# PHYSICS – Paper 2017 (Solved)

## SECTION I (40 Marks)

*Attempt **all** questions from this section*

### Question 1

*(a) 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]

**Ans.** In the adjacent Fig. 1, the force on the ball is the weight $W$ acting vertically downwards and the force on the thread is the tension $T$ upwards.

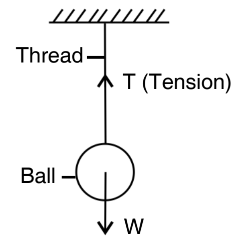



*Fig. 1*

(b) The distance between two bodies is doubled. How is the magnitude of gravitational force between them affected ? [2]

**Ans.** The gravitational force becomes one-fourth since it is inversely proportional to the square of the distance of separation (*i.e.*, $F \propto \frac{1}{d^2}$)

(c) Why is a jack screw provided with a long arm ? [2]

**Ans.** A jack screw is provided with a long arm so that a less force (or effort) may provide the sufficient moment of force to rotate it..

(d) If the power of a motor be 100 kW, at what speed can it raise a load of 50,000 N ? [2]

**Ans.** Given, power P = 100 kW = 100 × $10^3$ W, force F = 50,000 N

Power P = force F × speed $v$

$$\therefore \text{ Speed } v = \frac{P}{F} = \frac{100 \times 10^3}{50,000} = \mathbf{2\ m\ s^{-1}}.$$

(e) Which class of lever will always have M.A. > 1 and why ? [2]

**Ans.** The class II lever always has M.A. > 1 because it has the effort arm always longer than the load arm.

### Question 2

(a) Define heat capacity and state its S.I. unit. [2]

**Ans.** Heat capacity of a body is the amount of heat energy required to raise its temperature by 1 K.

Its S.I. unit is J $K^{-1}$ (joule per Kelvin).

(b) Why is the base of a cooking pan generally made thick ? [2]

**Ans.** By making base of a cooking pan thick, its heat capacity becomes large so it gets heated slowly and the food contents on it get sufficient heat for cooking.

(c) A solid of mass 50 g at 150°C is placed in 100 g of water at 11°C, when the final temperature recorded is 20°C. Find the specific heat capacity of the solid. (Specific heat capacity of water = 4·2 J g° $C^{-1}$). [2]

**Ans.** Mass of solid $m_1$ = 50 g, temperature of solid $t_1$ = 150°C, mass of water $m_2$ = 100 g, temperature of water $t_2$ = 10°C, temperature of mixture t = 20°C

$$\text{Heat lost by the solid } Q_1 = m_1 c_1 (t_1 - t)$$
$$= 50 \times c_1 \times (150 - 20) = 6500\, c_1 \text{ J}$$

* Not included in syllabus for 2020

$$\text{Heat gained by water} = m_2 \times c_2 \times (t - t_2)$$
$$= 100 \times 4{\cdot}2 \times (20 - 11) = 3780 \text{ J}$$

If there is no loss of heat, by the principle of calorimetry

$$\text{Heat lost by the solid} = \text{Heat gained by water}$$

or $$6500\, c_1 = 3780$$

∴ $$c_1 = \frac{3780}{6500} = 0{\cdot}582 \text{ J g}^{-1}\ {}^\circ\text{C}^{-1}.$$

(d) How is the refractive index of a material related to :

(i) real and apparent depth ?

(ii) velocity of light in vacuum or air and the velocity of light in a given medium ? **[2]**

**Ans.** (i) Refractive index $\mu = \dfrac{\text{Real depth}}{\text{Apparent depth}}$

(ii) Refractive index $\mu = \dfrac{\text{Speed of light in vacuum or air}}{\text{Speed of light in the given medium}}$

(e) State the conditions required for total internal reflection of light to take place. **[2]**

**Ans.** (1) The light must travel from a denser medium to a rarer medium.

(2) The angle of incidence of light in the denser medium must be greater than the critical angle for that pair of media.

***Question 3***

(a) Draw a ray diagram to show the refraction of a monochromatic ray through a prism when it suffers minimum deviation. **[2]**

**Ans.** Fig. 2 shows the refraction of a monochromatic ray of light through a prism in the position of minimum deviation. The refracted ray QR is parallel to the base BC of the prism or angle of incidence $i$ = angle of emergence $e$.

