the point of application of force.  
(a) 2.5 m  
(b) 10 m  
(c) 0.1 m  
(d) 0.4 m
- ii) Which of the following terms does not represent electrical power in a circuit?  
(a)  $IR^2$   
(b)  $VI$   
(c)  $I^2R$   
(d)  $V^2/R$
- iii) A gear can be considered as a lever with an additional property. What is the additional property of a gear?  
(a) It can be considered as a lever.  
(b) it increases the speed of rotation.  
(c) It can be continuously rotated instead of moving back and forth.  
(d) it decreases the speed of rotation.
- iv) Whenever light goes from one medium to another, the characteristic that does not change is:  
(a) Colour  
(b) Frequency  
(c) Wavelength  
(d) Velocity

v) **Assertion (A):** Sound waves in air, solid and liquid traverse in the form of longitudinal waves.

**Reason (R):** If the vibrations of medium particles are along the direction of propagation of the waves, then such waves are said to be longitudinal waves.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A
- (c) Assertion is false but reason is true.
- (d) Assertion is true reason is false.

vi) The nature of the image formed by the concave lens is always \_\_\_\_\_.

- (a) Real and inverted.
- (b) Real and erect.
- (c) Virtual and erect.
- (d) Virtual and inverted.

vii) If two parallel conducting wires carry current in the same direction, then they will \_\_\_\_\_.

- (a) attract each other.
- (b) repel each other.
- (c) exert no force on each other.
- (d) exert force at right angles to the plane of the wire.

viii) Which effect is utilized by an electric bulb?

- (a) Magnetic effect
- (b) Chemical effect
- (c) Heating effect
- (d) Power effect

ix) The change of state of solid directly into gaseous state on heating without going through the liquid state is:

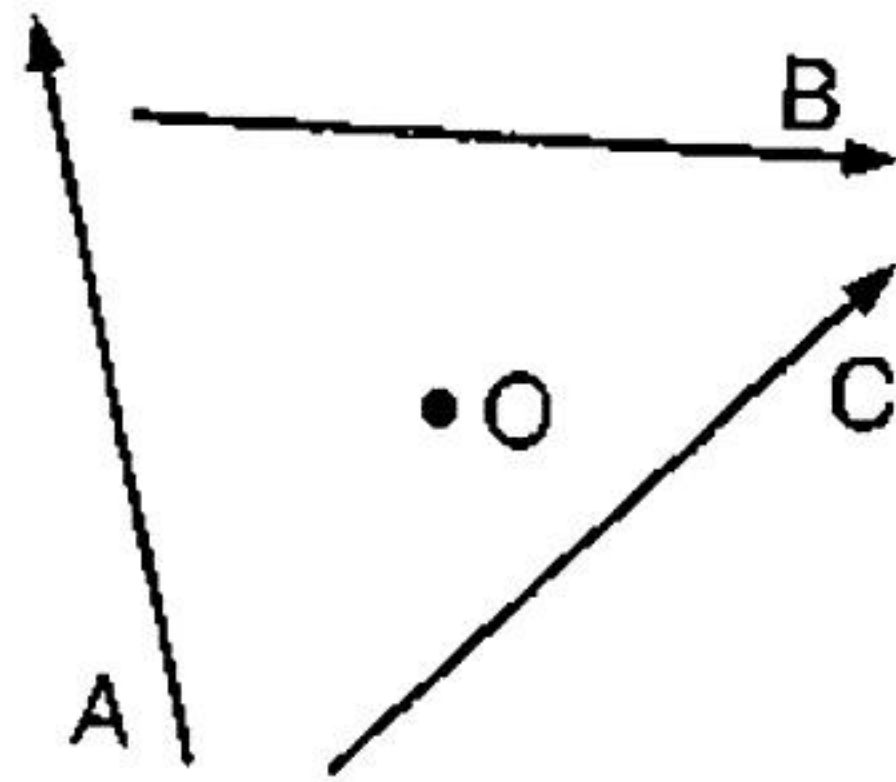
- (a) condensation
- (b) sublimation
- (c) melting
- (d) evaporation

x) A radioactive substance is oxidised. What changes would you expect to take place in the nature of radioactivity? Explain your answer.

- (a) increases
- (b) decreases
- (c) remains constant
- (d) cannot be predicted



- xi) Moving two like poles together usually causes a magnet resting on a table to repel and rotate. This occurs because:
- (a) Like magnetic poles repel
  - (b) Unlike magnetic poles attract
  - (c) Both A and B
  - (d) None of these
- xii) Where should an object be placed in front of the convex lens so as to obtain the image formed on slide projector?
- (a) Between  $F_1$  and  $2F_1$
  - (b) At  $2F_1$
  - (c) Beyond  $F_1$
  - (d) At  $F_1$
- xiii) Suppose if A, B and C are three forces each of magnitude 4 N acting in the plane of paper as shown in fig.



- Which force has the least moment about O and which force has the greatest moment about O?
- (a) A has the least moment and B has the greatest moment.
  - (b) B has the least moment and C has the greatest moment.
  - (c) C has the least moment and A has the greatest moment.
  - (d) C has the least moment and B has the greatest moment.
- xiv) The cold air layers of the atmosphere behave as optically
- (a) Rarer medium
  - (b) Denser medium
  - (c) Inactive medium
  - (d) Either inactive or rarer medium
- xv) Name a machine which is used to multiply force.
- (a) a movable pulley
  - (b) gear system or class III lever
  - (c) single fixed pulley
  - (d) inclined plane

## Question 2

- i) Complete the following by choosing the correct answers from the bracket: [6]
- (a) The conversion of 1 a.m.u. of mass results in \_\_\_\_\_ [ $9.31 \times 10^6$ / $9.31 \times 10^{-6}$ /931]eV of energy.
  - (b) Ohm-metre is the S.I unit of \_\_\_\_\_ [resistance/resistivity/conductivity].
  - (c) A transformer works on the principle of \_\_\_\_\_ [eddy current/mutual inductance/electrostatic inductance].
  - (d) A simple microscope employs a \_\_\_\_\_ [concave/convex] lens.
  - (e) The characteristic of musical sound is called \_\_\_\_\_ or \_\_\_\_\_.
- ii) A resistance of 6 ohm and an electric toy motor of resistance 20 ohm are connected in series with a 12-V battery. [2]
- (a) Find the total resistance of the circuit.
  - (b) Find the total current of the circuit.
- iii) Name the material calorimeter is made of. Give two reasons behind using these materials. [2]

## Question 3

- i) [3]
- (a) Name any two factors on which the strength of the magnetic field produced by a current-carrying solenoid depends.
  - (b) Write about two uses of electromagnets.
  - (c) Why does the surface of an empty test tube (kept in a beaker filled with water) shine like a mirror? Explain.
- ii) A ray of light traveling in air falls on the surface of a rectangular slab of a plastic material whose refractive index is 1.6. If the incident ray makes an angle of  $53^\circ$  with the normal, find the angle made by the refracted ray with the normal ( $\sin 53^\circ = 4/5$ ) [2]
- iii) [2]
- (a) Define the term energy and state its SI unit.
  - (b) State the principal of conservation of energy.
- iv) A piece of ice of mass 40 g is added to 200 g of water at  $50^\circ\text{C}$ . Calculate the final temperature of water when all the ice has melted.  
(Specific heat capacity of water =  $4200 \text{ J Kg}^{-1} \text{ K}^{-1}$  and specific latent heat of fusion of ice =  $336 \times 10^3 \text{ J kg}^{-1}$ ) [2]
- v) For the same angle of incidence, the angle of refraction in three media is  $15^\circ$ ,  $25^\circ$  and  $35^\circ$ , respectively. In which medium will the velocity of light be minimum? [2]



vi) State how are the two resistors joined with a battery in each of the following cases when [2]

(a) The same current flows in each resistor

(b) The potential difference is the same across each resistor.

vii) State two differences between light and sound. [2]

## SECTION B

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

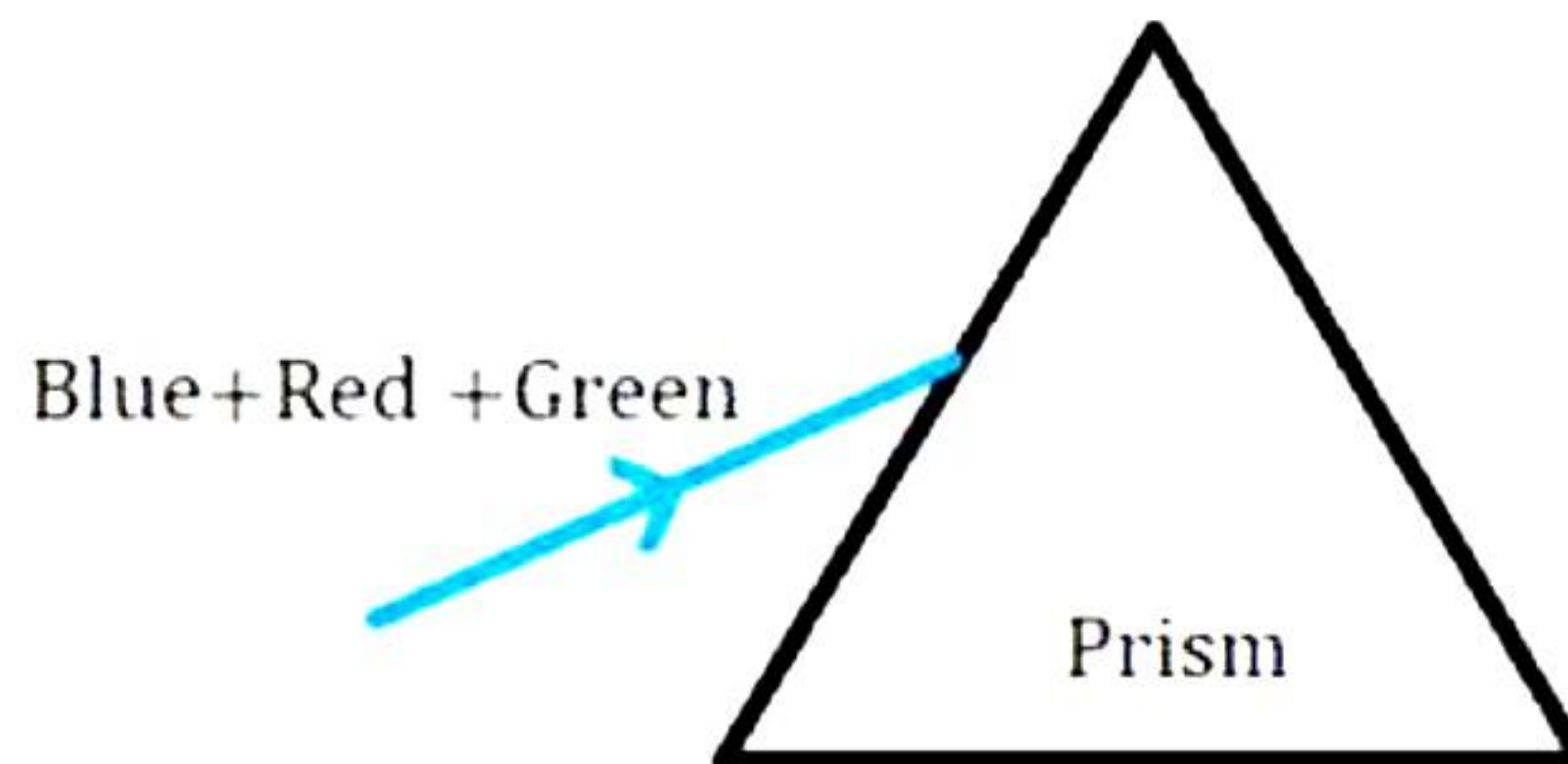
### Question 4

i) [3]

