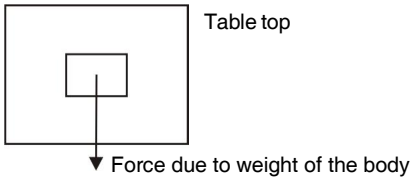
PHYSICS – Paper 2015 (Solved)

SECTION I (40 Marks)

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

Question 1

*(a) In the diagram below, when a body is placed on a table top, it exerts a force equal to its weight downwards on the table top but does not move or fall.



(i) Name the force exerted by the table top.

(ii) What is the direction of the force ? **[2]**

Ans. (i) Force of reaction of weight.

(ii) Vertically upwards.

(b) (i) Name *one* factor that affects the lateral displacement of light as it passes through a rectangular glass slab.

(ii) On reversing the direction of the current in a wire, the magnetic field produced by it gets ..... **[2]**

Ans. (i) Thickness of glass slab.

(ii) On reversing the direction of the current in a wire, the magnetic field produced by it gets **reversed**.

(c) (i) On what factor does the position of centre of gravity of a body depend ?

(ii) What is the S.I. unit of moment of force. **[2]**

Ans. (i) On the distribution of mass in the body.

(ii) The S.I. unit is N m (newton metre).

(d) Name the factors affecting the turning effect of a body. **[2]**

Ans. The turning effect of body depends on

(i) magnitude of the force applied

(ii) perpendicular distance of the line of action of force from the axis of rotation of the body.

(e) (i) Define equilibrium.

(ii) In a beam balance when the beam is balanced in a horizontal postion, it is in ..... equilibrium. **[2]**

Ans. (i) When a number of forces acting on a body produce no change in its state of rest or of motion (linear or rotational), the body is said to be in equilibrium.

(ii) In a beam balance when the beam is balanced in a horizontal position, it is in **static** equilibrium.

Question 2

(a) How is the work done by a force measured when the force :

(i) is in the direction of displacement

(ii) is at an angle to the direction of displacement. **[2]**

Ans. (i) It is equal to the product of force and displacement (*i.e.*, $W = F \times S$).

(ii) It is equal to the product of force, displacement and cosine of angle between the force and displacement (*i.e.*, $W = F \times S \times \cos \theta$).

(b) State the energy changes in the following while in use

(i) burning of a candle.

(ii) a steam engine. **[2]**

Ans. (i) Chemical energy to light and heat energy

(ii) Heat energy to mechanical (or kinetic) energy.

* Not included in syllabus for 2019

(c) (i) A scissor is a ..... multiplier.

(ii) 1 kWh = ... J. **[2]**

Ans. (i) A scissor is a **speed** multiplier.

(ii) 1 kWh = **$3{\cdot}6 \times 10^6$ J**

(d) Explain the motion of a planet around the sun in a circular path. **[2]**

Ans. The gravitational force of attraction of sun on the planet provides the necessary centripetal force required for the circular motion.

(e) Rajan exerts a force of 150 N in pulling a cart at a constant speed of 10 m s^{-1}. Calculate the power exerted. **[2]**

Ans. Given, $F = 150$ N, $v = 10$ m s^{-1}

Power = $F \times v = 150 \times 10 = 1500$ J s^{-1} or 1500 W

Question 3

*(a) (i) Give the expression for the mechanical advantage of an inclined plane in terms of length of an inclined plane.

(ii) Name a common device where a gear train is used. **[2]**

Ans. (i) For an inclined plane, mechanical advantage = $\frac{\text{length of the plane}}{\text{height of the plane}}$ $\left(\text{or M.A.} = \frac{l}{h}\right)$.

(ii) Clock (or watch) makes use of a gear train.

(b) The speed of light in glass is 2×10^5 km s^{-1}. What is the refractive index of glass ? **[2]**

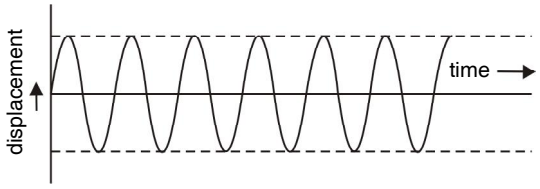
Ans. Speed of light in glass = 2×10^5 km $s^{-1} = 2 \times 10^8$ m s^{-1}

Refractive index of glass = $\frac{\text{speed of light in vacuum}}{\text{speed of light in glass}} = \frac{3 \times 10^8 \text{ m s}^{-1}}{2 \times 10^8 \text{ m s}^{-1}}$ = **1·5**

(c) (i) Draw a graph between the displacement and the time for a body executing free vibrations.

