PHYSICS – Paper 2014 (Solved)

SECTION I (40 Marks)

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

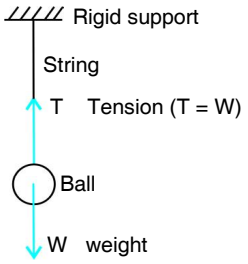
Question 1

*(a) A force is applied on (i) a non-rigid body and (ii) a rigid body. How does the effect of the force differ in the above two cases ? **[2]**

Ans. A force applied on a non-rigid body can deform the body as well as it can cause motion in the body while a force applied on a rigid body can only cause motion in the body.

*(b) A metallic ball is hanging by a string from a rigid support. Draw a neat labelled diagram showing the forces acting on the ball and the string. **[2]**

Ans. Adjoining figure gives the labelled diagrams in which the weight W of the ball is acting downwards and tension T ($=W$) in string is acting upwards.



(c) *(i) What is the weight of a body placed at the centre of the earth ?

(ii) What is the principle of an ideal machine ? **[2]**

Ans. (i) Zero.

(ii) Work done by effort (input) = Work done by load (output).

(d) Is it possible to have an accelerated motion with a constant speed ? Explain. **[2]**

Ans. Yes. In uniform circular motion, speed remains constant but due to continuous change in direction of motion, velocity is variable *i.e.*, motion is accelerated.

(e) (i) When does a force do work ?

(ii) What is the work d1one by the moon when it revolves around the earth ? **[2]**

Ans. (i) When force causes displacement.

(ii) Zero.

Question 2

(a) Calculate the change in the kinetic energy of a moving body if its velocity is reduced to $\frac{1}{3}$rd of the initial velocity. **[2]**

Ans. Let initial kinetic energy, $K_i = \frac{1}{2}mv^2$

When velocity is reduced to $\frac{1}{3}$rd of initial velocity, then

final kinetic energy, $K_f = \frac{1}{2}m\left(\frac{v}{3}\right)^2 = \frac{K_i}{9}$

$\therefore$ change in kinetic energy, $K_i - K_f = \frac{8}{9}K_i$

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

(i) A loud speaker (b) A glowing electric bulb. **[2]**

Ans. (i) In a loud speaker, electrical energy changes to sound energy.

(ii) In a glowing bulb, electrical energy changes to heat and light energies.

(c) (i) What is nuclear energy ?

(ii) Name the process used for producing electricity using nuclear energy. **[2]**

Ans. (i) The energy released in a nuclear process due to loss in mass (conversion of mass into energy) is called nuclear energy.

(ii) Nuclear fission.

* Not included in syllabus for 2018

*(d) State *one* important advantage and disadvantage each of using nuclear energy for producing electricity. **[2]**

Ans. **Advantage** — A tremendous amount of energy is released even with a small mass of fuel.
Disadvantage — The waste obtained is very harmful.

(a) Complete the sentences :

(i) The conversion of part of the energy into an undesirable form is called ..... .

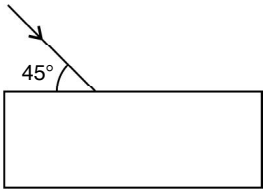
*(ii) For a given height *h*, ... the length *l* of the inclined plane, lesser will be the effort required. **[2]**

Ans. (i) The conversion of part of the energy into an undesirable form is called **degradation of energy** .

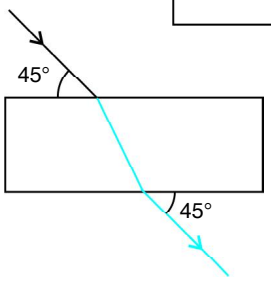
(ii) For a given height *h*, **more** the length *l* of the inclined plane, lesser will be the effort required.

Question 3

(a) Draw the diagram given alongside and clearly show the path taken by the emergent ray. **[2]**



Ans. The path taken by the emergent ray is shown alongside.
The emergent ray is parallel to the incident ray.