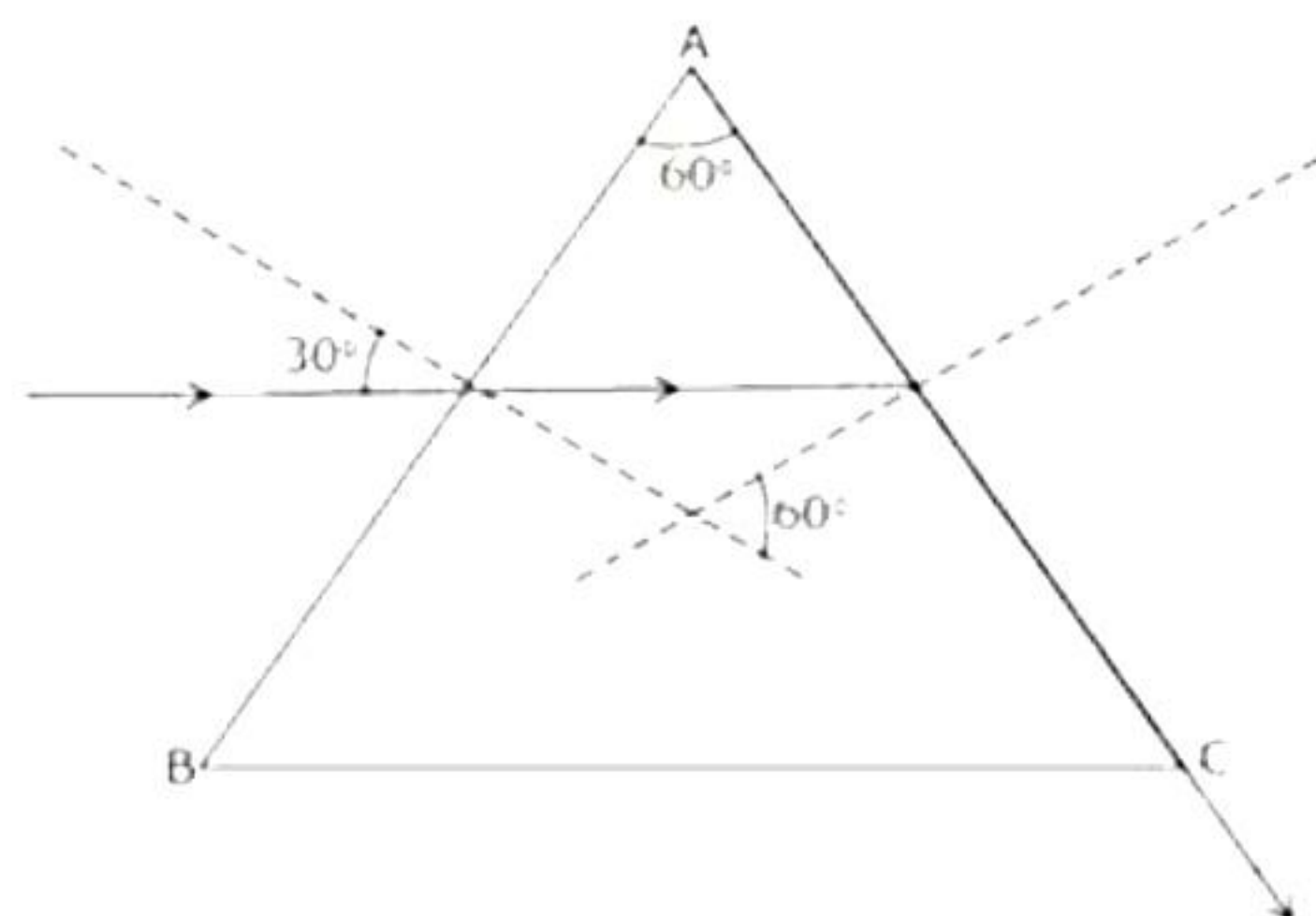
- (a) What is a totally reflecting prism?
- (b) The ozone layer gives us protection from which part of solar radiation?
- (c) Why does a converging lens behave as a 'burning glass'?

ii) [3]

- (a) The (blue + red + green) light is incident on a prism. Complete the diagram by drawing the emergent and refracted rays.



- (b) At what angle should a ray of light be incident on the face of a  $60^\circ$  prism, so that the ray just passes grazingly along the interface AC? If angle of refraction at face AB is  $19^\circ$ , find the angle of incidence at face AC. Give its specific name.



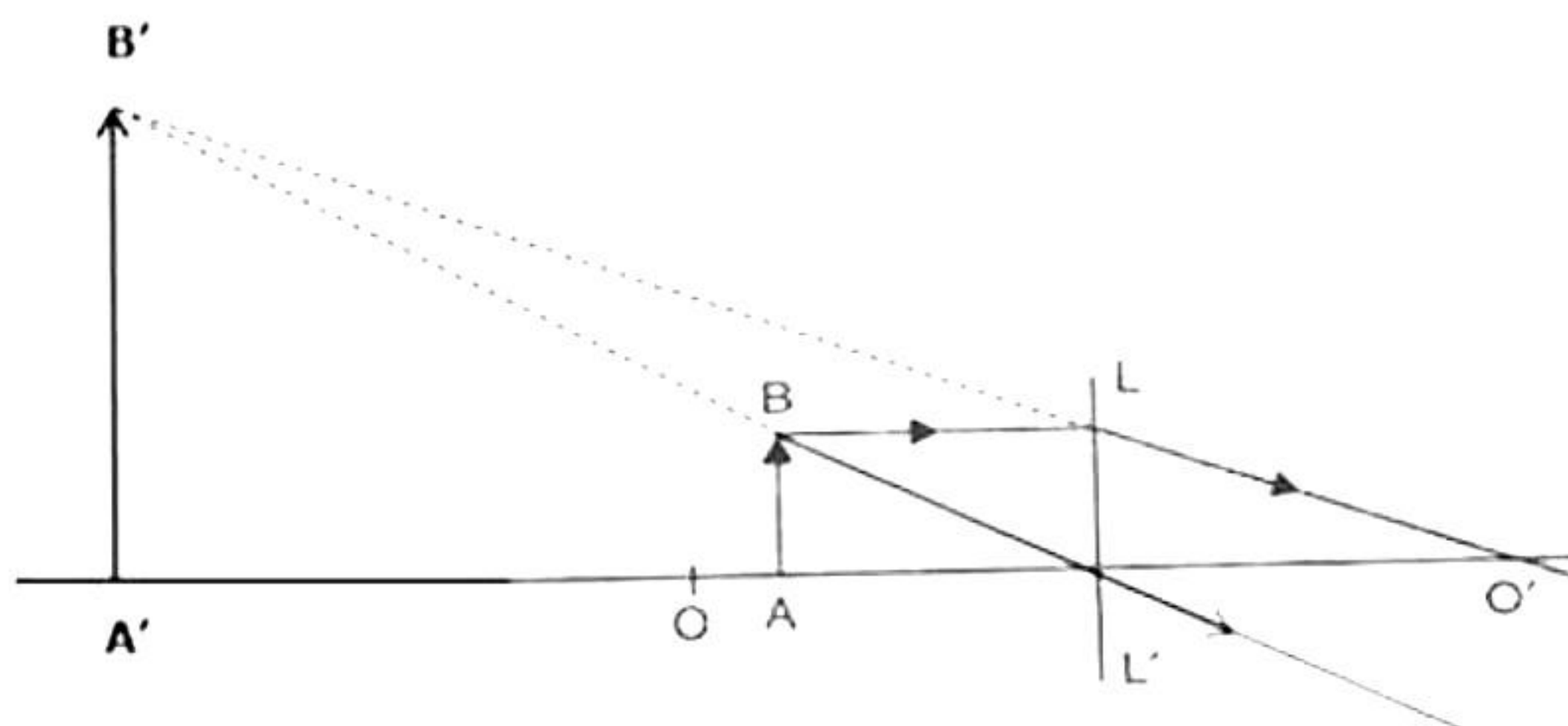
iii) [4]

- (a) A tank of water is viewed normally from above.
  - 1. State how the depth of tank appears to change.
  - 2. Draw a labelled ray diagram to explain your answer.
- (b) 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.



### Question 5

- i) Observe the ray diagram given below and answer the following questions: [3]



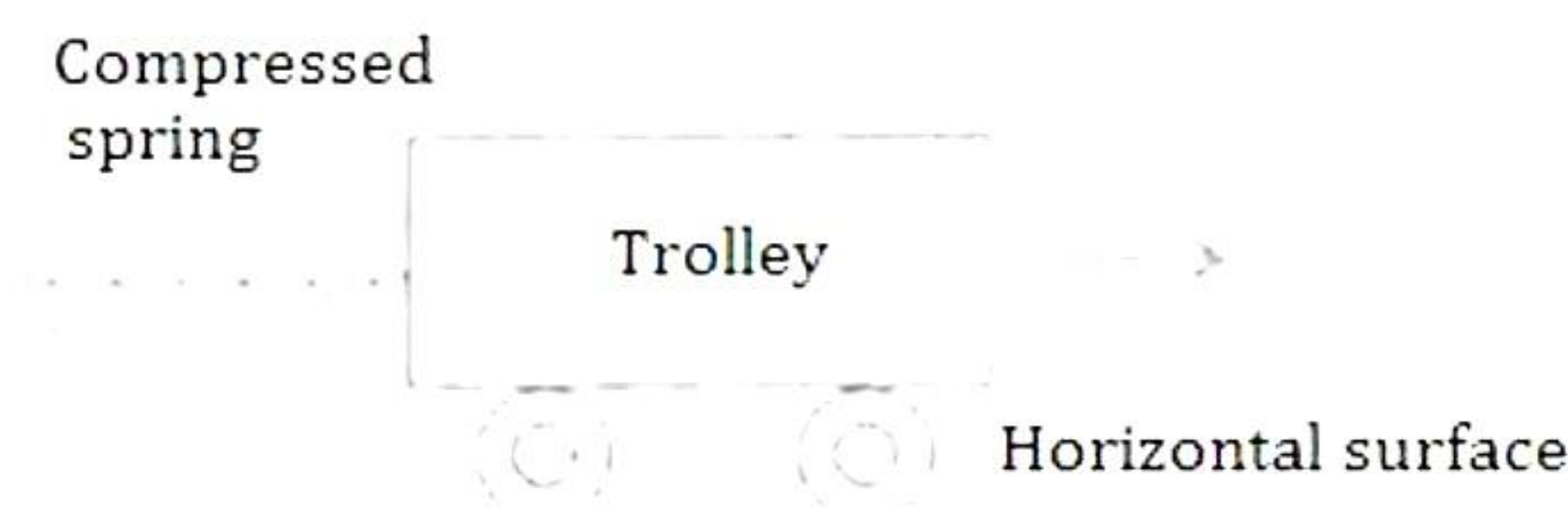
- (a) Name the lens LL'.
- (b) State one application of the lens used in above ray diagram.
- (c) State the characteristics of image formed by the lens.
- ii) [3]
- (a) Draw a ray diagram to illustrate the determination of the focal length of a convex lens using an auxiliary plane mirror.
- (b) State the condition for each of the following.
1. A symmetrical biconvex lens has both its focal lengths equal.
  2. A ray passes un-deviated through the lens.
- iii) State the changes in the position, size and nature of the image of an object when brought from infinity up to a convex lens. Illustrate your answer by drawing the ray diagrams. [4]
- (a) When the object is situated at infinity, the position of image is at  $F_2$ .
- (b) When the object (AB) is situated beyond  $2F_1$ .
- (c) When the object (AB) is situated at  $2F_1$ .
- (d) When the object (AB) is situated between  $2F_1$  and  $F_1$ .