(ii) Where can a body execute free vibrations ? **[2]**

Ans. (i) Displacement-time for free vibrations graph is given below :



(ii) A body can execute free vibrations in vacuum.

(d) (i) What happens to the resistivity of semiconductors with the increase in temperature ?

(ii) For a fuse, higher the current rating ..... is the fuse wire. **[2]**

Ans. (i) The resistivity of semiconductors decreases with the increase in temperature.

(ii) For a fuse, higher the current rating **thicker** is the fuse wire.

(e) (i) Name the high energetic invisible electromagnetic waves which help in the study of the structure of crystal.

(ii) State an additional use of the waves mentioned in part (e) (i). **[2]**

Ans. (i) X-rays.

(ii) For detecting the fracture in bones.

Question 4

(a) Rishi is surprised when he sees water boiling at 115°C in a container. Give reasons as to why water can boil at the above temperature. **[2]**

Ans. The boiling point of water increases with the increase in pressure. When water is boiled in a closed container and vapours are not allowed to escape out of it, due to vapour pressure the pressure on water surface becomes higher than the atmospheric pressure and it boils at 115°C.

* Not included in syllabus for 2019

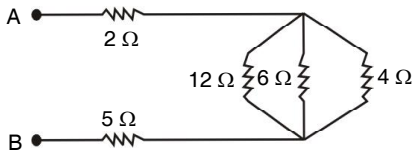
(b) (i) Why does a current carrying, freely suspended solenoid rest along a particular direction ?

(ii) State the direction in which it rests. **[2]**

Ans. (i) A current carrying solenoid behaves like a bar magnet. When it is freely suspended, it rests in the direction of the magnetic field of earth.

(ii) It rests along the north-south direction.

(c) Find the equivalent resistance between the points A and B. **[2]**



Ans. Resistance of 12 Ω, 6 Ω and 4 Ω are in parallel, therefore their equivalent resistance R_p is given by

$$\frac{1}{Rp} = \frac{1}{12} + \frac{1}{6} + \frac{1}{4} = \frac{6}{12} \quad \therefore R_p = \frac{12}{6} = 2\ \Omega$$

Now resistance of 2 Ω, R_p (= 2 Ω) and 5 Ω are in series therefore equivalent resistance between A and B is

$$R = 2 + R_p + 5 = 2 + 2 + 5 = \mathbf{9\ \Omega}$$

(d) Give *two* similarities between an A.C. generator and a D.C. motor. **[2]**

Ans. 1. Both transform energy from one form to the other.

2. In both devices, a coil rotates in a magnetic field.

*(e) (i) Why is a cathode ray tube evacuated to a low pressure ?

(ii) What happens if the negative potential is changed on the grid ? **[2]**

Ans. (i) The tube is evacuated to a low pressure so that there are no more air molecules and the electrons may move without collisions with them.

(ii) By changing the negative potential on the grid, the brightness of pattern on the screen changes.

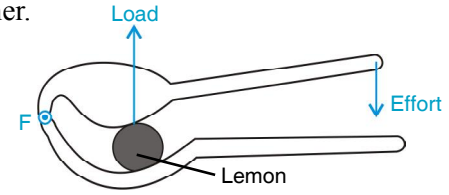
SECTION II (40 Marks)

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

Question 5

(a) Draw a simplified diagram of a lemon crusher, indicating the direction of load and effort. **[2]**

Ans. The diagram below shows a leman crusher.



(b) (i) Name the physical quantity measured in terms of horse power.

(ii) A nut is opened by a wrench of length 20 cm. If the least force required is 2 N, find the moment of force needed to loosen the nut.

(iii) Explain briefly why the work done by a fielder when he takes a catch in a cricket match, is negative. **[4]**

Ans. (i) **Power** is measured in the unit horse power (H.P.)

(ii) Force needed = 2 N, length of lever = 20 cm = 0·2 m.

$\therefore$ Moment of force = force × distance

= 2 × 0·2 = **0·4 N m**

(iii) When a fielder stops the ball, the force F applied by the fielder is in direction opposite to the direction of motion of the ball (*i.e.*, displacement), so the work done by the fielder is negative.