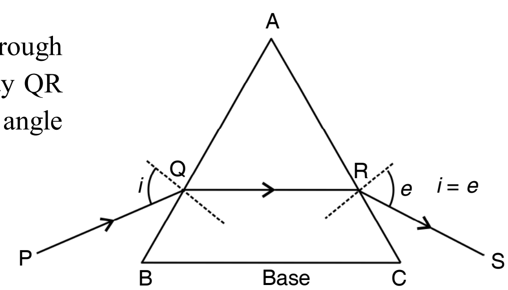



*Fig. 2*

(b) The human ear can detect continuous sounds in the frequency range from 20 Hz to 20,000 Hz. Assuming that the speed of sound in air is 330 m s$^{-1}$ for all frequencies, calculate the wavelength corresponding to the given extreme frequencies of the audible range. **[2]**

**Ans.** Given, $V = 330$ m s$^{-1}$, $f_{min} = 20$ Hz, $f_{max} = 20{,}000$ Hz

From relation $V = f\lambda$,

$$\lambda_{min} = \frac{V}{f_{max}} = \frac{330}{20{,}000} = 1{\cdot}65 \times 10^{-2} \text{ m} \text{ or } \mathbf{16{\cdot}5 \text{ mm}}$$

and $$\lambda_{max} = \frac{V}{f_{min}} = \frac{330}{20} = \mathbf{16{\cdot}5 \text{ m}}$$

Thus audible range of wavelength is from **16·5 mm to 16·5 m**.

(c) An enemy plane is at a distance of 300 km from a radar. In how much time the radar will be able to detect the plane ? Take velocity of radio waves as $3 \times 10^8$ m s$^{-1}$. **[2]**

**Ans.** Given, distance $d = 300$ km, velocity $V = 3 \times 10^8$ m s$^{-1}$, If it takes time $t$ for the signal to go up to the enemy plane and then come back, then

$$V = \frac{2d}{t} \text{ or } t = \frac{2d}{V} = \frac{2 \times (300 \times 10^3 \text{ m})}{3 \times 10^8 \text{ m s}^{-1}} = \mathbf{2 \times 10^{-3} \text{ s}}$$

(d) How is the frequency of a stretched string related to :

(i) its length ? (ii) its tension ? **[2]**

**Ans.** (i) Frequency is inversely proportional to its length *i.e.* $f \propto \frac{1}{l}$.

(ii) Frequency is directly proportional to the square root of the tension *i.e.* $f \propto \sqrt{T}$.

(e) Define specific resistance and state its S.I. unit. **[2]**

**Ans.** The specific resistance of a material is the resistance between the two opposite faces of cube of that material of each side 1 metre. Its S.I. unit is ohm × metre (or Ω m).

## *Question 4*

(a) An electric bulb of resistance 500 Ω, draws a current of 0·4 A. Calculate the power of the bulb and the potential difference at its ends. **[2]**

**Ans.** Given, $R = 500\ \Omega$, $I = 0{\cdot}4$ A.

Power of bulb $P = I^2R = (0{\cdot}4)^2 \times 500 = 80$ W.

Potential difference at the ends of the bulb $V = IR = 0{\cdot}4 \times 500 = 200\ V$.

(b) State *two* causes of energy loss in a transformer. **[2]**

**Ans.** (1) Heating loss in the wire of primary and secondary coils.

(2) Hysteresis loss in the core of the transformer due to its magnetisation and demagnetisation in each cycle.

*(c) State *two* characteristics of a good thermion emitter. **[2]**

**Ans.** (i) Its melting point must be high.

(ii) Its work function must be low.

*(d) State *two* factors upon which the rate of emission of thermions depends. **[2]**

**Ans.** (i) The temperature of the emitter.

(ii) The surface area of the emitter.

(e) When does the nucleus of an atom tend to be radioactive ? **[2]**

**Ans.** The nucleus of an atom tends to be radioactive when the number of neutrons inside it becomes more than the number of protons in it.

## SECTION II (40 Marks)

*Attempt any **four** questions from this section*

## *Question 5*

(a) 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.

(i) Draw a diagram of the arrangement.

(ii) What is the weight of the half metre rule ? **[3]**

**Ans.** (i) The arrangement is shown in Fig. 3.

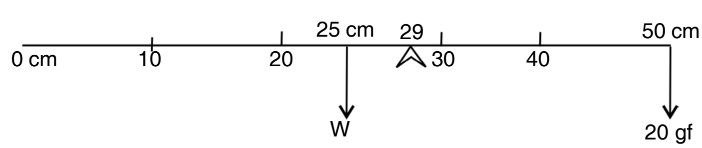



*Fig. 3*

(ii) If W gf is the weight of half metre rule, by the principle of moments,

$$W \times (29 - 25) = 20 \times (50 - 29)$$

or $W \times 4 = 20 \times 21$ or W = **105 gf**

* Not included in syllabus for 2020

(b) (i) 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.