### Question 6

- i) An effort of 6 kgf is applied on a machine through a displacement of 90 cm, when a load of 100 kgf moves through a distance of 4 cm. [3]
- Calculate:
- (a) Velocity Ratio
- (b) M.A
- (c) % age efficiency of machine.



- ii) 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: [3]



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

- What will be the magnitude of kinetic energy?
  - What type of potential energy did the spring possess when compressed?
  - Find the magnitude of potential energy.
- iii) [4]
- A man drops a 50 kg stone from the top of a ladder of length 10 m. What is its kinetic energy when it reaches the ground? What is its speed just before it hits the ground?
  - A uniform meter scale of weight 50 g f is balanced at 30 cm mark when weights of 80 g f and 60 g f act at 5 cm mark and 45 cm mark respectively. What force must be applied at 20 cm mark to balance the meter scale?

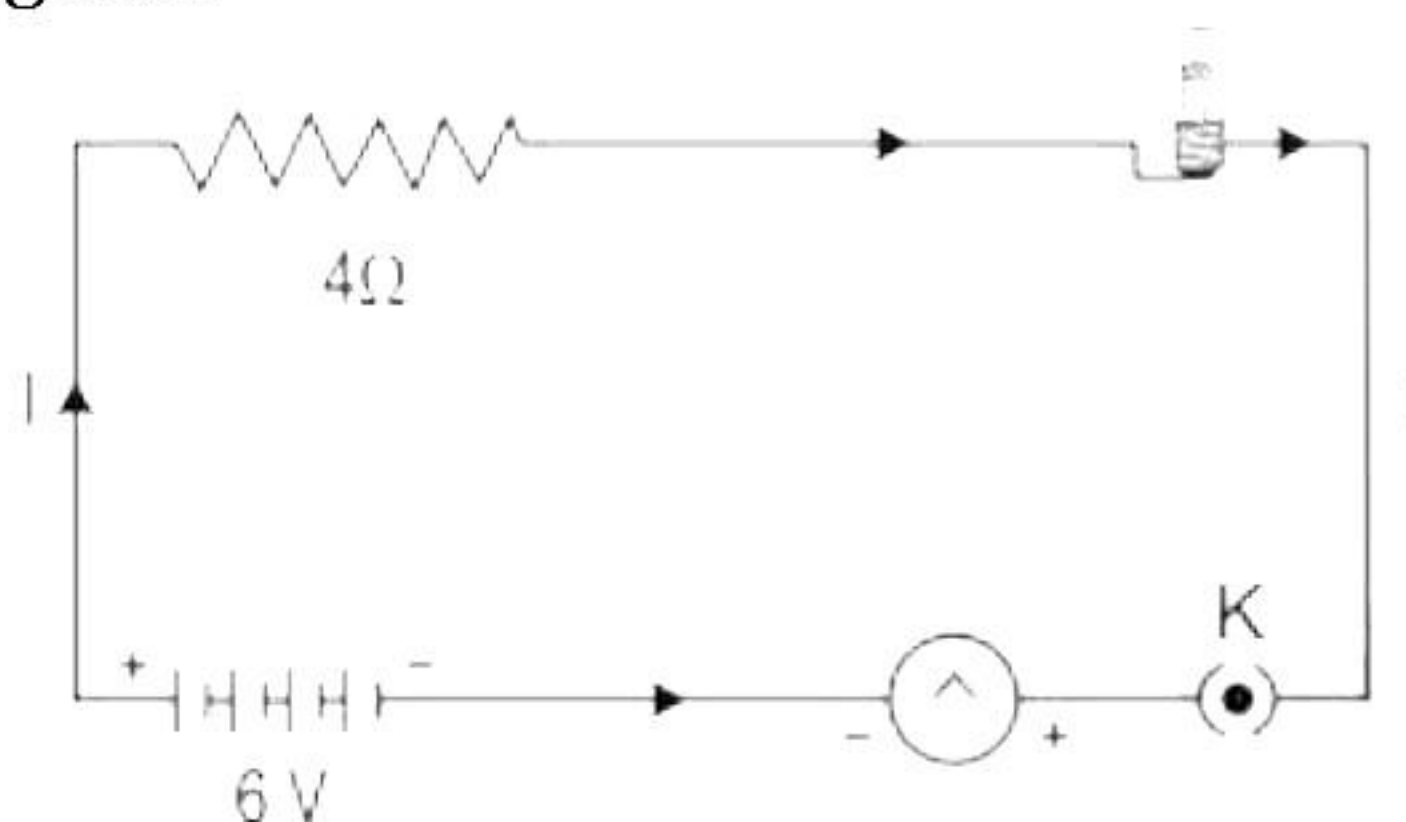
### Question 7

- i) [3]
- State the difference between a tone and a note.
  - A violin note and a sitar note may have the same frequency, yet we can distinguish between these two notes. Explain.
  - How does a stretched string produce an audible sound on being set into vibration?
- ii) Two balls of mass ratio 1:2 are dropped from the same height. [3]
- What is the ratio of their velocities when they strike the ground?
  - What is the ratio of their kinetic energy just before it hits the ground?
  - Find the ratio of the forces acting on them during motion.
- iii) A certain nucleus X has a mass number 15 and atomic number 7. [4]
- Find the number of neutrons.
  - Write the symbol for the nucleus X.
  - The nucleus X loses one proton, one  $\beta$ -particle, one  $\alpha$ -particle. Write the symbol of the new nucleus in each case and express each change by a reaction.



### Question 8

- i) [3]
- (a) Water is used in hot water bottles for fomentation. Give reason.
  - (b) Calculate the amount of heat energy required to raise the temperature of 200 g of copper from  $20^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .  
[Specific heat of capacity of copper =  $390 \text{ J kg}^{-1} \text{ K}^{-1}$ ]
- ii) An electric lamp of resistance  $20 \Omega$  and a resistor of  $4 \Omega$  are connected to a 6 V battery as shown in the circuit diagram. [3]



Calculate:

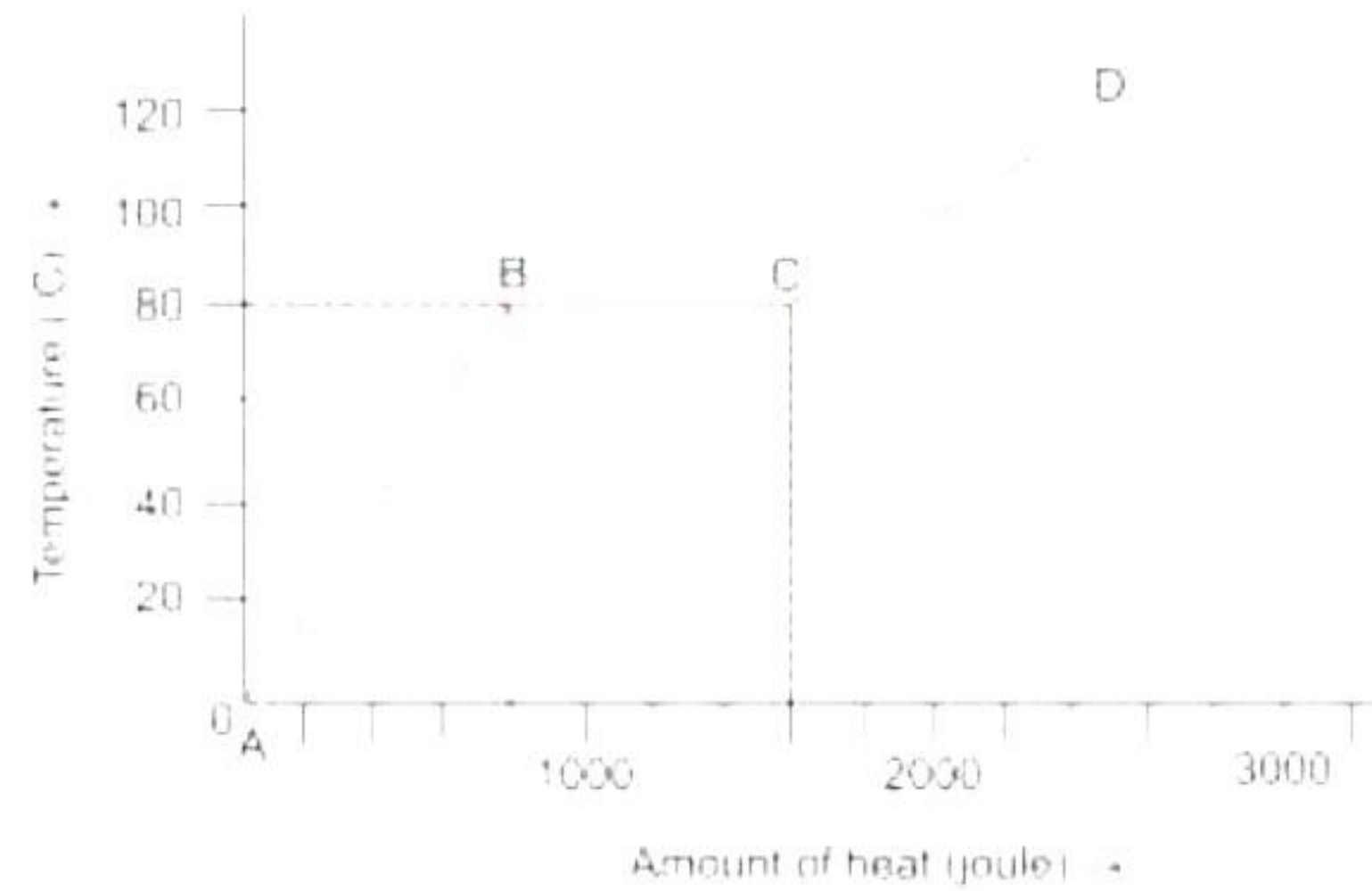
- (a) total resistance of the circuit
  - (b) current through the circuit
  - (c) potential difference across the electric lamp and the resistor.
- iii) A student, while studying the force experienced by a current-carrying conductor in a magnetic field records the following observations. [4]
- 1. The force experienced by the conductor increases as the current is increased
  - 2. The force experienced by the conductor decreases as the strength of the magnetic field is increased.
- (a) Which of the two observation is correct and why?
  - (b) State the rule which gives the direction of force acting on a current carrying conductor placed in a magnetic field.
  - (c) Draw magnetic field lines in case of a Solenoid and a bar magnet.

### Question 9

- i) The stem of a vibrating tuning fork is pressed against a table top. [3]
- (a) Would it produce any audible sound?
  - (b) Does it cause the table to set in vibrations?
  - (c) Under what condition does it lead to resonance?
- ii) How can you join three resistors of 2 ohms, 4 ohms, and 8 ohms to get [3]
- (a) Least equivalent resistance,
  - (b) Resistance in between the least and maximum equivalent resistance.
  - (c) Determine the P.D (voltage), which must be applied to a  $2\text{k}\Omega$  resistor in order that a current of 10mA may flow.



- iii) For an experiment a substance initially in solid state at  $0^{\circ}\text{C}$  is heated. The graph showing the variation in temperature with the amount of heat supplied is shown below: [4]



[Consider: specific heat capacity of the solid substance =  $500 \text{ J kg}^{-1}\text{C}^{-1}$ ]

Answer the following questions based on the given graph:

- Between which two points does temperature of substance remains constant?  
Explain why?
- Find the mass of the substance.
- State the temperature at which the substance starts changing from solid to liquid.
- What will be the specific latent heat of fusion of the substance in the liquid state.



# Solution

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## SECTION A

### Solution 1

Choose the correct answers to the questions from the given options. (Do not copy the questions, write the correct answer only.)