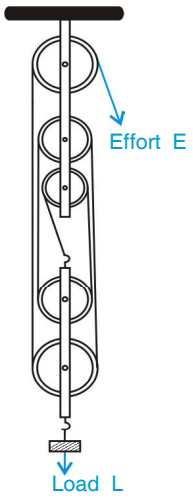
* Not included in syllabus for 2019

(c) A block and tackle system has V.R. = 5.

(i) Draw a neat labelled diagram of a system indicating the direction of its load and effort.

(ii) Rohan exerts a pull of 150 kgf. What is the maximum load he can raise with his pulley system if its efficiency = 75%. **[4]**

Ans. (i) The diagram of block and tackle with V.R. = 5, is shown below :



(ii) Given, V.R. = 5, L = ? efficiency $\eta = 75\% = 0{\cdot}75$, $E = 150$ kgf

$$\text{M.A.} = \eta \times \text{V.R.} = 0{\cdot}75 \times 5 = 3{\cdot}75$$

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

$\therefore$ $$L = E \times \text{M.A.} = 150 \text{ kgf} \times 3{\cdot}75 = \mathbf{562{\cdot}5 \text{ kgf}}$$

Thus Rohan can lift a load of 562·5 kgf.

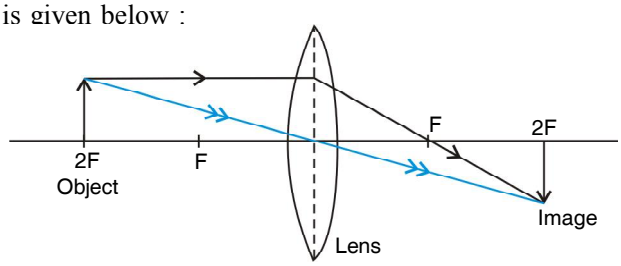
Question 6

(a) (i) Where should an object be placed so that a real and inverted image of the same size as the object is obtained using a convex lens ?

(ii) Draw a ray diagram to show the formation of the image as specified in part a (i). **[3]**

Ans. (i) Object should be placed in front of the lens at a distance twice the focal length from its optical centre.

(ii) The ray diagram is given below :



(b) (i) Why does the sun appear red at sunrise ?

(ii) Name the subjective property of light related to its wavelength. **[3]**

Ans. (i) It is due to the phenomenon of scattering of light. In the morning, light travels a longer distance in the atmosphere before reaching the observer. Since shorter wavelength gets more scattered therefore most of the violet and its adjacent colours are lost by scattering and light reaching the observer is highly rich in red colour.

(ii) **Colour** is the subjective property of light related to its wavelength.

(c) Jatin puts a pencil into a glass container having water and is surprised to see the pencil in a different state.

(i) What change is observed in the appearance of the pencil ?

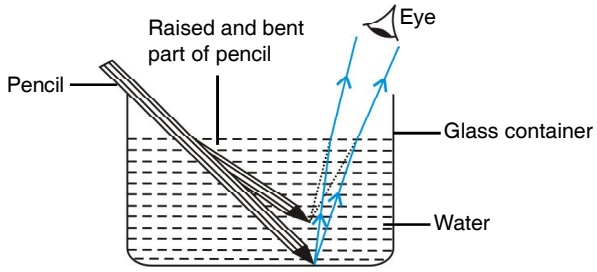
(ii) Name the phenomenon responsible for the change.

(iii) Draw a ray diagram showing how the eye sees the pencil. **[4]**

Ans. (i) The immersed part of the pencil appears raised and bent at the water surface inside the glass container.

(ii) The bending is due to the phenomenon of **refraction of light**.

(iii) The diagram below shows the ray diagram.



Question 7

(a) (i) State the safe limit of sound level in terms of decibel for human hearing.

(ii) Name the characteristic of sound in relation to its waveform. **[2]**

Ans. (i) For human beings, the safe limit of hearing sound is in the range of 0 to 80 dB.

(ii) The **quality** of sound depends on waveform.

