PHYSICS – Paper 2016 (Solved)

SECTION I (40 Marks)

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

Question 1

*(a) (i) Give an example of a non contact force which is always of attractive nature.

(ii) How does the magnitude of this non contact force on the two bodies depend on the distance of separation between them ? **[2]**

Ans. (i) Gravitational force.

(ii) The magnitude of gravitational force between the two bodies is inversely proportional to the square of the distance between them.

(b) A boy weighing 40 kgf climbs up a stair of 30 steps each 20 cm high in 4 minutes and a girl weighing 30 kgf does the same in 3 minutes. Compare :

(i) the work done by them, and

(ii) the power developed by them. **[2]**

Ans. Given : weight of the boy W_1 = 40 kgf, weight of the girl W_2 = 30 kgf,

height $h = 30 \times 20$ cm = 600 cm = 6 m, time t_1 = 4 min, t_2 = 3 min

(i) $\dfrac{\text{Work done by boy}}{\text{Work done by girl}} = \dfrac{W_1 h}{W_2 h} = \dfrac{W_1}{W_2} = \dfrac{40}{30} = \mathbf{4 : 3}$

(ii) $\dfrac{\text{Power developed by boy}}{\text{Power developed by girl}} = \dfrac{W_1 / t_1}{W_2 / t_2} = \dfrac{W_1}{W_2} \times \dfrac{t_2}{t_1} = \dfrac{4}{3} \times \dfrac{3}{4} = \mathbf{1 : 1}$

(c) With reference to the terms mechanical advantage, velocity ratio and efficiency of a machine, name and define the term that will not change for machine of a given design. **[2]**

Ans. Velocity ratio will not change.

Velocity ratio is defined as the ratio of the distance moved by the effort to the distance moved by the load in the same interval of time.

(d) Calculate the mass of ice required to lower the temperature of 300 g of water at 40°C to water at 0°C.

(Specific latent heat of ice = 336 J g^{-1}, specific heat capacity of water = 4·2 J g^{-1} $°C^{-1}$) **[2]**

Ans. Given : mass of water = 300 g, fall in temperature = (40 – 0) °C = 40°C. Let mass of ice required = m g

Heat lost by water = Heat gained by ice

i.e., mass of water × specific heat capacity of water × fall in temperature

= mass of ice × specific latent heat of ice

or $300 \times 4{\cdot}2 \times 40 = m \times 336$

$\therefore \quad m = \dfrac{300 \times 4{\cdot}2 \times 40}{336} = \mathbf{150\ g}$

(e) What do you understand by the following statements :

(i) The heat capacity of the body is 60 J K^{-1}.

(ii) The specific heat capacity of lead is 130 J kg^{-1} K^{-1}. **[2]**

Ans. (i) The heat energy required to raise the temperature of the body by 1 K is 60 J.

(ii) The heat energy required to raise the temperature of 1 kg of lead by 1 K is 130 J.

Question 2

(a) State *two* factors upon which the heat absorbed by a body depends. **[2]**

Ans. Heat absorbed by a body depends on (1) the mass of the body, and (2) the rise in temperature of the body.

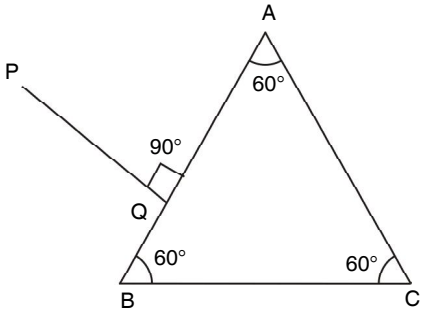
* Not included in syllabus for 2019

(b) A boy uses blue colour of light to find the refractive index of glass. He then repeats the experiment using red colour of light. Will the refractive index be the same or different in the two cases ? Give a reason to support your answer. **[2]**

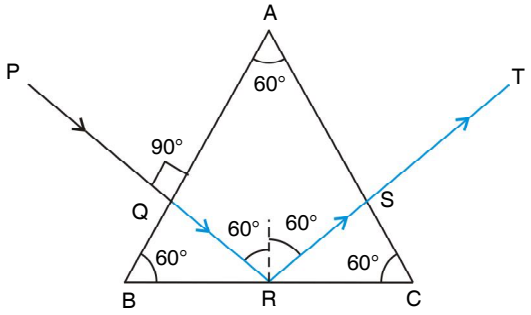
Ans. The refractive index will be different.