(ii) How does uniform circular motion differs from uniform linear motion ?

(iii) Name the process used for producing electricity using nuclear energy. **[3]**

**Ans.** (i) $\frac{\text{Effort applied by the boy using fixed pulley}}{\text{Effort applied by the boy using movable pulley}} = \frac{2}{1}$

**Reason :** Mechanical advantage of a single movable pulley is 2 while that of a single fixed pulley is 1.

(ii) A uniform circular motion is an accelerated motion with constant speed but variable velocity while a uniform linear motion is with zero acceleration in which both the speed and velocity are constant.

(iii) The process of releasing nuclear energy is the **nuclear fission** of uranium – 235 by slow neutrons.

(c) 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. ($g = 10\ \text{N kg}^{-1}$).

Calculate :

(i) Distance moved by the effort.

(ii) Work done by the effort.

(iii) M.A. of the pulley system.

(iv) Efficiency of the pulley system. **[4]**

**Ans.** Given, V.R. = 4, L = 175 kgf, $d_L = 15$ m, E = 50 kgf

(i) $$\text{V.R.} = \frac{d_E}{d_L}$$

$$\therefore \quad d_E = d_L \times \text{V.R.} = 15 \times 4 = \mathbf{60\ m}$$

(ii) $$\text{Work done by the effort} = E \times d_E$$
$$= (50 \times 10\ \text{N}) \times 60\ \text{m} = \mathbf{3 \times 10^4\ J}$$

(iii) $$\text{M.A.} = \frac{L}{E} = \frac{175\ \text{kgf}}{50\ \text{kgf}} = \mathbf{3{\cdot}5}$$

(iv) $$\text{Efficiency } \eta = \frac{\text{M.A.}}{\text{V.R.}} = \frac{3{\cdot}5}{4} = \mathbf{0{\cdot}875 \text{ or } 87{\cdot}5\%}$$

## *Question 6*

(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 J $\text{kg}^{-1}{}^\circ\text{C}^{-1}$, 380 J $\text{kg}^{-1}{}^\circ\text{C}^{-1}$ and 460 J $\text{kg}^{-1}{}^\circ\text{C}^{-1}$ respectively, to make a calorimeter. Which material will you select ? Justify your answer. **[3]**

**Ans.** (i) To prevent heat transference by radiation, the walls of calorimeter are polished and made smooth from inside as well as outside.

(ii) For calorimeter, metal B will be used.

**Reason :** Its specific heat capacity is lowest, so it will take least heat from its contents to acquire the temperature of contents.

(b) Calculate the mass of ice needed to cool 150 g of water contained in a calorimeter of mass 50 g at 32°C such that the final temperature is 5°C. Specific heat capacity of calorimeter = 0·4 J $\text{g}^{-1}\ {}^\circ\text{C}^{-1}$, specific heat capacity of water = 4·2 J $\text{g}^{-1}\ {}^\circ\text{C}^{-1}$, latent heat capacity of ice = 330 J $\text{g}^{-1}$. **[3]**

**Ans.** Given, mass of water $m_1$ = 150 g, mass of calorimeter $m_2$ = 50 g, temperature of water $t_1$ = 32°C,

final temperature $t$ = 5°C.

Let $m$ be the mass of ice added

$$\text{Heat given by calorimeter } Q_1 = m_2\, c_2 \times (t_1 - t)$$
$$= 50 \times 0{\cdot}4 \times (32 - 5) = 540 \text{ J}$$
$$\text{Heat given by water } Q_2 = m_1 \times c_1 \times (t_1 - t)$$
$$= 150 \times 4{\cdot}2 \times (32 - 5) = 17010 \text{ J}$$
$$\text{Heat taken by ice to melt at } 0°\text{C} = mL = m \times 330 = 330\, m \text{ J}$$

and heat taken by iced water to raise its temperature to 5°C

$$= m \times 4{\cdot}2 \times (5 - 0) = 21\, m \text{ J}$$

$\therefore$ Total heat taken by ice = $330\, m + 21\, m = 351\, m$ J

By principle of calorimetry, if there is no less of heat,

$$351\, m = 540 + 17010$$

or $$m = \frac{17550}{351} = \mathbf{50\ g}$$

(c) (i) Name the radiations which are absorbed by greenhouse gases in the earth's atmosphere.