(b) A person standing between two vertical cliffs and 480 m from the nearest cliff shouts. He hears the first echo after 3 s and the second echo 2 s later. Calculate :

(i) the speed of sound, and

(ii) the distance of the other cliff from the person. **[3]**

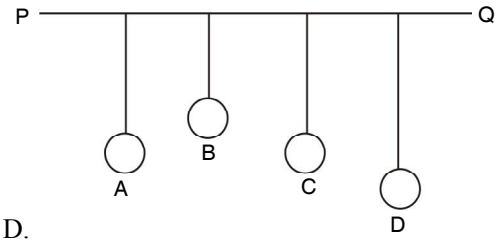
Ans. (i) The first echo from the nearest cliff at 480 m is heard after 3 s. Therefore $d = 480$ m, $t = 3$ s.

$$\text{Speed of sound } V = \frac{2d}{t} = \frac{2 \times 480\ \text{m}}{3\ \text{s}} = 320\ \text{m s}^{-1}$$

(ii) Since the echo from the other cliff reaches after 3 + 2 = 5 s hence $t = 5$ s, $V = 320$ m s^{-1}.

$$\therefore \text{ Distance of the other cliff } d = \frac{Vt}{2} = \frac{320 \times 5}{2} = \mathbf{800\ m}.$$

(c) In the diagram shown alongside A, B, C and D are four pendulums suspended from the same elastic string PQ. The length of A and C are equal to each other, while the length of pendulum B is smaller than that of D. Pendulum A is set into a mode of vibrations.



(i) Name the type of vibrations taking place in pendulums B and D.

(ii) What is the state of pendulum C ?

(iii) State the reason for the type of vibrations in pendulums B and C. **[5]**

Ans. (i) **Forced vibrations** are executed by the pendulums B and D.

(ii) Pendulum C is in the state of **resonance** with the pendulum A.

(iii) Since the length of pendulum B is less than that of A so its natural frequency of vibration is more than that of the pendulum A, therefore it vibrates only due to vibrations forced by A. On the other hand, the pendulum C has same frequency as of A, therefore the energy from pendulum A is quickly transferred to C and it vibrates with the increasing amplitude and is in the state of resonance with A.

Question 8

(a) (i) Name the device used to increase the voltage at a generating station.

(ii) At what frequency is A.C. supplied to residential houses ?

(iii) Name the wire in a household electrical circuit to which the switch is connected. **[3]**

Ans. (i) **Step-up transformer** is used to increase the voltage.

(ii) At frequency 50 Hz.

(iii) Switch is connected to **live wire** of the circuit.

(b) The relationship between the potential difference and the current in a conductor is stated in the form of a law.

(i) Name the law.

(ii) What does the slope of V–I graph for a conductor represent ?

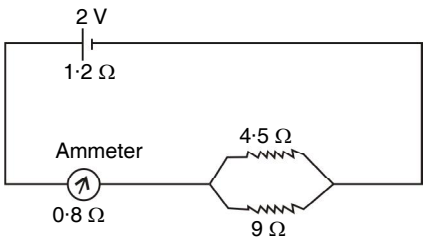
(iii) Name the material used for making the connecton wires. **[3]**

Ans. (i) Relationship between potential difference and current is given by **Ohm's law**.

(ii) The slope of the V–I graph gives the resistance of the conductor.

(iii) The connection wires are made from **copper**.

(c) A cell of emf 2 V and internal resistance 1·2 Ω is connected with an ammeter of resistance 0·8 Ω and two resistors of 4·5 Ω and 9 Ω as shown in the diagram alongside.



(i) What would be the reading of the ammeter ?

(ii) What is the potential difference across the terminals of the cell ? **[3]**

Ans. (i) Resistance of 4·5 Ω and 9·0 Ω are connected in parallel hence their equivalent resistance R_p is given by

$$\frac{1}{R_p} = \frac{1}{4{\cdot}5} + \frac{1}{9} = \frac{3}{9} \quad \text{or} \quad R_p = \frac{9}{3} = 3\ \Omega$$

Now R_p (= 3 Ω), internal resistance 1·2 Ω and resistance of ammeter 0·8 Ω are in series

$\therefore$ Total resistance = 3 Ω + 1·2 Ω + 0·8 Ω = 5 Ω

$\therefore$ Current in the ammeter $I = \dfrac{\text{e.m.f.}}{\text{total resistance}} = \dfrac{2}{5} =$ **0·4 A**

(ii) Potential difference across the terminals of the cell $V = \varepsilon - Ir$

$= 2 - 0{\cdot}4 \times 1{\cdot}2 =$ **1·52 V**

Question 9

(a) *(i) Name a gas caused by the green house effect.