Reason : The speed of blue light in glass is less than that of red light and refractive index of glass is $\mu = \dfrac{c}{\text{speed of light in glass}}$. $\therefore \mu_{blue} > \mu_{red}$.

(c) Copy the diagram given alongside and complete the path of the light ray till it emerges out of the prism. The critical angle of glass is 42°. In your diagram mark the angles wherever necessary.



Ans. The completed diagram is given below.



(d) State the dependence of angle of deviation :

(i) on the refractive index of the material of the prism.

(ii) on the wavelength of light. **[2]**

Ans. (i) Angle of deviation increases with the increase in refractive index of the material of the prism.

(ii) Angle of deviation decreases with the increase in wavelength of the light.

(e) The ratio of amplitude of two waves is 3 : 4. What is the ratio of their :

(i) loudness ?

(ii) frequencies ? **[2]**

Ans. Given : $a_1 : a_2 = 3 : 4$

(i) Loudness $\propto a^2$ $\therefore$ ratio of loudness $= (a_1 / a_2)^2 = (3/4)^2 =$ **9 : 16**

(ii) The frequency does not depend on amplitude. $\therefore$ Ratio of frequencies = **1 : 1**

Question 3

(a) State *two* ways by which the frequency of transverse vibrations of a stretched string can be increased.

Ans. The frequency of transverse vibrations of a stretched string can be increased :

Ans. (i) by increasing the tension on the string.

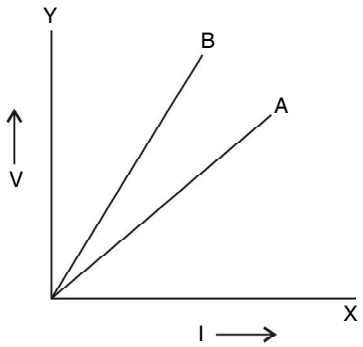
(ii) by decreasing the length of the string.

(b) What is meant by noise pollution ? Name *one* source of sound causing noise pollution. **[2]**

Ans. The undesirable, loud and harsh sound of level above 120 dB which causes headache is called noise pollution.

Source : siren.

(c) The *V-I* graph for a series combination and for a parallel combination of two resistors is shown in the adjacent figure. Which of the two A or B, represents the parallel combination ? Give reasons for your answer. **[2]**



Ans. A

Reason : The slope of *V-I* graph gives the resistance. In the figure, the slope of straight line A is less than that of B, so resistance of combination A is less than that of the combination B. When two resistors are joined in parallel, the equivalent resistance decreases, but in series it increases. Therefore A represents the parallel combination.

(d) The music system draws a current of 400 mA when connected to a 12 V battery.

(i) What is the resistance of the music system ?

(ii) The music system if left playing for several hours and finally the battery voltage drops and the music system stops playing when the current drops to 320 mA. At what battery voltage does the music system stop playing ? **[2]**

Ans. Given : $I = 400\ \text{mA} = 400 \times 10^{-3}\ \text{A} = 0{\cdot}4\ \text{A}$, $V = 12\ \text{V}$

(i) Resistance $R = \dfrac{V}{I} = \dfrac{12}{0{\cdot}4} = \mathbf{30\ \Omega}$

(ii) Current drops to $I' = 320\ \text{mA} = 320 \times 10^{-3}\ \text{A} = 0{\cdot}32\ \text{A}$