(b) (i) What is consumed using different electrical appliances, for which electricity bills are paid ?

(ii) Name a common device that uses electromagnets. **[2]**

Ans. (i) Electrical energy (ii) Electric bell.

(c) (i) A ray of light passes from water to air. How does the speed of light change ?

(ii) Which colour of light travels fastest in any medium except air ? **[2]**

Ans. (i) Increases (ii) Red.

(d) Name the factors affecting the critical angle for the pair of media. **[2]**

Ans. (i) Colour of light and (ii) refractive indices of media.

(e) (i) Name a prism required for obtaining a spectrum of ultraviolet light.

(ii) Name the radiations which can be detected by a thermopile. **[2]**

Ans. (i) Quartz prism. (ii) Infra red radiations.

Question 4

(a) Why is the colour red used as a sign of danger ? **[2]**

Ans. Red colour is scattered least by the air molecules, so it can be seen from a far distance even in fog.

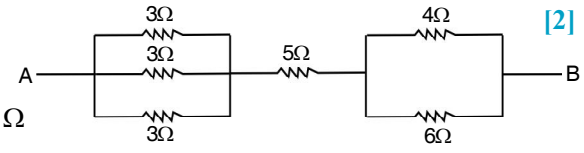
(b) (i) What are mechanical waves ?

(ii) Name *one* property of waves that do not change when the wave passes from one medium to another. **[2]**

Ans. (i) The waves produced due to vibrations of medium particles, in which there is mutual interchange in potential and kinetic energies, are called the mechanical waves.

(ii) Frequency of wave.

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



Ans. Equivalent resistance of 3 Ω, 3 Ω and 3 Ω connected in parallel be R_{p_1} where $\frac{1}{R_{p_1}} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3}$ or $R_{p_1} = 1\ \Omega$

* Not included in syllabus for 2018

Equivalent resistance of 4 Ω and 6 Ω connected in parallel be R_{p_2} where $\frac{1}{R_{p_2}} = \frac{1}{4} + \frac{1}{6} = \frac{5}{12}$ or $R_{p_2} = \frac{12}{5} = 2{\cdot}4\ \Omega$

∴ Equivalent resistance between A and B (series combination of $R_{p_1} = 1\ \Omega$, 5 Ω and $R_{p_2} = 2{\cdot}4\ \Omega$) is

$$R = 1 + 5 + 2{\cdot}4 = 8{\cdot}4\ \Omega$$

(d) 50g of metal piece at 27°C requires 2400 J of heat energy so as to attain a temperature of 327°C. Calculate the specific heat capacity of the metal ? **[2]**

Ans. Specific heat capacity $c = \frac{\text{Heat required}}{\text{Mass} \times \text{Rise in temperature}} = \frac{2400\,\text{J}}{(\frac{50}{1000})\,\text{kg} \times (327 - 27)°\text{C}} = 160\ \text{J kg}^{-1}\ °\text{C}^{-1}$.

*(e) Complete the following :

An electron emitter must have ..... work function and ..... melting point. **[2]**

Ans. An electrons emitter must have **a low** work function and **high** melting point.

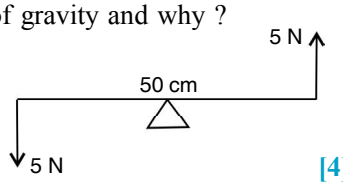
SECTION II (40 Marks)

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

Question 5

(a) (i) A man having a box on his head, climbs up a slope and another man having an identical box walks the same distance on a levelled road. Who does more work against the force of gravity and why ?

(ii) Two forces each of 5 N act vertically upwards and downwards respectively on the two ends of a uniform metre rule which is placed at its mid-point as shown in the diagram. Determine the magnitude of the moment of these forces about the midpoint. **[4]**



Ans. (i) The man who climbs up a slope does work against the force of gravity because his displacement is opposite the force of gravity while the man who walks on a levelled road does no work because his displacement is normal to the force of gravity.

