ICSE Board
Class X Physics
Silver Series
Sample Paper - 3 Solution

Section I

Answer 1

(a) We know that kinetic energy = $1/2\ mv^2$

i. If mass m is doubled, the kinetic energy gets doubled.
ii. If velocity is halved, the kinetic energy becomes one fourth.

(b)

i. When air exerts force on us, it is a type of contact force.
ii. A spring exerts force on objects attached to its ends when it is stretched or compressed.

(c) According to the principle of a machine, work done by the machine will be at the most equal to the work done on the machine, i.e. for a perfect machine (whose parts are weightless and frictionless) work done on the machine (input) is equal to work done by the machine (output).

(d) Levers having a mechanical advantage necessarily greater than one are levers of the second order. The nutcracker (or mango cutter or wheel barrow) is an example of a lever of the second order.

(e) The bob has maximum potential energy at points B and C, and maximum kinetic energy at point A.

Answer 2

(a) Load L is balanced by the same tension (i.e. $T_1 = T_2 = T$) in two segments of the strings.

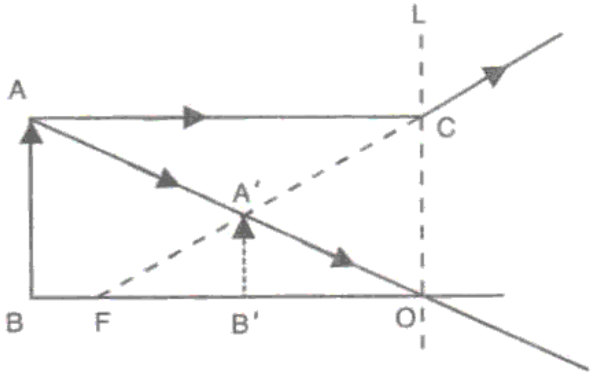
Therefore, $L = T_1 + T_2 = 2T$

Tension, $T = L/2 = 30/2 = 15$ N

Hence, $T_1 = T_2 = 15$ N

Effort, $E = T = 15$ N

(b) Since the image is diminished and erect, the lens is concave.



(c) Polychromatic light: A light consisting of several colours (or wavelengths) is called polychromatic light.

Monochromatic light: A light which consists of one colour (or a single wavelength) only is called monochromatic light.

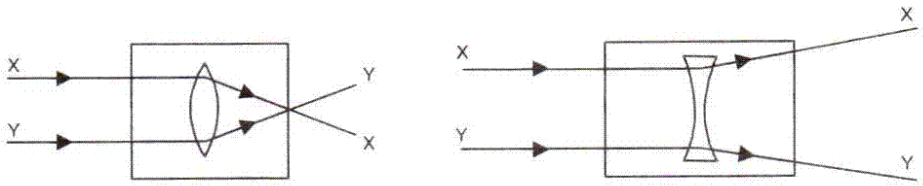
(d) The ray is totally reflected at faces AC and CB. The angle of incidence at each face is at least $i_c = 45°$

$$\mu = \frac{1}{\sin i_c} = \frac{1}{\sin 45} = \frac{1}{\frac{1}{\sqrt{2}}} = \sqrt{2}$$

(e) Infrared radiation is used for photography amid fog or mist because this radiation is not scattered by mist or fog and can appreciably penetrate through it.

Answer 3

(a)

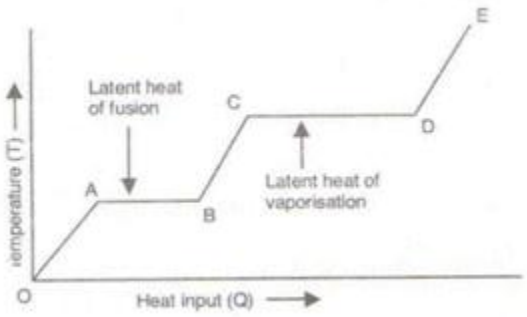


(b) Vibrating strings of stringed instruments produce a very weak sound which cannot be heard. Therefore, these instruments are provided with a sound box (or chamber). When the strings are set into vibration, forced vibrations are produced in the sound box. The large area of the sound box sets a large volume of air into vibrations which produces a large sound of the same frequency as that of the string.

(c)

i. The slope of the part DE of the graph represents $\frac{\Delta T}{Q}$, i.e. the reciprocal of the thermal capacity $\frac{Q}{\Delta T}$ of the vapour.

ii. CD = 2.5 AB means that the latent heat of vaporisation is 2.5 times the latent heat of fusion.