- i) Correct answer – d: 0.4 m

We know that,

$$\tau = r \times f$$

$$\therefore \tau = \frac{2}{5} = 0.4 \text{ m}$$

- ii) Correct answer – a:  $IR^2$

$$P = VI = I^2R = V^2/R$$

- iii) Correct answer – c: It can be continuously rotated instead of moving back and forth.  
The additional property of a gear is that it can be continuously rotated instead of moving back and forth as is the case with an ordinary lever.

- iv) Correct answer – b: Frequency

When the light goes from one medium to another, the velocity, and the wavelength (colour) of light do change, only the frequency of the light does not change.

- v) Correct answer – a: Both A and R are true and R is the correct explanation of A.

If the vibrations of medium particles are along the direction of propagation of the waves, then such waves are said to be longitudinal waves.

- vi) Correct answer – c: Virtual and erect

Concave lens always forms a virtual and erect image, irrespective of the position of the object.

- vii) Correct answer – a: attract each other.

If two parallel conducting wires carry current in the same direction, then they will attract each other.

- viii) Correct answer – c: Heating effect

When electric current passes through a thin, high resistance tungsten filament of an electric bulb, the filament becomes hot and emits light. This is the heating effect of electric current.



- ix) Correct answer – b: sublimation  
The change of state of solid directly into gaseous state on heating without going through the liquid state is called sublimation.
- x) Correct answer – c: remains constant  
No change because radioactivity is a nuclear phenomenon.
- xi) Correct answer – Both A and B  
This occurs because like magnetic poles repel and unlike attract each other.
- xii) Correct answer – a: Between  $F_1$  and  $2F_1$   
An object should be placed between  $F_1$  and  $2F_1$  so as to obtain the image formation used in a slide projector. This is because the image has to be enlarged and has to form at a little larger distance from the projector.
- xiii) Correct answer – c: C has the least moment and A has the greatest moment.  
C has the least moment and A has the greatest moment because C is nearest to O and force A is D farthest from O.
- xiv) Correct answer – b: Denser medium  
The cold air layers of the atmosphere behave as an optically denser medium for the light rays whereas warmer air layer acts as the rarer medium for the light rays.
- xv) Correct answer – a: a movable pulley  
The machine which is used to multiply force is a movable pulley.

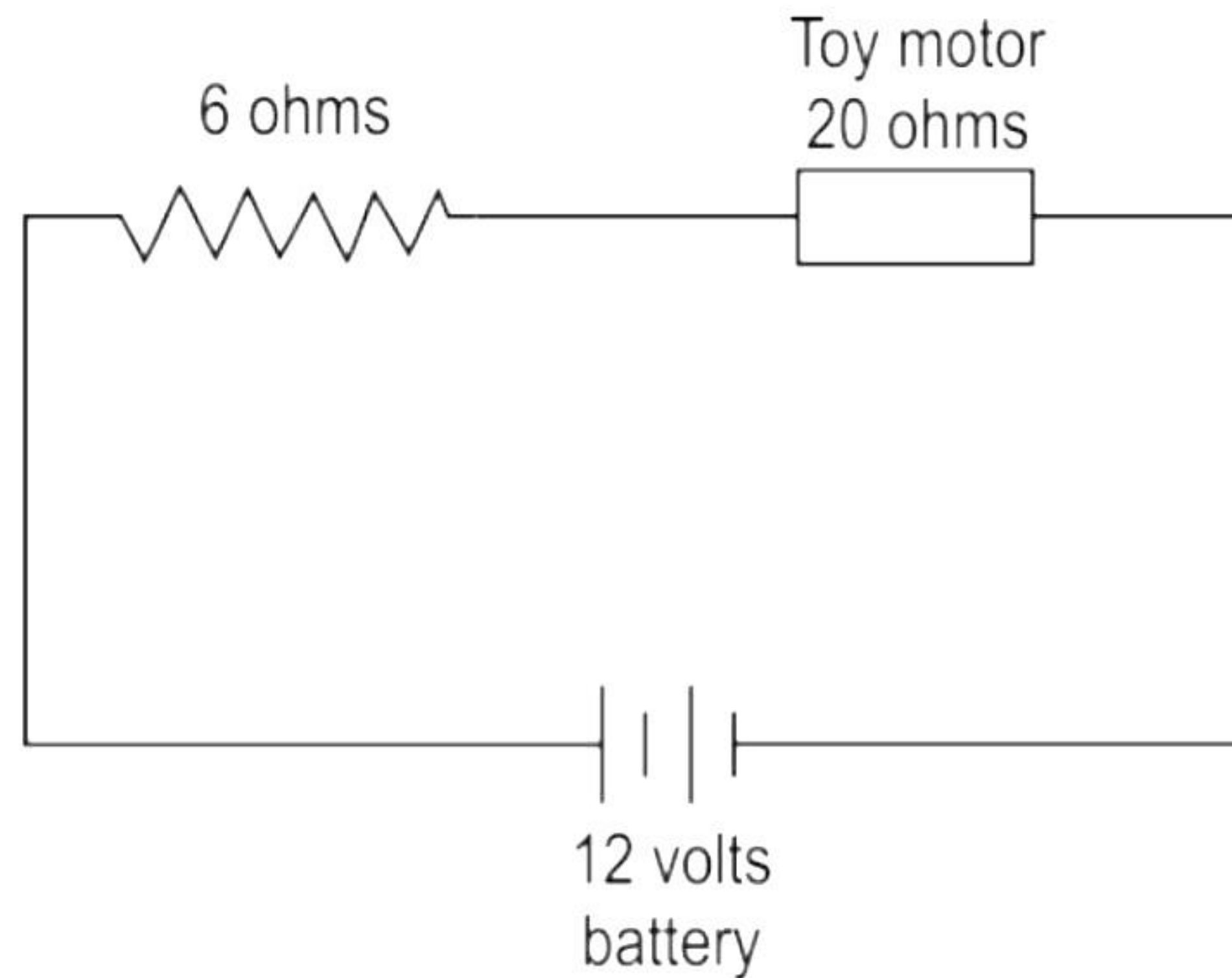
## Solution 2

- i)
- (a) The conversion of 1 a.m.u. of mass results in  $9.31 \times 10^6$  eV of energy.
  - (b) Ohm-metre is the S.I unit of resistivity.
  - (c) A transformer works on the principle of mutual inductance.
  - (d) A simple microscope employs a convex lens.
  - (e) The characteristic of musical sound is called quality or timbre.



ii)

(a)



Total resistance of the circuit is  $R_t = 6 + 20 = 26 \Omega$

(b)

$$\begin{aligned}\text{Current } I &= \frac{\text{Voltage}}{\text{Resistance}} \\ &= \frac{V}{R_t} \\ &= \frac{12}{26} = 0.46\text{A}\end{aligned}$$

iii) A calorimeter is made of a thin sheet of copper because

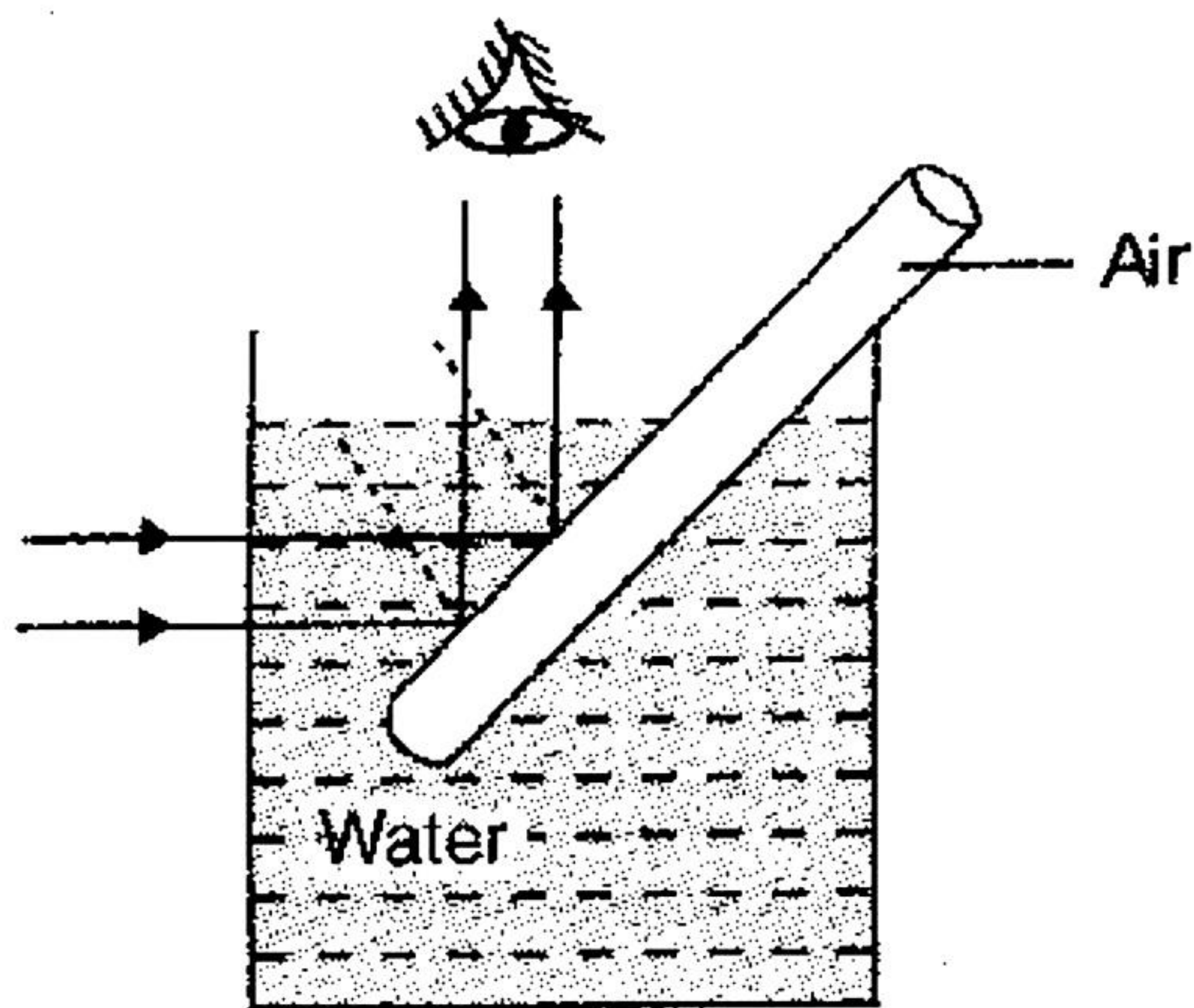
- Copper is a good conductor of heat, so the vessel soon acquires the temperature of its contents.
- Copper has low specific heat capacity, so the heat capacity of the calorimeter is low and the amount of heat taken by the calorimeter from the contents to acquire its temperature is very small.

### Solution 3

i)

- (a) Number of turns in the solenoid: Larger the number of turns in the solenoid, greater will be the magnetism.
- (b) Electromagnets are used in electric bells also it is used for removing the pieces of iron from waste product.
- (c) The surface of the test tube separates water (denser medium) from air (rarer medium) in the tube. The incident rays on the surface of tube shows the phenomenon of total internal reflection which makes the surface of an empty test tube shiny like a mirror.





ii)

Refractive index = 1.6;

$\angle i = 53^\circ$

By Snell's law, we have

$$n = \frac{\sin i}{\sin r}$$

$$\text{or, } 1.6 = \frac{\sin 53^\circ}{\sin r}$$

$$\Rightarrow \sin r = \frac{\sin 53^\circ}{1.6} = \frac{4}{5 \times 1.6} = \frac{1}{2}$$

$$\text{or, } r = 30^\circ$$

The angle made by the refracted ray with the normal is  $30^\circ$ .

iii)

(a) Energy of the body is its capacity to do work. Like work, energy is also a scalar quantity. The SI unit of energy is joule.