(ii) Moment of forces = 5 N × 0·5 m + 5 N × 0·5 m

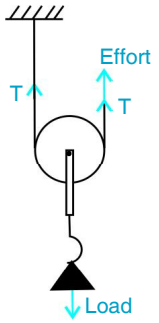
= 5 N m (anti-clockwise)

(b) (i) A body is thrown vertically upwards. Its velocity keeps on decreasing. What happens to its kinetic energy as its velocity becomes zero ?

(ii) Draw a diagram to shown how a single pulley can be used so as to have its ideal M.A. = 2. **[3]**

Ans. (i) Its kinetic energy changes to potential energy and when its velocity becomes zero, the potential energy is equal to the initial kinetic energy imparted to the body when it was thrown.

(ii) The diagram of a single movable pulley with M.A. = 2 is shown alongside.



(c) Derive a relationship between mechanical advantage, velocity ratio and efficiency of a machine. **[3]**

Ans. By definition, $\text{M.A.} = \frac{\text{Load}\,(L)}{\text{Effort}\,(E)}$

$$\text{Velocity ratio V.R.} = \frac{\text{Distance moved by effort}\,(d_E)}{\text{Distance moved by load}\,(d_L)}$$

* Not included in syllabus for 2018

$$\text{Efficiency } \eta = \frac{\text{Work done by load} = L \times d_L}{\text{Work done by effort} = E \times d_E} = \frac{L}{E} \times \frac{d_L}{d_E}$$

$$= \text{M.A.} \times \frac{1}{\text{V.R.}}$$

$$\therefore \quad \text{M.A.} = \eta \times \text{V.R.}$$

Question 6

(a) (i) Light passes through a rectangular glass slab and through a triangular glass prism. In what way does the direction of two emergent beams differ and why ?

(ii) Ranbir claims to have obtained an image twice the size of the object with a concave lens. Is he correct ? Give a reason for your answer. **[4]**

Ans. (i) When light passes through a rectangular glass slab, two refractions of light, first from air to glass and then from glass to air, occur at two parallel surfaces so the emergent ray is parallel to the incident ray, but it is slightly laterally displaced. But when light passes through a triangular glass prism, these refractions occur at two inclined surfaces, deviating the ray towards the base in each refraction, so the emergent ray is deviated towards the base of prism with respect to the incident ray.

(ii) No. Reason is that a concave lens diverges the incident rays, so the image is always diminished.

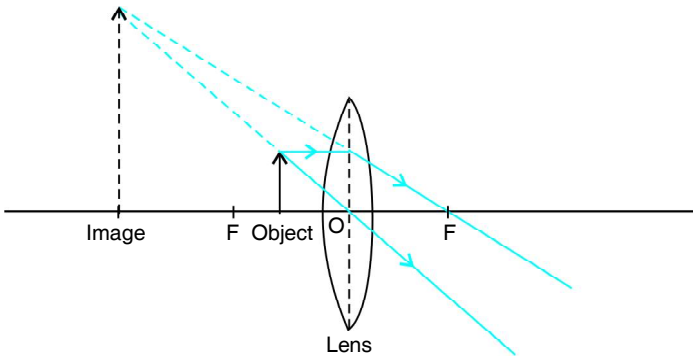
(b) A lens forms an erect, magnified and virtual image of an object.

(i) Name the lens.

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

Ans. (i) Convex lens.

(ii) The labelled ray diagram is given alongside.



(c) (i) Define the power of a lens.

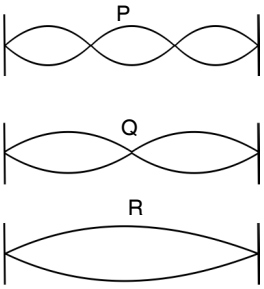
(ii) The lens mentioned in part (b) above is of focal length 25 cm. Calculate the power of the lens. **[3]**

Ans. (i) Power of a lens is its ability to deviate the incident ray of light. It is reciprocal of the focal length of lens.