(ii) Which property of water makes it an effective coolant ? **[2]**

Ans. (i) Carbon dioxide causes green house effect.

(ii) The high specific heat capacity of water makes it an effective coolent.

(b) (i) Water in lakes and ponds do not freeze at once in cold countries. Give a reason in support of your answer.

(ii) What is the principle of calorimetry ?

(iii) Name the law on which this principle is based.

(iv) State the effect of an increase of impurities on the melting point of ice. **[4]**

Ans. (i) Water has high specific latent heat of fusion so it has to liberate a large amount of heat to the surroundings for freezing. Hence it does not freeze all at once.

(ii) According to the principle of calorimetry, when two bodies at different temperatures are mixed, heat flows from a body at high temperature to the body at low temperature till both acquire the same temperature.

Heat lost by the hot body = Heat gained by the cold body, when there is no loss of heat to the surrounding.

* Not included in syllabus for 2019

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

(iv) The melting point of ice decreases on adding the impurities in it.

(e) A refrigerator converts 100 g of water at 20°C to ice at –10°C in 35 minutes. Calculate the average rate of heat extraction in terms of watt.

Given : Specific heat capacity of ice = 2·1 J g^{-1} $°C^{-1}$.

Specific heat capacity of water = 4·2 J g^{-1} $°C^{-1}$.

Specific latent heat of fusion of ice = 336 J g^{-1}. **[4]**

Ans. Heat extracted in converting 100 g of water from 20°C to 0°C = $m\ c_{water}\ \Delta t = 100 \times 4{\cdot}2 \times (20 - 0) = 8400$ J.

Heat extracted in converting 100 g of water at 0°C to 100 g ice at 0°C = $m\ L = 100 \times 336 = 33600$ J

Heat extracted in converting 100 g ice at 0°C to –10°C = $m\ c_{ice}\ \Delta t = 100 \times 2{\cdot}1 \times [0 - (-10)] = 2100$ J

$\therefore$ Total heat extracted = 8400 + 33600 + 2100 = 44100 J

$$\therefore \text{Average rate of heat extraction} = \frac{\text{total heat extracted}}{\text{time taken}}$$

$$= \frac{44100\ \text{J}}{35 \times 60\ \text{s}} = 21\ \text{J s}^{-1} = \mathbf{21\ W}$$

Question 10

*(a) (i) What is thermionic emission ?

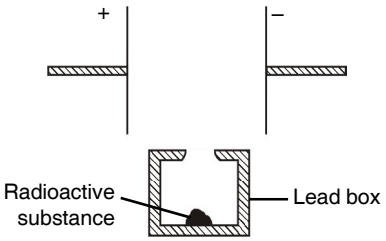
(ii) Name the unit in which the work function of the metal is expressed ? **[2]**

Ans. (i) The emission of electrons from the surface of a metal when heat energy is given to it, is called thermionic emission.

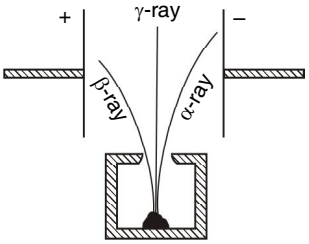
(ii) **Electron-volt (eV)** is the unit of expressing of work function of a metal.

(b) (i) Complete the diagram as given alongside by drawing the deflection of radioactive radiations in an electric field.

(ii) State any *two* precautions to be taken while handling the radioactive substances. **[5]**



Ans. (i) The completed diagram is given below.



(ii) The persons handling the radioactive substance should (1) put on special lead lined aprons and lead gloves.
(2) handle the radioactive substance with long lead tongs.

(c) An atomic nucleus A is composed of 84 protons and 128 neutrons.

(i) The nucleus A emits an alpha particle and is transformed into a nucleus B. What is the composition of the nucleus B ?

(ii) The nucleus B emits a beta particle and is transformed into a nucleus C. What is the composition of nucleus C ?

(iii) Does the composition of nucleus C change if it emits gamma radiations ? **[3]**

Ans. (i) Nucleus B has 82 protons and 126 neutrons.

(ii) Nucleus C has 83 protons and 125 neutrons.

(iii) Composition of nucleus C does not change on emission of gamma radiations.

* Not included in syllabus for 2019