(b) According to the principle of conservation of energy, energy can be neither created nor destroyed. It only changes from one form to the other.

iv) Heat taken by ice to melt at  $0^\circ\text{C}$

$$Q_1 = mL = 0.04 \times 336 \times 10^3$$

Energy taken by melted ice to rise its temperature from  $0^\circ$  to  $t^\circ$

$$Q_2 = mc\Delta t = 0.2 \times 4200 \times t = 2100t$$

Heat energy given by water to reduce its temperature from  $50^\circ$  to  $t^\circ$  is

$$= 0.2 \times 4200 \times (50 - t)$$

Total heat energy taken by ice = Heat energy given by water

$$13440 + 168t = 42000 - 840t$$

$$1008t = 28560$$

$$t = 28.33^\circ$$

- v) For the same value of the angle of incidence  $i$ , the refractive indices of three media will be

$$\mu_A = \frac{\sin i}{\sin 15^\circ}; \mu_B = \frac{\sin i}{\sin 25^\circ}; \mu_C = \frac{\sin i}{\sin 35^\circ}$$

$$\mu_A > \mu_B > \mu_C$$

$$\mu = \frac{c}{v}$$

The velocity of light will be minimum in the medium whose refractive index is maximum. As  $\mu_A$  is maximum, velocity of light will be minimum in medium A.

- vi)

(a) Series

(b) Parallel

- vii)

Light	Sound
Light is electromagnetic waves in nature	Sound wave is mechanical waves in nature
They are transverse waves	They are longitudinal waves



## SECTION B

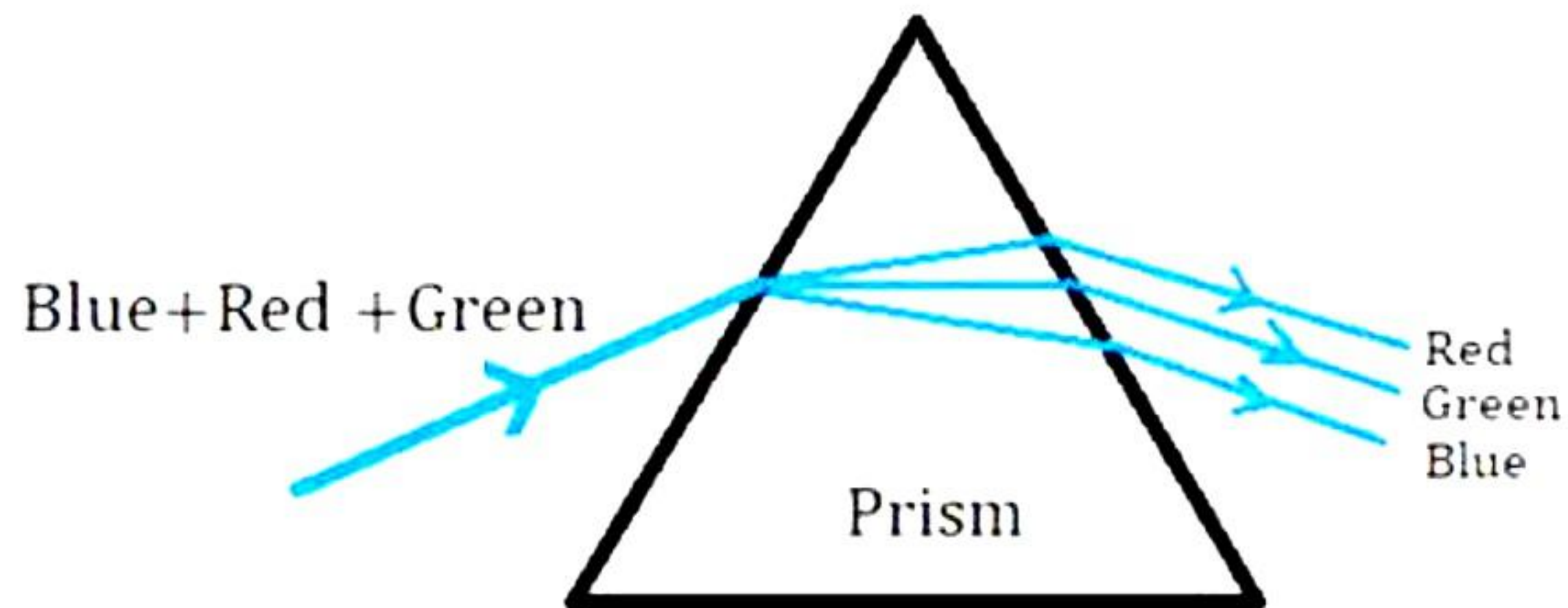
### Solution 4

i)

- (a) A prism with an angle of  $90^\circ$  between its two refracting surfaces and the other two angles of  $45^\circ$  each, is known as a total reflecting prism.
- (b) The Ozone layer protects us from the harmful UV rays of the sun.
- (c) When the rays from the sun which is at infinity are brought to focus on a piece of paper with the help of a converging lens, the paper burns due to the sufficient heat of the sun rays. Hence, a converging lens behaves as a burning glass.

ii)

(a)



- (b) The angle of deviation,  $\theta = 120^\circ$   
Now, as  $\theta = i_1 + i_2 - A$   
Where  $A = 60^\circ$   
And  $i_2 = 90^\circ$   
 $\Rightarrow i_1 = 120 + 60 - 90$   
 $i_1 = 90^\circ$   
So, the angle of incidence will be  $90^\circ$   
Now, if  $r_1 = 19^\circ$   
Then as  $r_1 + r_2 = A$   
 $\Rightarrow r_2 = A - r_1$   
 $\therefore r_2 = 60 - 19$   
 $= 41^\circ$   
Hence, the angle of incidence at the face AC is  $41^\circ$   
It is known as critical angle.

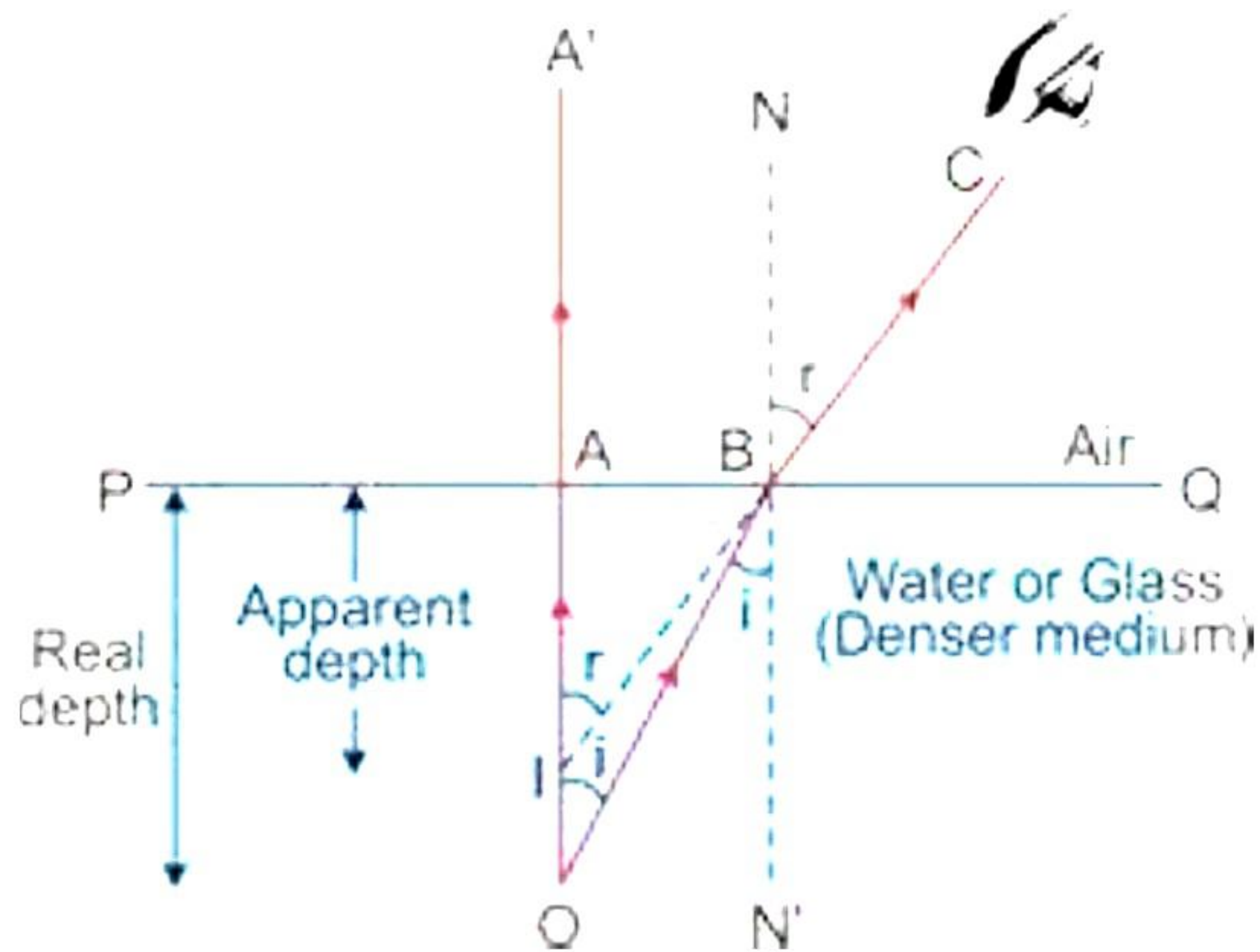
iii)

(a)

1. The depth of the tank appears to be lesser than its real depth. This happens due to the refraction of light from a denser medium (water) to a rarer medium.



2.



(b) Refractive index of the glass block,  $\mu_g = 1.5$

Shift in the image = 7mm or 0.7 cm

Thickness of glass block or real depth = ?

$$\text{Shift} = \text{Real depth} \times \left(1 - \frac{1}{\mu}\right)$$

$$0.7 = R \times \left(1 - \frac{1}{\mu}\right)$$

$$R = \frac{0.7 \times 1.5}{0.5} = 2.1 \text{ cm}$$

### Solution 5

i)