(ii) $f = +25 \text{ cm} = 0{\cdot}25 \text{ m} \quad \therefore \quad P = \frac{1}{f} = \frac{1}{0{\cdot}25 \text{ m}} = 4{\cdot}0 \text{ D}$

Question 7

(a) The adjacent diagram shows three different modes of vibration P, Q and R of the same string.



(i) Which vibration will produce a louder sound and why ?

(ii) The sound of which string will have maximum shrillness.

(iii) State the ratio of wavelength of P and R. **[4]**

Ans. (i) *R* because its amplitude is maximum.

(ii) *P* because its frequency is maximum.

(iii) $\lambda_P : \lambda_R = 1 : 3 \quad (\text{since } \frac{3}{2}\lambda_P = \frac{1}{2}\lambda_R)$

(b) A type of electromagnetic wave has wavelength 50 Å.

(i) Name the wave.

(ii) What is the speed of wave in vacuum ?

(iii) State *one* use of this type of wave. **[3]**

Ans. (i) X-ray

(ii) 3×10^8 m s^{-1}

(iii) To study crystal structure (or to detect fracture in bones).

(c) (i) State *one* important property of waves used for echo depth sounding.

(ii) A radar sends a signal to an aircraft at a distance of 30 km away and receives it back after 2×10^{-4} second. What is the speed of the signal ? **[3]**

Ans. (i) Directional property.

(ii) $\text{Speed} = \dfrac{\text{Total distance travelled}}{\text{Time interval}} = \dfrac{2 \times (30 \times 10^3 \text{ m})}{2 \times 10^{-4} \text{ s}} = 3 \times 10^8 \text{ m s}^{-1}$.

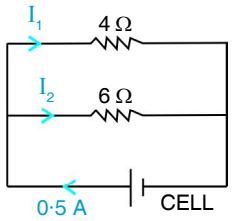
Question 8

(a) Two resistors of 4 Ω and 6 Ω are connected in parallel to a cell to draw 0·5 A current from the cell.

(i) Draw a labelled circuit diagram showing the above arrangement.

(ii) Calculate the current in each resistor. **[4]**

Ans. (i) Labelled circuit diagram is shown alongside.



(ii) If current in 4 Ω resistor is I_1 and in 6 Ω resistor is I_2, then

$$I_1 + I_2 = 0{\cdot}5 \text{ A}$$

and $$I_1 \times 4 = I_2 \times 6$$

on solving, $$I_1 = \frac{0{\cdot}5 \times 6}{4+6} = 0{\cdot}3 \text{ A} \quad \text{and} \quad I_2 = \frac{0{\cdot}5 \times 4}{4+6} = 0{\cdot}2 \text{ A}$$

(b) (i) What is an ohmic resistance ?

(ii) Two copper wires are of same length, but one is thicker than the other.

(1) Which wire will have more resistance ?

(2) Which wire will have more specific resistance ? **[3]**

Ans. (i) A resistance for which $\frac{V}{I}$ is constant for each value of V or I, is called an ohmic resistance.

(ii) (1) Thin wire will have more resistance.

(2) Both will have same specific resistance.

(c) (i) Two sets A and B, of three bulbs each, are glowing in two separate rooms. When one of the bulbs in set A is fused, the other two bulbs also cease to glow. But in set B, when one bulb fuses, the other two bulbs continue to glow. Explain why this phenomenon occurs.

(ii) Why do we prefer arrangements of set B for house circuiting ? **[3]**

Ans. (i) In set A, the three bulbs are joined in series with the mains. When one bulb gets fused, the circuit breaks and no current flows in the other two bulbs so they cease to glow.

In set B, the three bulbs are joined in parallel with the mains. When one bulb fuses, it does not affect the current in other two bulbs, so they continue to glow.

(ii) We prefer parallel arrangement for house circuiting because each appliance operates at same voltage equal to the mains voltage (or rated voltage).

