ICSE QUESTION PAPER

Class X Physics

(2016) Solution

SECTION I

1.

(a)

(i) The gravitational force is always attractive in nature.

(ii) The magnitude of non-contact forces acting on two bodies depends on the distance of separation between them. The magnitude of force decreases with an increase in separation and increases as the separation decreases. It varies inversely as the square of the distance of separation.

(b) Given:

Force of gravity of the boy, F_b = 40 kgf

Time taken by him, t_b = 4 minutes = 4 × 60 s = 240 s

Force of gravity of the girl, F_g = 30 kgf

Time taken by her, t_g = 3 minutes = 3 × 60 s = 180 s

Distance covered by both in 30 steps is

D = 30 × 20 = 600 cm

While climbing, both have to do work against the force of gravity.

(i) Work done by the boy in climbing the stairs:

$W_b = F \times D$ = 40 kgf × 600 cm

W_b = 24000 J

Work done by the girl in climbing the stairs:

$W_g = F \times D$ = 30 kgf × 600 cm

W_g = 18000 J

$$\rightarrow \frac{W_b}{W_g} = \frac{24000\ J}{18000\ J}$$

$$\therefore \frac{W_b}{W_g} = \frac{4}{3}$$

(ii)

$$\text{Power developed} = \frac{\text{Work done}}{\text{Time taken}}$$

For the boy:

$$\text{Power developed} = \frac{24000\ J}{240\ s} = 100\ W$$

For the girl:

$$\text{Power developed} = \frac{18000\ J}{180\ s} = 100\ W$$

Thus, power developed by them is 1 : 1

(c) Velocity ratio.

It is the ratio of the velocity of effort to the velocity of load.

$$V.R. = \frac{V_E}{V_L}$$

(d) Let m be the mass of the ice to be added.

Heat energy required to melt to lower the temperature is = mL = m $\times$ 336

Heat energy imparted by the water in fall of its temperature from 40°C to 0°C = mass of the water $\times$ specific heat capacity $\times$ fall in temperature

= 300 $\times$ 4.2 $\times$ 40°C

If there is no loss of heat,

m $\times$ 336 J/g = 300 g $\times$ 4.2 J/g°C $\times$ 40°C

$$\therefore m = \frac{300 \times 4.2 \times 40}{336}$$

$$\therefore m = 150g$$

(e)

(i) Heat capacity is the amount of heat required to raise the temperature of a body by 1°C or 1 K. Thus, 60 JK^{-1} of energy is required to raise the temperature of the given body by 1 K.

(ii) Specific heat capacity is the amount of heat energy required to raise the temperature of unit mass of a substance through 1°C or 1 K. Thus, 130 $Jkg^{-1}K^{-1}$ of heat energy required to raise the temperature of unit mass of lead through 1 K.

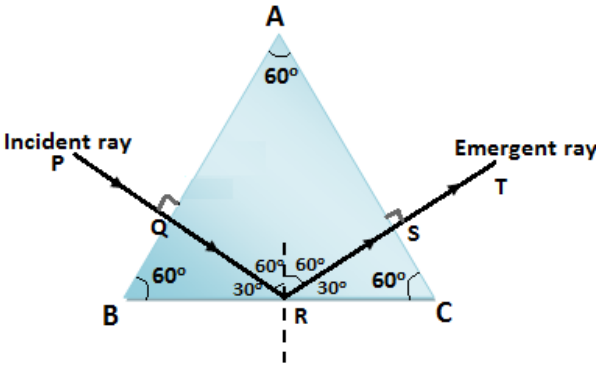
2.

(a) Heat absorbed by a body depends on the mass of the body and the specific heat capacity of the body.

(b) The refractive index will be different in both cases.

Refractive index of glass is different for different colours. The speed of blue light is less than the speed of red light. So, the wavelength of blue light is less than that of red light. Thus, red light would deviate less than blue light because of difference in wavelength.

(c)



(d)

(i) For a given angle of incidence, the prism with higher refractive index produces a greater deviation than the prism which has a lower refractive index. Thus, the angle of deviation increases with an increase in the refractive index of the medium.