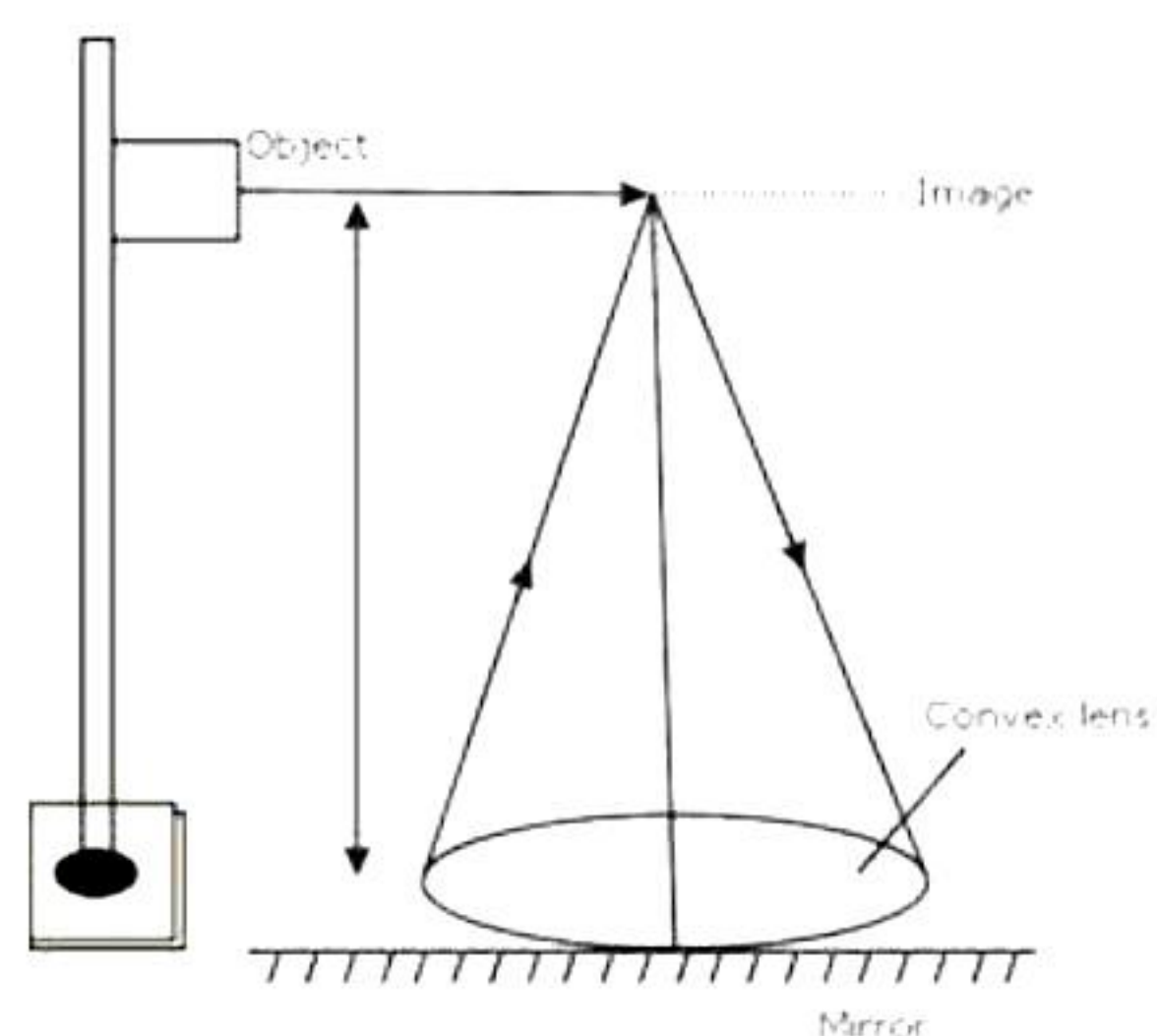
(a) LL' represents the convex lens.

(b) Magnifying glass is an application of convex lens.

(c) The image formed by the convex lens in above ray diagram is magnified, virtual and erect.

ii)

(a)



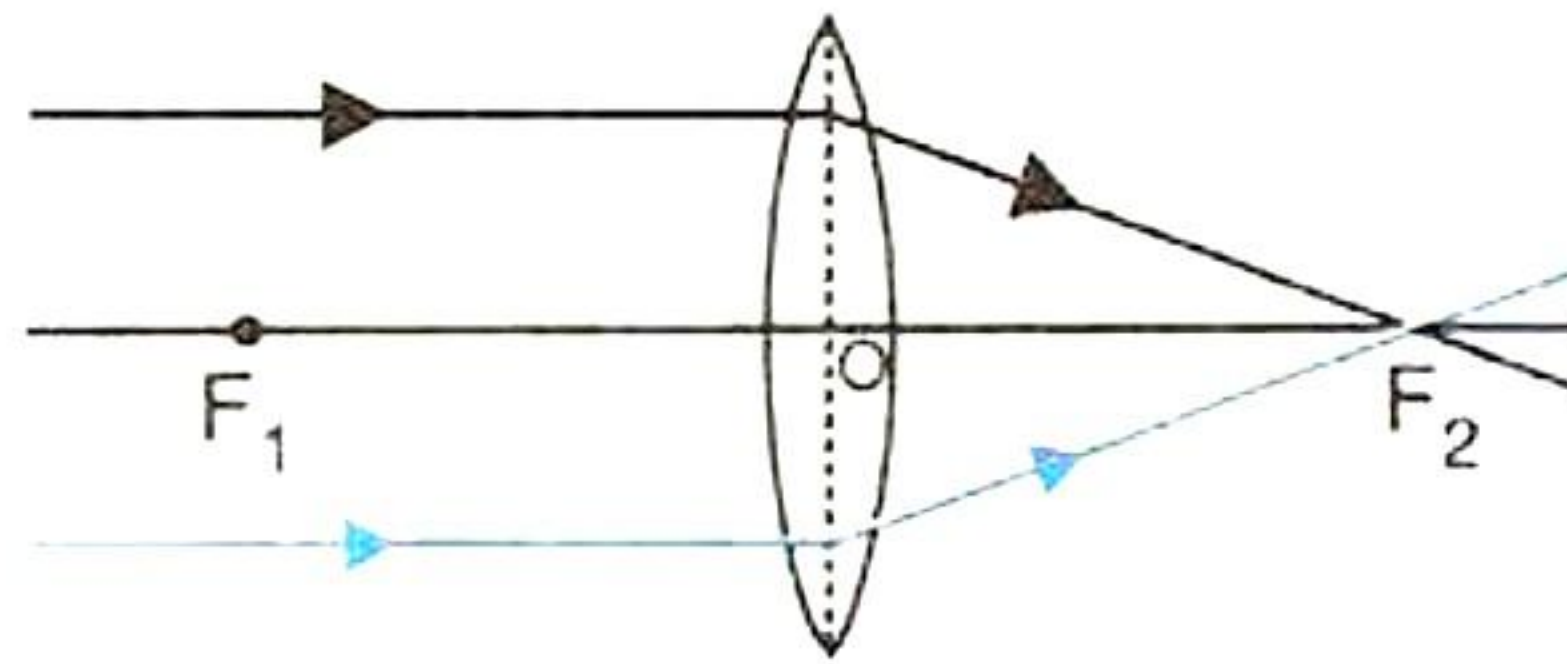


(b)

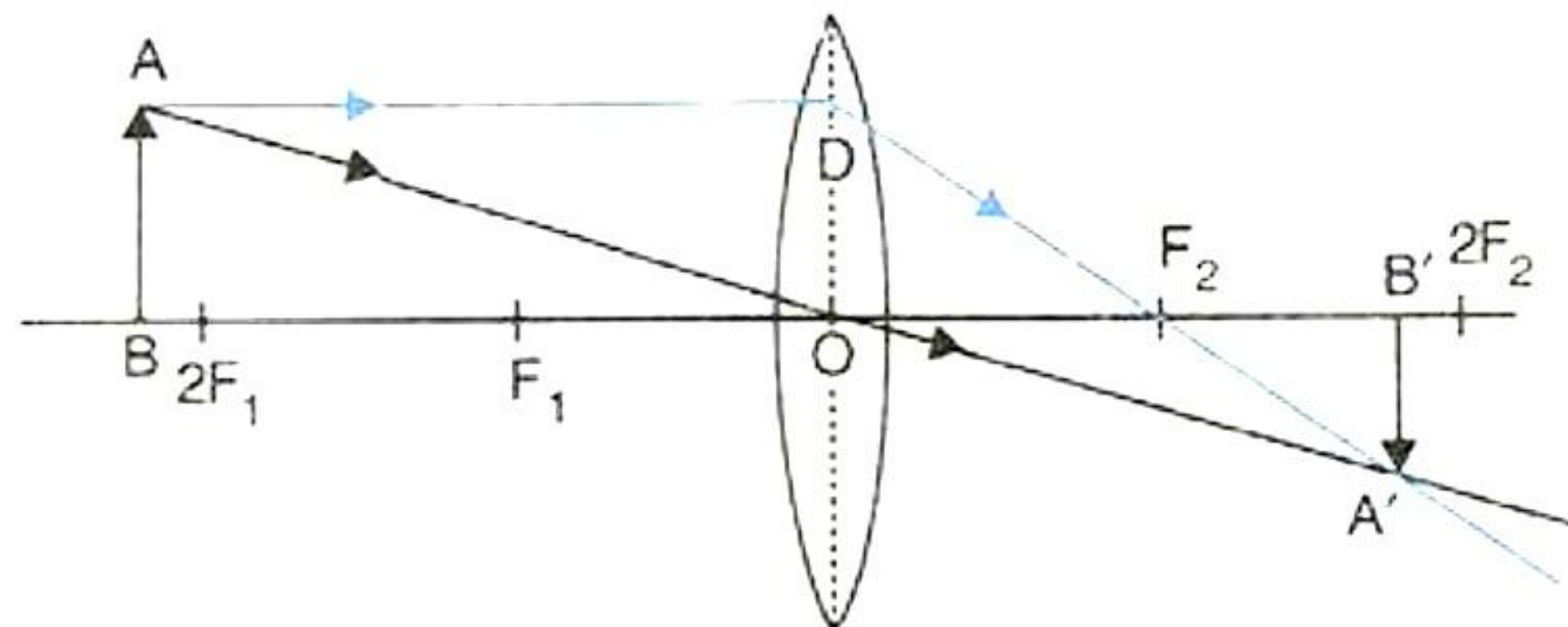
1. Both the focal lengths of a lens are equal when medium is same on both the sides of lens.
2. A ray of light passes undeviated after refraction from a thin lens when it passes through the optical centre of the lens.

iii)

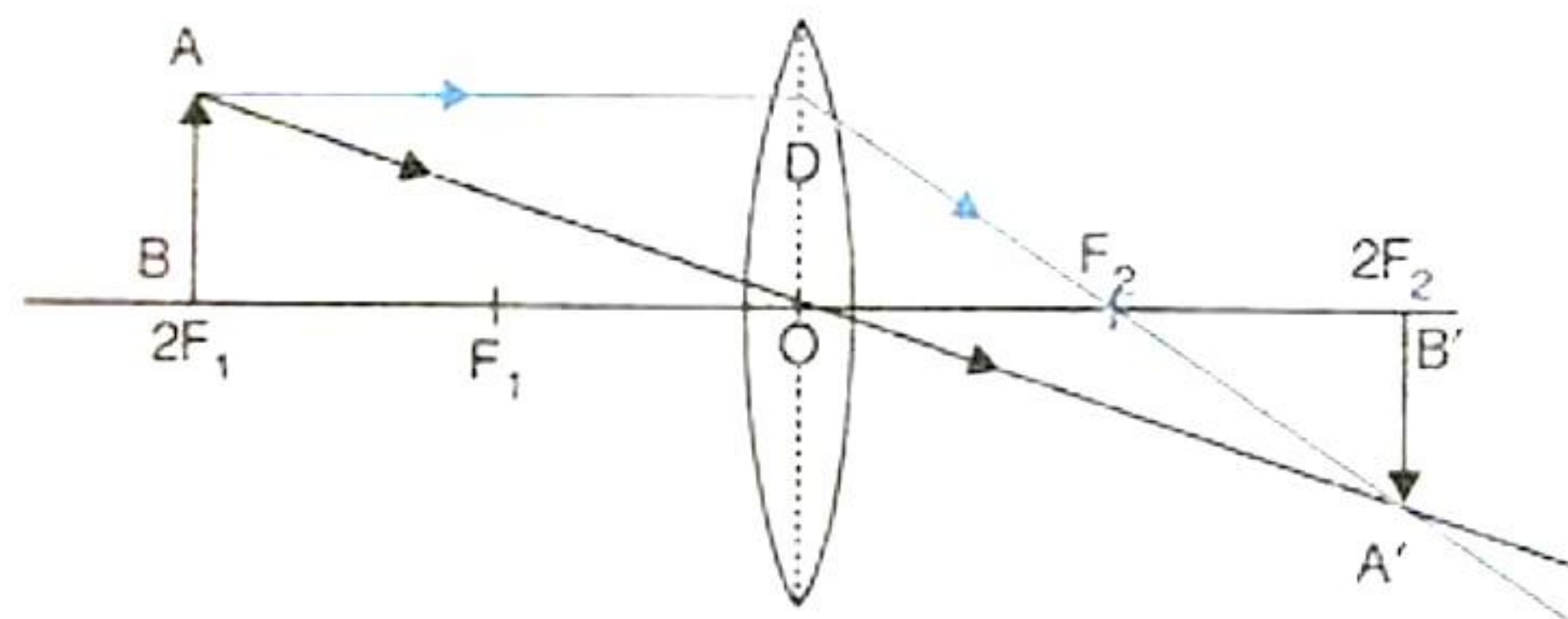
- (a) When the object is situated at infinity, the position of image is at  $F_2$ , it is very much diminished in size, and it is real and inverted.