Question 9

(a) Heat energy is supplied at a constant rate to 100 g of ice at 0°C. The ice is converted into water at 0°C in 2 minutes. How much time will be required to raise the temperature of water from 0°C to 20°C ? Given : specific heat capacity of water = 4·2 J g^{-1} $°C^{-1}$, specific latent heat of ice = 336 J g^{-1}. **[4]**

Ans. Heat energy required for melting ice Q = mass × sp. latent heat of ice

= 100 × 336 = 33600 J

$$\text{Power of source} = \frac{\text{Heat energy}}{\text{Time taken}} = \frac{33600\ \text{J}}{2 \times 60\ \text{s}} = 280\ \text{J s}^{-1}$$

Heat energy required to raise the temperature of water

= Mass of water × sp. heat capacity × rise in temperature

= 100 × 4·2 × (20 – 0) = 8400 J

$$\text{Time taken} = \frac{\text{Heat energy required}}{\text{Power of source}} = \frac{8400\ \text{J}}{280\ \text{J s}^{-1}} = 30\ \text{s}$$

(b) Specific heat capacity of substance A is 3·8 J g^{-1} K^{-1} whereas the specific heat capacity of substance B is 0·4 J g^{-1} K^{-1}.

(i) Which of the two is a good conductor of heat ?

(ii) How is one led to the above conclusion ?

(iii) If substances A and B are liquids, then which one would be more useful in car radiators ? **[3]**

Ans. (i) Substance B.

(ii) For the same quantity of heat, a given mass of substance B of lower specific heat capacity will be heated more than the same mass of substance A of higher specific heat capacity. Thus B conducts more than A.

(iii) A of high specific heat capacity.

*(c) (i) State any *two* measures to minimise the impact of global warming.

(ii) What is green house effect ? **[3]**

Ans. (i) 1. More plantation and banning the forest cutting.

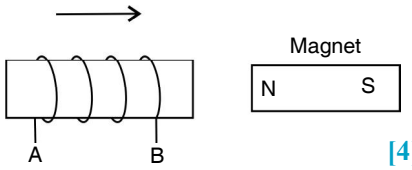
2. Banning the petrol/diesel consuming vehicles.

(ii) To keep the surface of a planet warm by absorbing the visible light and short wavelength infra red radiations and also protecting the low temperature heat radiations from escaping out of the planet's atmosphere, is called green house effect.

Question 10

(a) (i) Name *two* factors on which the magnitude of an induced e.m.f. in the secondary coil depends.

(ii) In the adjacent diagram, arrow shows the motion of coil towards the bar magnet.



1. State in which direction the current flows : A to B or B to A ?

2. Name the law used to come to the conclusion. **[4]**

Ans. (i) 1. On the e.m.f. applied across the primary coil.

2. On the ratio of number of turns in the secondary coil to the number of turns in primary coil.

(ii) 1. A to B.

2. Lenz's law.

(b) A nucleus $^{24}_{11}Na$ emits a beta particle to change into magnesium (Mg).

(i) Write the symbolic equation for the process.

* Not included in syllabus for 2018

(ii) What are the numbers 24 and 11 called ?

(iii) What is the general name of $^{24}_{12}Mg$ with respect to $^{24}_{11}Na$? **[3]**

Ans. (i) $^{24}_{11}Na \longrightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e$ (beta particle).

(ii) 24 $\longrightarrow$ Mass number, 11 $\longrightarrow$ atomic number.

(iii) Isobars.

*(c) In a cathode ray tube, state :

(i) the purpose of covering cathode by thorium and carbon.

(ii) the purpose of the fluorescent screen.

(iii) how is it possible to increase the rate of emission of electrons. **[3]**

Ans. (i) To reduce the work function (*i.e.* for emission of electrons at low temperature).

(ii) To have visual picture of path of cathode rays.

(iii) By increasing the filament current (*i.e.* e.m.f. of low tension battery used for heating the filament).

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