(ii) The angle of deviation decreases with an increase in the wavelength of light. Thus, a prism deviates violet light the most and red light the least.

(e)

(i) Let a_1 and a_2 be the amplitudes and I_1 and I_2 be the intensities of the two waves.

$$\therefore \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{3^2}{4^2}$$

$$\therefore \frac{I_1}{I_2} = \frac{9}{16}$$

(ii) Frequency is the number of waves formed per second. It only depends on time period. Thus, the ratio of their frequencies is 1:1.

3.

(a) The frequency of transverse vibration is given by

$$f = \frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2 d}}$$

$$\text{or } f = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$$

where ℓ = length of the vibrating string

T = tension in the string

m = mass per unit length of the string

Therefore, the frequency of transverse vibration of a stretched string can be increased by

(i) decreasing the length of the string

(ii) decreasing the radius of the string

(iii) increasing the tension T in the string

(b) The disturbance produced in the environment because of undesirable loud and harsh sound of level more than 120 dB from the various sources such as a loudspeaker and moving vehicles is called noise pollution.

(c) For the same change in I, change in V is less for the straight line A than for the straight line B (i.e. the straight line A is less steep than B). The straight line A represents small resistance, while the straight line B represents more resistance. The equivalent resistance is less in a parallel combination than in a series combination. So, line A represents a parallel combination.

(d)

(i) Given: $I = 400\ mA = 400 \times 10^{-3}\ A$

$V = 12\ V$

$V = IR$

$\therefore R = \frac{V}{I} = \frac{12\ V}{400 \times 10^{-3}\ A}$

$\therefore R = 30\,\Omega$

(ii) Current drops to $I = 320\ mA = 320 \times 10^{-3}\ A$

The music stops playing at

$V = IR$

$= 320 \times 10^{-3} \times 30$

$\therefore V = 9.6\ V$

(e)

Given : $R = 20\ \Omega$, $I = 2.5\ A$

$t = 5\ \text{minutes} = 5 \times 60 = 300\ s$

Quantity of heat produced is given as

$H = I^2Rt$

$= (2.5)^2 \times 20 \times 300$

$\therefore H = 37500\ J$

4.

(a) Two characteristics which a thermionic emitter should possess are

1. The work function of the substance should be low such that the electrons are emitted from it even when it is not heated to a very high temperature.
2. The melting point of the substance should be quite high so that it may not melt when it is heated to the temperature required for thermionic emission.

(b)

$${}_{Z}S^{A} \rightarrow {}_{85}R^{222} + 2\left({}_{2}^{4}He\right) + 1\,{}_{-1}^{0}e$$

$$A = 222 + 2(4) + 0$$

$$\therefore A = 230$$

$$Z = 85 + 2(2) + (-1)$$

$$\therefore Z = 88$$

(c) There will be no change in the nature of radioactivity of the substance.
This is because oxidation is a chemical process and does not involve the nucleus of the substance.

(d) Characteristics required in a material to be used as an effective fuse wire are
a. High resistivity
b. Low melting point

(e) In a step-up transformer, the primary coil is made of thicker wire.
This is because in a step-up transformer the number of turns in the secondary coil is more than the number of turns in the primary coil.

As $\frac{E_s}{E_p} = \frac{N_s}{N_p} > 1$ and $E_s I_s = E_p I_p$

$\therefore E_s > E_p$

But $I_s < I_P$, i.e. more current flows through the primary coil. Therefore, one must use a thicker wire in the primary coil as compared to that in the secondary coil.

SECTION II

5.

(a)

(i) The stone is moving with uniform speed as given in the question.

(ii) Although the stone is rotating with uniform speed, its direction keeps on changing. Hence, the stone is said to be moving with uniform acceleration. The direction of acceleration is towards the centre of the circle.

(iii) 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.

(b)

(i) The pulley A is a single movable pulley and B is a single fixed pulley.

(ii) Pulley B is a single fixed type pulley. Its purpose is to change the direction of the effort applied.