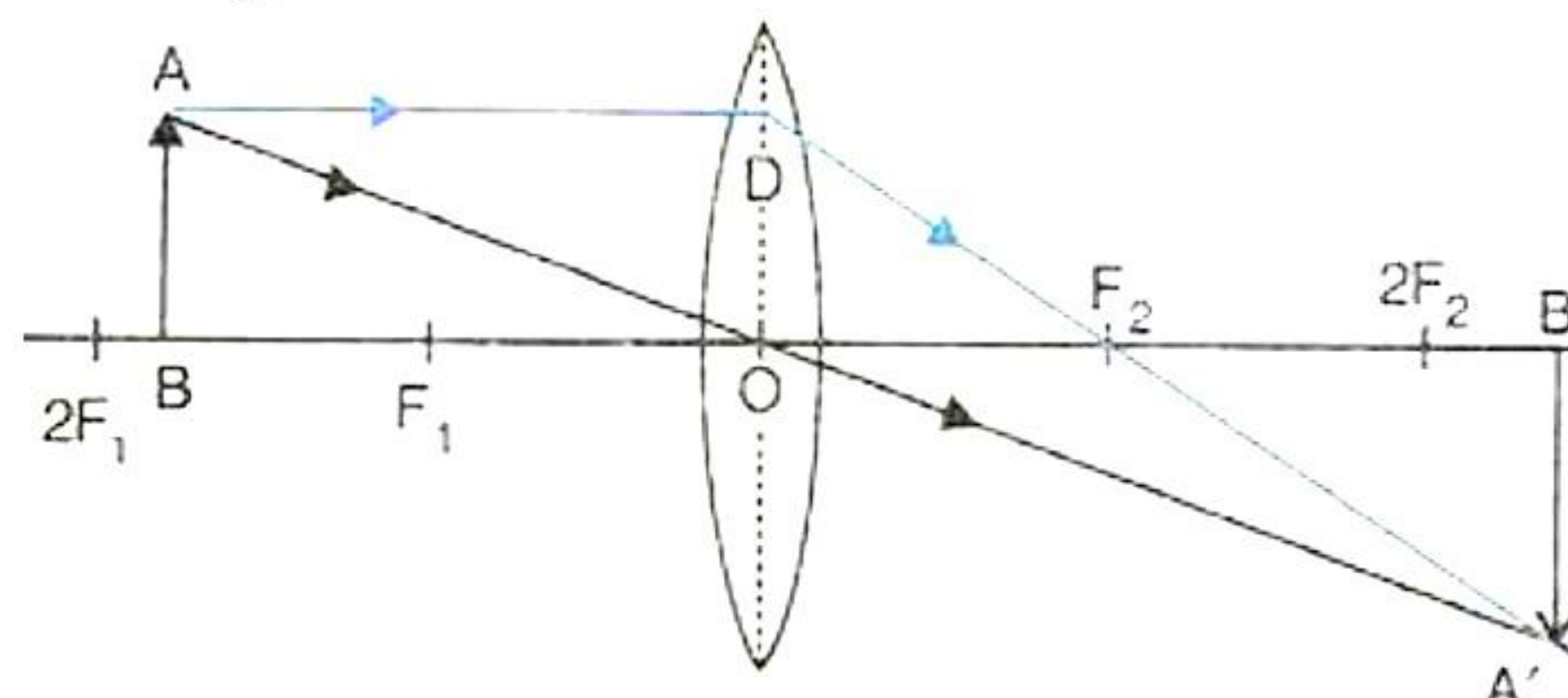
- (b) When the object ( $AB$ ) is situated beyond  $2F_1$ , the position of image ( $A'B'$ ) is between  $F_2$  and  $2F_2$ , it is diminished in size and real and inverted.



- (c) When the object ( $AB$ ) is situated at  $2F_1$ , the position of image ( $A'B'$ ) is at  $2F_2$ , it is of same size as the object and real and inverted.



- (d) When the object ( $AB$ ) is situated between  $2F_1$  and  $F_1$ , the position of image ( $A'B'$ ) is beyond  $2F_2$ , it is magnified in size and real and inverted.





## Solution 6

i)

$$(a) \text{ V.R} = \frac{\text{Distance through which effort moves}}{\text{Distance through which load moves}} = \frac{90}{4} = 22.5$$

$$(b) \text{ M.A} = \frac{\text{Load}}{\text{effort}} = \frac{100}{6} = 16.66$$

$$(c) \eta = \frac{\text{M.A}}{\text{V.R}} \times 100 = \frac{16.66}{22.5} \times 100 = 74\%$$

ii)

$$(a) \text{ K.E} = (1/2) m v^2$$

$$= (1/2) \times 0.5 \times (2)^2 = 1 \text{ Joule}$$

(b) The spring possesses elastic potential energy when compressed.

(c) Potential Energy of the spring = Kinetic Energy when released

$$\therefore \text{P.E} = 1 \text{ Joule}$$

iii)

(a) When it reaches the ground, its velocity becomes 0.

$$\text{So, K.E} = \frac{1}{2} m v^2$$

$$= \frac{1}{2} \times 50 \times 0 = 0$$

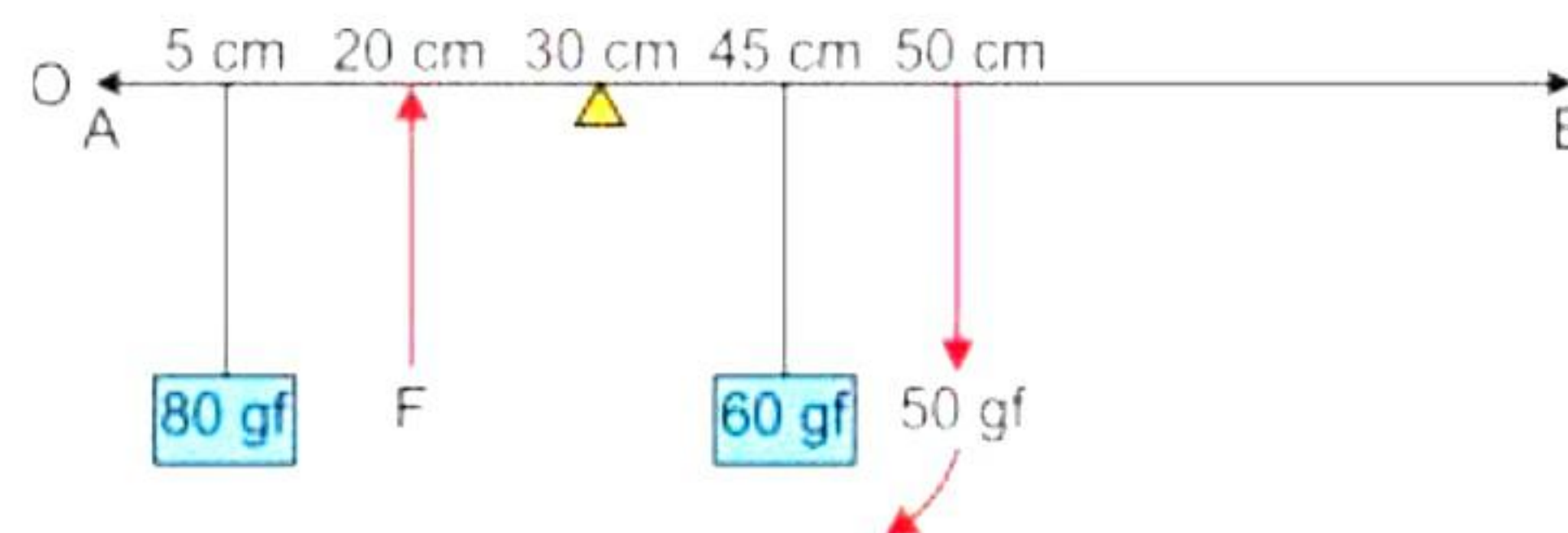
Just before it hits the ground its kinetic energy = initial potential energy

$$= mgh$$

$$= 50 \times 9.8 \times 10$$

$$= 4900 \text{ J}$$

(b)



If we take moment about the 30 cm mark

$$\text{Anticlockwise moment} = 80 \text{ g f} \times 25 \text{ cm}$$

$$= 2000 \text{ g f cm}$$

$$\text{Clockwise moment} = 60 \text{ g f} \times 15 \text{ cm} + 50 \text{ g f} \times 20 \text{ cm}$$

$$= 1900 \text{ g f cm}$$

Here, anti-clockwise moment > clockwise moment

Therefore, force at 20 cm mark must act in an upward direction in order to keep the scale in equilibrium.

Now, taking moment about the 30 cm mark

$$\text{Sum of anticlockwise moments} = \text{Sum of clockwise moments}$$

$$80 \text{ g f} \times 25 \text{ cm} = 60 \text{ g f} \times 15 \text{ cm} + F \times 10 \text{ cm} + 50 \text{ g f} \times 20 \text{ cm}$$

$$2000 \text{ g f cm} = 1900 \text{ g f cm} + F \times 10 \text{ cm}$$

$$F = 100 \text{ g f cm} / 10 \text{ cm} = 10 \text{ g f}$$



### Solution 7

i)

- (a) Tone is the quality or character of the sound, while a note is a sign or character used to represent a tone, and its position and form indicate the pitch and duration of the tone.
- (b) A violin and sitar note can be distinguished by a characteristic called timber. Its objective measure is the waveform.
- (c) A stretched string on being set into vibrations sends sound waves through the medium in the form of compressions and rarefactions which are received by the ear in the form of sound.

ii)

- (a) The ratio of their potential energies:

$$\frac{m_1gh}{m_2gh} = \frac{\frac{1}{2}m_1v_1^2}{\frac{1}{2}m_2v_2^2}$$

$$v_1^2 = v_2^2$$

$$\frac{v_1}{v_2} = 1:1$$

- (b)  $\frac{KE_1}{KE_2} = \frac{\frac{1}{2}m_1v_1^2}{\frac{1}{2}m_2v_2^2} = \frac{1}{2}$

- (c) 1:2

Using  $F = ma$ , here acceleration acting is that due to gravity.

iii)

- (a) Mass number = number of protons + number of neutrons and atomic number = number of protons. Therefore, number of neutrons = mass number - atomic number =  $15 - 7 = 8$ .

- (b) Element X can be written as  ${}^{15}_7\text{X}$ .

(c)

1. After the loss of 1 proton, the mass number and atomic number of the nucleus  ${}^{15}_7\text{X}$  will decrease by 1. The new nucleus will be  ${}^{14}_6\text{Y}$  (say). The change can be written as:  ${}^{15}_7\text{X} \rightarrow {}^{14}_6\text{Y} + {}^1_1\text{P}$
2. After the loss of one  $\beta$ -particle, the mass number will remain the same but the atomic number will increase by 1. The element  ${}^{15}_7\text{X}$  changes to  ${}^{15}_8\text{P}$  (say) as follows:  ${}^{15}_7\text{X} \rightarrow {}^{15}_8\text{P} + {}^0_{-1}\text{e}$
3. After the loss of one  $\alpha$ -particle, the mass number decreases by 4 and the atomic number decreases by 2. The element  ${}^{15}_7\text{X}$  changes to  ${}^{11}_5\text{Q}$  (say) as follows:  ${}^{15}_7\text{X} \rightarrow {}^{11}_5\text{Q} + {}^4_2\text{He}$

### Solution 8

i)

(a) The reason is that water does not cool quickly due to its large specific heat capacity, so a hot water bottle provides heat energy for fomentation for a long time.