(ii) A radiation X is focused by a particular device on the bulb of a thermometer and mercury in the thermometer shows a rapid increase. Name the radiation X.

(iii) Name *two* factors on which the heat energy liberated by a body depends. **[4]**

**Ans.** (i) The greenhouse gases in the earth's atmosphere absorb the low energy infrared radiations.

(ii) Infrared radiation.

(iii) The two factors are (1) material of the body and (2) temperature of the body.

### *Question 7*

(a) A lens forms an upright and diminished image of an object when the object is placed at the focal point of the given lens.

(i) Name the lens.

(ii) Draw a ray diagram to show the image formation. **[3]**

**Ans.** (i) The lens is **concave**.

(ii) The ray diagram showing the image formation is show in in Fig. 4.

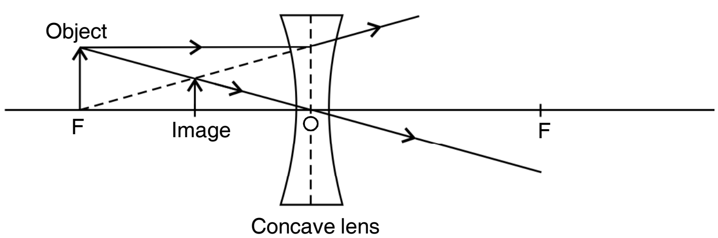



*Fig. 4*

(b) A ray of light travels from water to air as shown in Fig. 5.

(i) Copy the diagram and complete the path of the ray. Given that the critical angle for water is 48°.

(ii) State the condition so that total internal reflection occurs in the above diagram. **[3]**

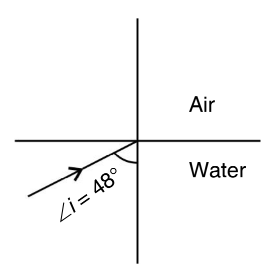



*Fig. 5*

**Ans.** (i) Fig. 6 showns the path of the ray AO after refraction as OB.

(ii) For total internal reflection, the angle of incidence $i$ of incident ray AO must be more than 48° (*i.e.* $\angle i > 48°$).

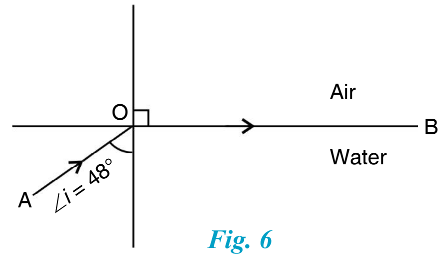



*Fig. 6*

(c) 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.

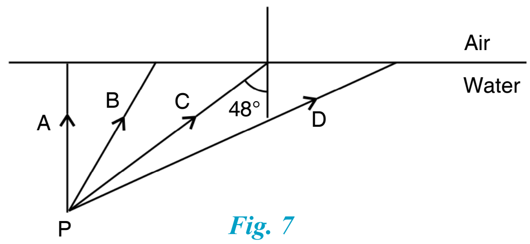



*Fig. 7*

(i) Show in the diagram the path of these rays after striking the water surface. The critical angle for water-air surface is 48°.

(ii) Name the phenomenon which the rays B and D exhibit. **[4]**

**Ans.** (i) The ray diagram is shown in Fig. 8.

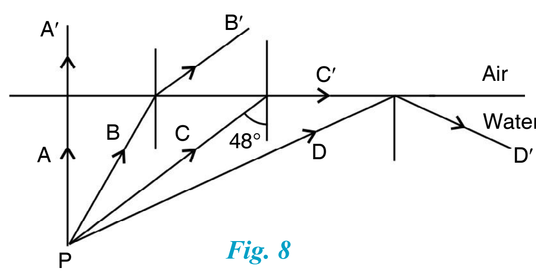



*Fig. 8*

(ii) The ray B exhibits refraction while the ray D exhibits total internal reflection.

### *Question* 8

(a) Name the factor that determines :

(i) Loudness of the sound heard.

(ii) Quality of the note.

(iii) Pitch of the note. **[3]**

**Ans.** (i) The amplitude of wave determines the loudness of the sound heard.

(ii) The wave form determines the quality of the note.

(iii) The frequency of wave determines the pitch of the note.

(b) (i) What are damped vibrations ?

(ii) Give *one* example of damped vibrations.

(iii) 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. **[3]**

**Ans.** (i) The vibrations of a body in the presence of frictional force are called damped vibrations.

(ii) The vibrations of a simple pendulum in air is an example of damped vibrations.