(iii) Effort at C is equal to the load. This is because B is a single fixed pulley and its mechanical advantage is 1. So, we have

$$\text{M.A.} = \frac{L}{E} = 1$$

$$\therefore E = L = 20 \text{ kgf}$$

(c)

(i) The number of teeth in the driving wheel is $n_B = 32$ and that in the driven wheel is $n_A = 8$. Hence, this system is used to obtain gain in speed.

$$\text{Gain in speed} = \frac{n_B}{n_A} = \frac{32}{8} = 4$$

(ii) Load = 120 N; E = 50 N; n = 3

Mechanical advantage of pulley system is

$$\text{M.A.} = \frac{L}{E} = \frac{120}{50} = 2.4$$

The efficiency of the system is

$$\eta = \frac{\text{M.A.}}{\text{V.R.}} = \frac{2.4}{n} = \frac{2.4}{3} = 0.8 = 80\%$$

6.

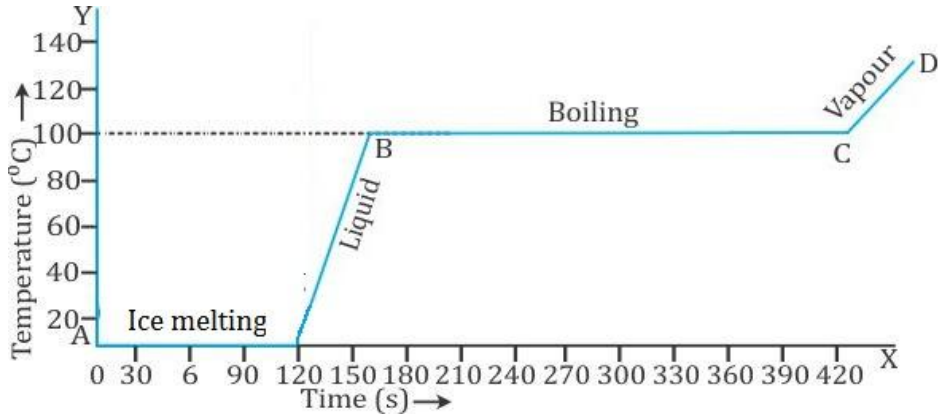
(a)

(i) The principle of method of mixtures says that the heat lost by a hot body is equal to the heat gained by a cold body.

(ii) The other name given to the principle of mixtures is the principle of calorimetry.

(iii) The principle of mixtures is based on the law of conservation of energy.

(b) The figure for phase change is shown below:



(c) Heat energy lost by the vessel and water contained in it in cooling the water from 50°C to 5°C is used in heating ice to melt it and then to raise its temperature from 0°C to 5°C.

Now, heat energy lost by the copper vessel is

$Q_C = m_C c_C \Delta t = 100 \times 0.4 \times (50 - 5)$

$Q_C = 1800 \text{ J}$

Similarly, heat energy lost by water is

$Q_W = m_W c_W \Delta t = 150 \times 4.2 \times (50 - 5)$

$Q_W = 28350 \text{ J}$

Hence, the total heat energy lost is

$Q_L = 1800 + 28350 = 30150 \text{ J}$

Let m g of ice be used to cool water. So, heat gained by ice is

$Q_I = mL_{ice} + mc_W \Delta t$

$Q_I = 336m + m \times 4.2 \times 5 = 336m + 21m = 357m \text{ J}$

Therefore, from the principle of calorimetry, the mass of ice is

$Q_L = Q_I$

$\therefore 357m = 30150$

$\therefore m = \dfrac{30150}{357} = 84.45 \text{ g}$

7.

(a)

(i) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant for a given pair of media called the refractive index.

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

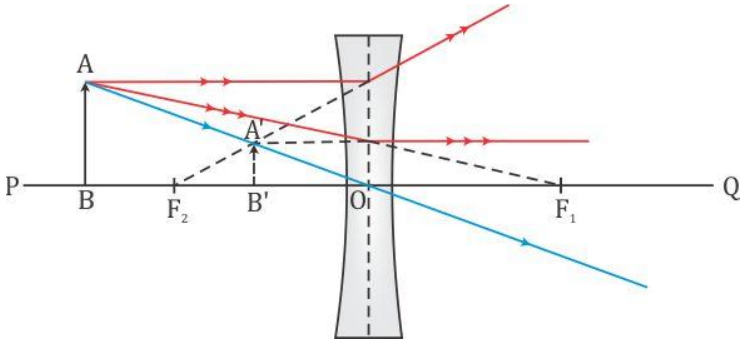
(ii) When a ray of light enters from one medium to another with different optical densities, it bends because there is a change in the speed of light in the two media.