(d) The specific latent heat of fusion is 3.36×10^5 J kg^{-1} means that 3.36×10^5 J heat is required to convert 1 kg of ice at 0°C to water at 0°C or 3.36×10^5 J of heat is to be withdrawn to convert 1 kg of water at 0°C to ice at 0°C.

(e) The filament of the bulb and the supply wires are connected in series. So, the same current flows in the connecting wires and the bulb. We know that thick wires have less resistance and very fine wires have large resistance. We also know that heat produced due to current is directly proportional to the resistance, i.e. $H \propto R$. Therefore, due to negligible resistance of the thick supply wires, the connecting wires remain practically unheated, while due to very large resistance of the fine filament, a large amount of heat is produced in the filament, and hence, the bulb glows.

Answer 4

(a) As point D divides the resistance of arm BC in two equal halves, the resistances in part BD = DC = $2\,\Omega$.

Let the equivalent resistance between P and Q be R.

Now, from the figure, resistances AB and BD are in series and their equivalent resistance is $4\,\Omega + 2\,\Omega = 6\,\Omega$.

Similarly, AC and CD are in series and their equivalent resistance is also $4\,\Omega + 2\,\Omega = 6\,\Omega$.

According to the figure, these two $6\,\Omega$ resistances are in parallel. So, we have

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

$$\therefore R = 3\,\Omega$$

(b) Internal resistance of a cell depends on

i. Distance between the plates
ii. Nature of the electrolyte
iii. Nature of electrodes
iv. Area of the plates immersed in the electrolyte

(c) In a DC motor, the split ring acts as a commutator. The direction of the current through the coil is reversed after every half rotation so that the direction of the rotating couple remains unchanged and the coil continues to rotate in the same direction.

(d) The properties of metal necessary for thermionic emission:

i. The melting point of the metal should be quite high so that it may not melt on heating.
ii. The work function should be low so that the electrons may be emitted even at a low temperature.

(e) i. $^{226}_{88}\mathrm{Ra} \rightarrow ^{222}_{86}\mathrm{Rn} + ^{4}_{2}\mathrm{He}$

ii. $^{228}_{88}\mathrm{Ra} \rightarrow ^{228}_{89}\mathrm{Ac} + ^{0}_{-1}\mathrm{e}$

Section II

Answer 5

(a)

i. Work done by the effort W_E = Work done in raising the load + Work done against friction = (500 N × 20 m) + 2000 J = 12000 J

$$\eta = \frac{\text{Work done in raising the load}}{\text{Work done by effort}}$$

$$= \frac{10000\ \text{J}}{12000\ \text{J}} = \frac{10}{12} = 0.833 = 83.3\%$$

ii. VR = n = 5

$W_E = E \times d_E$

$$VR = \frac{d_E}{d_L} = 5$$

$\therefore d_E = 5 \times d_L = 5 \times 20\ \text{m} = 100\ \text{m}$

iii. $$E = \frac{W_E}{d_E} = \frac{12000\ \text{J}}{100\ \text{m}} = 120\ \text{N}$$

$$MA = \frac{L}{E} = \frac{500\ \text{N}}{120\ \text{N}} = 4.17$$

iv. VR = n = 5

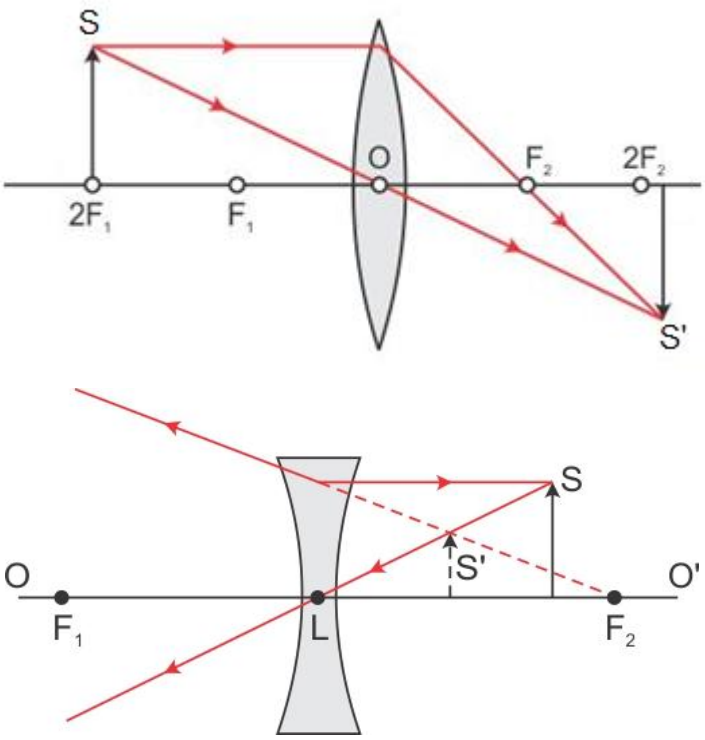
(b)

i. Electrical energy is converted to chemical energy.
ii. Light energy is converted to chemical energy which is used by plants for producing carbohydrates.
iii. Heat energy is converted to chemical energy.