(b) Mass of copper  $m = 200 \text{ g} = 0.2 \text{ kg}$

Change of temperature  $\Delta t = (70 - 20) = 50^\circ\text{C}$  or  $50 \text{ K}$

Specific heat of capacity of copper  $= 390 \text{ J kg}^{-1} \text{ K}^{-1}$

Amount of heat required to raise the temperature of  $0.1 \text{ kg}$  of copper is

$$Q = mc\Delta T$$

$$Q = 0.2 \times 50 \times 390$$

$$= 3900 \text{ J}$$

ii)

(a) The resistance of the electric lamp  $R_1 = 20 \Omega$ .

The resistance of the conductor connected in series  $R_2 = 4 \Omega$ .

The total resistance in the circuit

$$R = R_1 + R_2$$

$$R = 20 \Omega + 4 \Omega = 24 \Omega$$

(b) The total potential difference across the two terminals of the battery  $V = 6 \text{ V}$ .

By Ohm's law, the current through the circuit is given by

$$I = V/R$$

$$= 6 \text{ V}/24$$

$$= 0.25 \text{ A}$$

(c) On applying Ohm's law to the electric lamp and resistor separately, we get potential difference across the electric lamp.

$$V_1 = 20 \Omega \times 0.25 \text{ A} = 5 \text{ V}$$

and that across the conductor

$$V_2 = 4 \Omega \times 0.25 \text{ A} = 1 \text{ V}$$

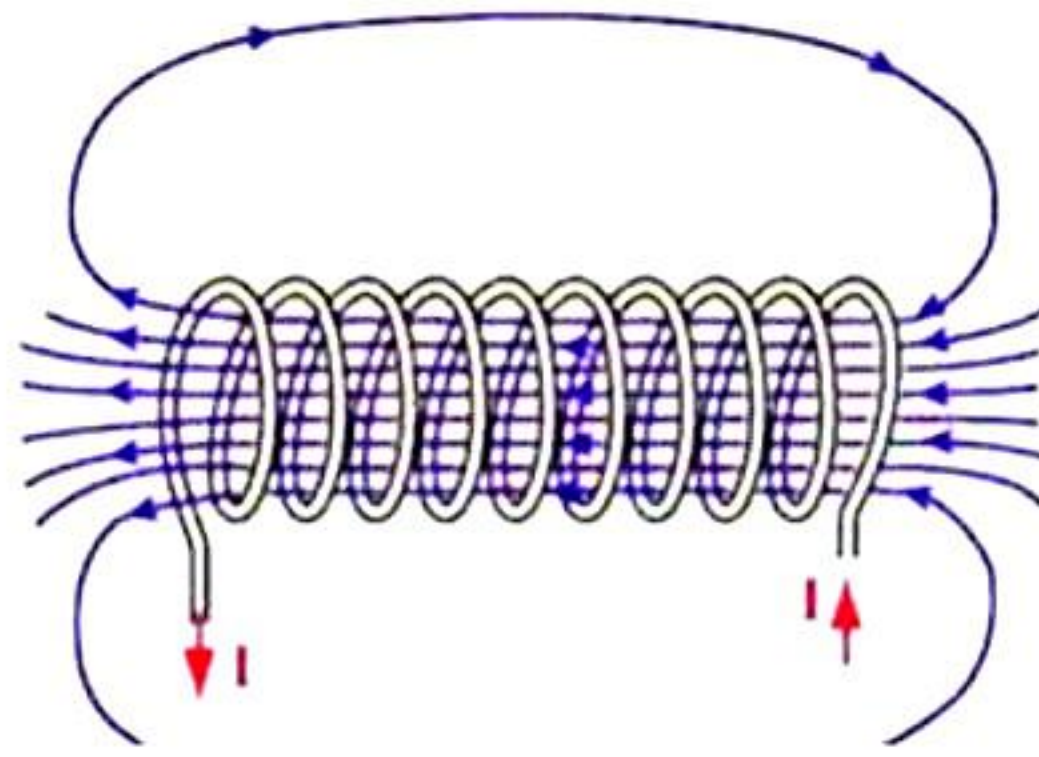
iii)

(a) Observation 1 is correct. Because force experienced by a current carrying conductor in a magnetic field is proportional to the strength of the current. Fleming's left hand rule gives the direction of force acting on a current carrying conductor placed in a magnetic field.

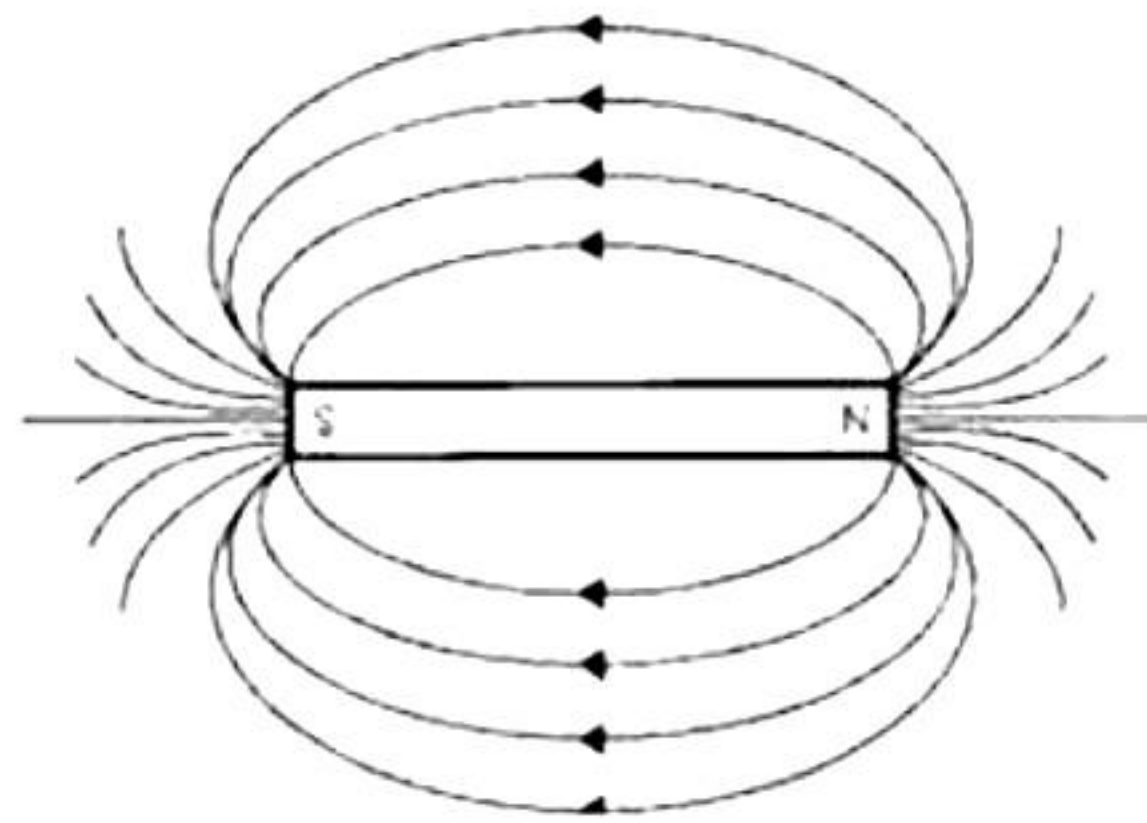
(b) Fleming's left-hand rule: Hold the forefinger, the centre finger and the thumb of your left hand at right angles to one another. Adjust your hand in such a way that the forefinger points in the direction of magnetic field and the centre finger points in the direction of current, then the direction in which thumb points, gives the direction of force acting on the conductor.



(c) The magnetic field lines for a solenoid



The magnetic field lines of a bar magnet



### Solution 9

i)

- (a) Yes
- (b) Yes, the vibrations caused in the table are the forced vibrations.
- (c) It leads to resonance if the natural frequency of vibrations of the table top becomes equal to the frequency of the vibrating tuning fork.

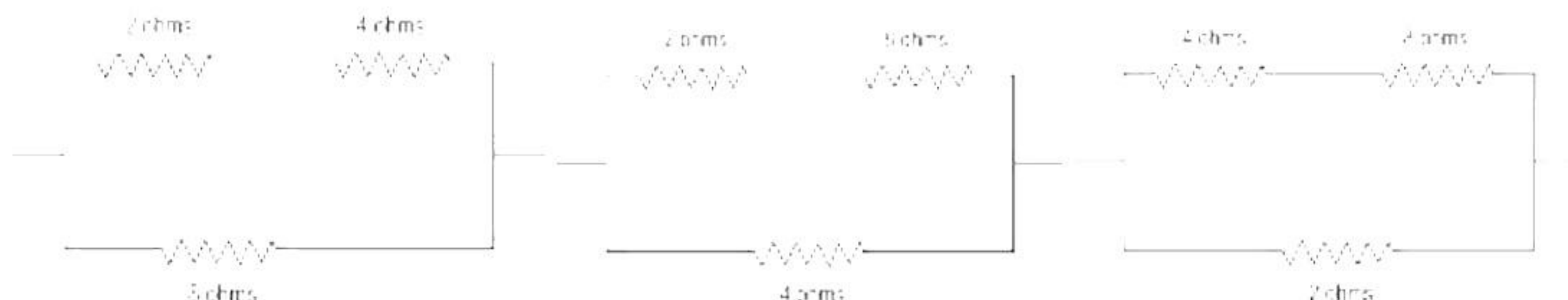
ii)

- (a) Join all resistors in parallel.

$$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} = \frac{7}{8}$$

$$R_{eq} = 1.14 \text{ ohms}$$

- (b) For resistance between 1.14 and 14 ohm any of the following configurations are possible.



- (c) Resistance  $R = 2 \text{ k}\Omega = 2 \times 10^3 \Omega = 2000 \Omega$

$$\text{Current } I = 10 \text{ mA} = 10 \times 10^{-3} \text{ A} = 0.01 \text{ A}$$

From Ohm's law,

$$\text{Potential difference is } V = IR = (0.01)(2000) = 20 \text{ V}$$

iii)

(a) Between point B and C the temperature of substance will be constant as shown in the graph. This is because of latent heat of fusion.

(b) In the graph, AB part represents the increase in temperature of solid substance from 0 °C to 80 °C on absorbing the heat  $Q = 800 \text{ J}$ .

If  $m \text{ kg}$  is the mass of solid substance, then Heat absorbed will be

$Q = \text{mass} \times \text{specific heat capacity} \times \text{rise in temperature}$

$$800 = m \times 500 \times 80$$

$$\therefore m = 1/50 \text{ kg} = 0.02 \text{ kg} = 20 \text{ g}$$

(c) In the graph, BC part represents the change of state of substance from solid to liquid at 80 °C.

(d) Now,

Heat energy observed,  $Q = 1600 \text{ J} - 800 \text{ J} = 800 \text{ J}$ .

If  $L \text{ J kg}^{-1}$  is the latent heat of fusion of the substance in the liquid state then

Heat absorbed,  $Q = \text{mass} \times \text{latent heat of fusion}$

$$800 = 0.02 \times L$$

$$\therefore L = 800 / 0.02 = 40000 \text{ J kg}^{-1}.$$