(iii) A ray of light passing from one medium to another does not bend when it is incident normally on the surface.

(b)

(i) The image formed by the lens is virtual and between the object and the lens. Hence, the lens used is a concave lens.

(ii) The following image is of formation of the above image:



(c) Scattering is the process of absorption and then re-emission of light energy. The red colour of the white light is scattered the least, while the violet colour is scattered the most.

8.

(a)

(i) The waves used for echo depth sounding are ultrasonic waves.

(ii) Ultrasonic waves are used for echo depth ranging because they can travel undeviated through a long distance.

(iii) Ultrasonic waves have frequency larger than 20000 Hz. Hence, these waves are not audible to us as the audible range for the human ear is 20 Hz to 20000 Hz.

(b)

(i) The sound heard after reflection from a distant obstacle after the original sound has ceased is called an echo.

(ii) The conditions for an echo to take place are

a. The minimum distance between the source of sound and the reflector in air must be 17 m.

b. The size of the reflector must be large enough as compared to the wavelength of sound wave.

(c)

(i) The phenomenon involved in tuning a radio set to a particular station is called resonance.

(ii) Resonance: When the frequency of an externally applied periodic force on a body is equal to its natural frequency, the body readily begins to vibrate with an increased amplitude. This phenomenon is known as resonance.

(iii) Loudness is the property by virtue of which a loud sound can be distinguished from a faint one, both having the same pitch and quality.

(iv) The loudness of sound is measured in phon.

9.

(a)

(i) Electrons are responsible for current in conductors.

(ii) The metal case of a geyser should be connected to the Earth wire.

(iii) The fuse should always be connected to the live wire.

(b)

(i) A step-up transformer is used in the power transmitting station of a power plant.

(ii) An alternating current is transmitted from the power station.

(iii) The current is available to our household at a voltage of 220 V.

(c) $E = 12$ V; $r_i = 2\ \Omega$; $R_A = 4\ \Omega$; $R_B = 6\ \Omega$

(i) The current in the circuit is

$$I = \frac{E}{R_{total}} = \frac{E}{r_i + r_A + r_B}$$

$$\therefore I = \frac{12}{2+4+6} = 1 \text{ A}$$

(ii) The terminal voltage of the cell is

$$V = E - Ir_i$$

$$\therefore V = 12 - (1 \times 2) = 12 - 2 = 10 \text{ V}$$

(iii) The potential difference across the 6 Ω resistor is

$$V_B = IR_B$$

$$\therefore V_B = 1 \times 6 = 6 \text{ V}$$

(iv) The electrical energy spent per minute (=60 s) is

$$E = I^2Rt$$

$$E = 1^2 \times 4 \times 60 = 240 \text{ J}$$

10.

(a)

(i) Penetrating power: α, β, γ

(ii) Ionising power: γ, β, α

(iii) Biological effect: α, β, γ

(b)

(i) In a cathode ray tube, the anode not only accelerates the electrons but also focuses them in a fine energetic beam.

(ii) In a cathode ray tube, electrical energy is converted to light energy.

(iii) A cathode ray tube is used to investigate the wave form of an unknown alternating potential by applying it on the Y-plates and a known periodic time-base potential on the X-plates.

(c)

(i) In an unstable nucleus, the neutron is changed into a proton by emitting a beta particle. This is represented as

$$\underset{\text{(neutron)}}{{}^{1}_{0}n} \rightarrow \underset{\text{(proton)}}{{}^{1}_{1}p} + \underset{\text{(β–particle)}}{{}^{0}_{-1}e}$$

(ii) Elements with the same mass number but different atomic numbers are called isobars.

(iii) The nucleus of an atom tends to be radioactive when the number of neutrons in the nucleus exceeds the number of protons inside it.