(iii) On keeping the stem of a vibrating turning fork pressed on the surface of a table, forced vibrations are produced on the surface of table which cause a loud sound.

(c) (i) A wire of length 80 cm has a frequency of 256 Hz. Calculate the length of a similar wire under similar tension which will have frequency 1024 Hz.

(ii) A certain sound has a frequency of 256 hertz and a wavelength of 1·3 m.

(a) Calculate the speed with which this sound travels.

(b) What difference would be felt by a listener between the above sound and another sound travelling at the same speed, but of wavelength 2·6 m ? **[4]**

**Ans.** (i) Given $l_1 = 80$ cm, $f_1 = 256$ Hz, $f_2 = 1024$ Hz, $l_2 = ?$

Since $f \propto \frac{1}{l}$ $\therefore f_1 l_1 = f_2 l_2$ or $f_2 = \frac{f_1 l_1}{f_2} = \frac{256 \times 80}{1024} =$ **20 cm**

(ii) Given, $f = 256$ Hz, $\lambda = 1{\cdot}3$ m

(a) From $V = f\lambda$, $V = 256 \times 1{\cdot}3 = 332{\cdot}8$ m s$^{-1}$.

(b) $V = 332{\cdot}8$ m s$^{-1}$, $\lambda = 2{\cdot}6$ m

$\therefore f = \frac{V}{\lambda} = \frac{332{\cdot}8}{2{\cdot}6} = 128$ Hz

Thus to the listener the sound of wavelength 1·3 m will appear to be shriller than the sound of wavelength 2·6 m.

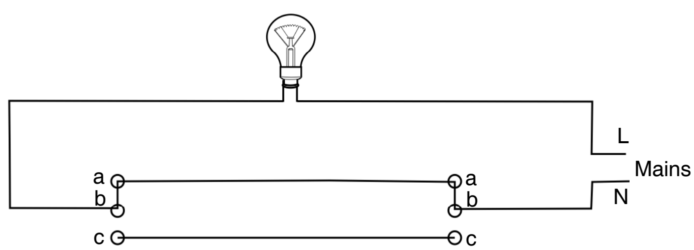
## *Question 9*

(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'. **[3]**

**Ans.** (i) **Green**.

(ii) Fig. 9 shows the dual control switch in ON condition.




(b) (i) Which particles are responsible for flow of 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 ? **[3]**

**Ans.** (i) **Free electrons** are responsible for flow of current in conductors.

(ii) **Earth wire** (green) is connected to the metal case of a geyser.

(iii) The fuse is connected to the live wire (red or brown).

(c) (i) Explain the meaning of the statement 'current rating of a fuse is 5 A'.

(ii) In the transmission of power the voltage of power generated at the generating station is stepped up from 11 kV to 132 kV before it is transmitted. Why ? **[4]**

**Ans.** (i) Current rating of a fuse is 5 A, implies that if the current in a circuit having this fuse in the live wire exceeds 5 A, it blows off and the circuit becomes incomplete without damaging the appliance connected in that circuit.

(ii) The power generated at the generating station is stepped up from 11 kV to 132 kV before transmission so as to reduce the magnitude of current to $\frac{1}{12}$th of its value so that the heating loss of power in the line wires used for transmission are reduced [since heat produced $\propto$ (current)$^2$].

## *Question* 10

*(a) Answer the following questions based on a hot cathode ray tube.

(i) Name the charged particles.

(ii) State the approximate voltage used to heat the filament.

(iii) What will happen to the beam when it passes through the electric field ? **[3]**

**Ans.** (i) Cathode rays (or electrons).

(ii) 6 volt.

(iii) The beam will deflect towards the positive plate.

*(b) State *three* factors on which the rate of emission of electrons from a metal surface depends. **[3]**

**Ans.** (i) Work function of the metal.

(ii) The temperature of the metal surface.

(iii) The surface area of the metal.

*(c) (i) What are free electrons ?

(ii) Why do they not leave the metal surface on their own ?

(iii) How can they be made to leave the meal surface ? (State any *two* ways). **[4]**

**Ans.** (i) The loosely bound outer most electrons of atoms in a metal which leave their atoms and become free to move inside the metal, are called free electrons.

(ii) The free electrons can move in a random manner inside the metal but they do not have sufficient kinetic energy to leave the metal surface.

(iii) The free electrons can be made to leave the metal surface by imparting energy from outside either.

(1) by heating in thermionic emission, or

(2) by making the ultraviolet radiations incident on it in photoelectric effect.

* Not included in syllabus for 2020