(c) In both cases, the work done is equal as the mass of the boy is equal to the mass of the girl, and the height above the ground is also the same. Hence, the ratio of the work done is 1:1.

Answer 6

(a)



(b)

i. In glass, speed is maximum for red light and minimum for violet light.

ii. Deviation between the incident ray and the emergent ray is called angular deviation. In case of a glass block, the incident ray and the emergent ray are parallel. Hence, angular deviation is zero.

(c) Due to refraction in the atmosphere, the rays from the rising sun are bent and reach the eyes of the observer before the sun reaches the horizon (before sunrise). In the same way, after the sun has gone below the horizon (after sunset), the rays from the setting sun continue to reach the eyes of the observer.

Answer 7

(a)

i. The fundamental frequency of a stretched string can be affected by the following three factors:

1. Tension (T): $f \propto \sqrt{T}$, where l and m are constants.
2. Length (l): $f \propto \frac{1}{l}$, where T and m are constants.
3. Radius (r): $f \propto \frac{1}{r}$, where T and l are constants.

ii. The frequency of the note emitted by an air column is inversely proportional to the length of the air column. So, as the length of the air column decreases, frequency increases, i.e. the sound becomes shrill. As the water level in the bucket rises, the length of the air column goes on decreasing and the sound produced goes on becoming shriller. Thus, one can estimate the height of the water level in the bucket simply by hearing the sound.

(b)

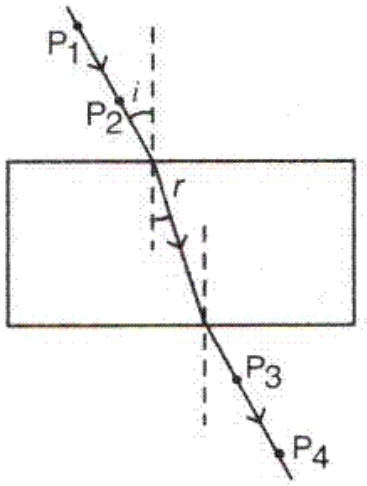
i. Heat capacity of a body changes directly as the mass of the body.
ii. Latent heat capacity changes directly as the mass of the body.
iii. Specific latent heat does not depend on the mass of the body as it is the characteristic of the material of the body.
iv. Specific heat capacity does not depend on the mass of the body as it is the characteristic of the material of the body.

(c) Mass of water = m
Fraction of water which freezes = f
Latent heat of vaporisation = L_1
Latent heat of freezing = L_2
Mass of water frozen = m × f
Heat lost when freezing water = m × f × L_2
Mass of vapour formed = m (1 − f)
Heat gained by vapour = m (1 − f) L_1
If there is no heat loss,
Heat lost when freezing water = Heat gained by vapour
m × f × L_2 = m (1 − f) × 7 L_2
f = 7 − 7f or f = 7/8

Answer 8

(a)

i.



ii. Lateral displacement

iii. Red light

iv. Light will retrace its original path or it will pass without any deviation.

(b) Total amount of heat required = Amount of heat required for heating the vessel and water

$= m_{Al}\, c_{Al}\, (\theta_2 - \theta_1) + m_w c_w\, (\theta_2 - \theta_1)$

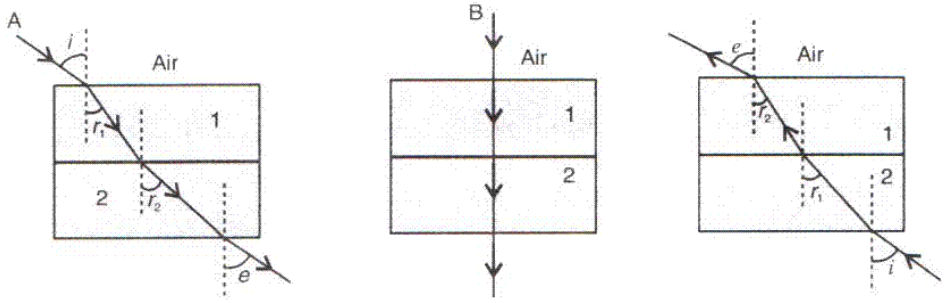
$= (m_{Al}\, c_{Al} + m_w\, c_w)\, (\theta_2 - \theta_1)$

$= [200\ g \times 0.21\ cal/g°C + (500\ cm^3 \times 1\ g/cm^3) \times 1\ cal/g°C]\ (75 - 25)°C$

$= [42 + 500] \times 50$

$= 27100\ cal = 27.1\ kcal$

(c)



Speed of light in medium '1' is less than speed of light in medium '2'.
So, the refractive index of medium '1' is more than that of medium '2', i.e. medium '1' is optically denser than medium '2'.

Answer 9

(a) Total resistance of the circuit

$R = 1\,\Omega + 4\,\Omega + 20\,\Omega = 25\,\Omega$

i. Current in the circuit $I = E/R = 1.5\text{ V}/25\,\Omega = 0.06$

ii. PD across the $4\,\Omega$ resistor, $V_1 = IR_1 = 0.06\text{ A} \times 4\,\Omega = 0.24\text{ V}$

PD across the $20\,\Omega$ resistor, $V_2 = IR_2 = 0.06\text{ A} \times \text{A}\ 20\,\Omega = 1.20\text{ V}$

iii. PD across the cell is the total PD in the external circuit:

$0.24\text{ V} + 1.20\text{ V} = 1.44\text{ V}$

Alternatively, terminal voltage $V = E - Ir = 1.5\text{ V} - 0.06\text{ A} \times 1\ \Omega = 1.44\text{ V}$

iv. Voltage drop $= IR = 0.06\text{ A} \times 1\,\Omega = 0.06\text{ V}$

(b) Resistance of arm AFE, $R_1 = 2 + 2 = 4\,\Omega$. It is in parallel with arm AE. The effective resistance of the network AFE is given by $R_2 = \frac{4\times4}{4+4} = 2\Omega$

The network AFE + arm ED is given by $R_2 = 2 + 2 = 4\Omega$

The network AFED is given by $R_4 = \frac{4\times4}{4+4} = 2\Omega$

The network AFED + arm DC is given by $R_5 = 2 + 2 = 4\Omega$

The network AFEDC is given by $R_6 = \frac{4\times4}{4+4} = 2\Omega$

The network AFEDC + arm CB is given by $R_7 = 2 + 2 = 4\Omega$

The network AFEDCB + arm AB is given by $R_8 = \frac{4\times4}{4+4} = 2\Omega$

Hence, the effective resistance between A and B in the given circuit $= 2\Omega$

(c) Advantages of an electromagnet over a permanent magnet:

i. Strength of the magnetic field of an electromagnet can be changed easily.

ii. Polarity of an electromagnet can be changed by reversing the direction of the current.

iii. An electromagnet can be demagnetised easily.

Factors on which the strength of an electromagnet depends:

1. It is directly proportional to the diameter of the coil (area of cross-section).
2. It depends on the nature of the core.
3. It is directly proportional to the number of turns in the coil.

Answer 10

(a)

i. Loss in mass = 0.5 amu = $0.5 \times 1.66 \times 10^{-27} = 0.83 \times 10^{-27}$ kg

Energy released E = $\Delta m\, c^2 = 0.83 \times 10^{-27} \times (3 \times 10^8)^2 = 7.47 \times 10^{-11}$ joule

$= (7.47 \times 10^{-11}) / (1.6 \times 10^{-13}) = 466.87$ MeV

(b) Three safety precautions for handling radioactive materials:

(any three)

i. Nuclear material must be kept in thick lead containers which have a narrow mouth plugged with thick lead corks.
ii. Workers in nuclear establishments should handle radioactive materials with mechanical tongs.
iii. They should put on special lead lined aprons and lead gloves.
iv. The safety limit for each type of radiation is known. Therefore, care must be taken that no one is exposed beyond the safety limit.

(c) The earth pin plug is always made longer and thicker because of the following reasons:

i. The earth pin being thicker can never enter in the live or neutral sockets. Thus, there will be a proper electrical connection.
ii. The earth pin being longer gets connected to the earth terminal first as compared to the live or neutral pins. In case of any leakage of charge, the earth pin will conduct the charge to the earth. This ensures that the user will not get any electric shock.