Now battery voltage $V = I'R = 0{\cdot}32 \times 30 = \mathbf{9{\cdot}6\ V}$

(e) Calculate the quantity of heat produced in a 20 Ω resistor carrying 2·5 A current in 5 minutes. **[2]**

Ans. Given : $R = 20\ \Omega$, $I = 2{\cdot}5\ \text{A}$, $t = 5\ \text{min} = 5 \times 60\ \text{s} = 300\ \text{s}$

Heat produced $H = I^2Rt = (2{\cdot}5)^2 \times 20 \times 300 = \mathbf{3{\cdot}75 \times 10^4\ J}$

Question 4

*(a) State *two* characteristics required of good thermionic emitter. **[2]**

Ans. (i) The work function must be low.

(ii) The melting point must be high.

(b) An element ${}^{A}_{Z}S$ decays to ${}^{223}_{85}R$ after emitting 2 α-particles and 1 β-particle. Find the atomic number and atomic mass of the elements S. **[2]**

Ans. Due to emission of 2 α-particles and 1 β-particle from ${}^{A}_{Z}S$, the atomic number Z has decreased by 4 and increased by 1 (*i.e.*, net decreased by 3), while mass number A has decreased by 8 to form ${}^{222}_{85}R$.

$\therefore\ Z - 3 = 85$ and $A - 8 = 222$ *i.e.* $Z = \mathbf{88}$ and $A = \mathbf{230}$

(c) A radioactive substance is oxidized. Will there be any change in the nature of its radioactivity ? Give a reason for your answer. **[2]**

Ans. There will be no change in the nature of radioactivity of the substance.

Reason : Radioactivity is a nuclear phenomenon.

(d) State *two* characteristics required in a material to be used as an effective fuse wire. **[2]**

Ans. (i) The melting point must be low.

(ii) The resistance must be large.

(e) Which coil of a step up transformer is made of thicker wire and and why ? **[2]**

Ans. The primary coil of a step up transformer is made of the thicker wire.

Reason : Current in primary coil is more, so its resistance is made low for less heating loss. (In step up transformer $E_P < E_S$ $\therefore\ I_P > I_S$).

* Not included in syllabus for 2019

SECTION II (40 Marks)

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

Question 5

(a) A stone of mass m is rotated in a circular path with a uniform speed by tying a strong string with the help of your hand. Answer the following questions :

(i) Is the stone moving with a uniform or variable velocity ?

(ii) Is the stone moving with a uniform acceleration ? In which direction does the acceleration act ?

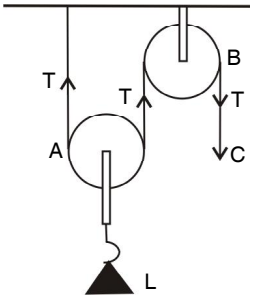
(iii) What kind of force acts on the hand and state its direction ? **[2]**

Ans. (i) The stone is moving with a variable velocity.

(ii) No, acceleration is variable. It is directed towards the centre of circular path.

(iii) The force of reaction of tension. Its direction is away from the centre of circular path.

(b) From the adjacent diagram, answer the following questions :



(i) What kind of pulleys are A and B ?

(ii) State the purpose of pulley B.

(iii) What effort has to be applied at C just to raise the load L = 20 kgf ?

(Neglect the weight of pulley A and friction)

Ans. (i) A — movable pulley

B — fixed pulley.

(ii) Purpose of pulley B — to change the direction of effort from upward to downward direction.

(iii) M.A. = 2; Effort required at C is $E = \frac{1}{2}L = \frac{1}{2} \times 20$ kgf = **10 kgf**

(c) *(i) An effort is applied on the bigger wheel of a gear having 32 teeth. It is used to turn a wheel of 8 teeth. Where is it used ?

(ii) A pulley system has three pulleys. A load of 120 N is overcome by applying an effort of 50 N. Calculate the mechanical advantage and efficiency of this system.

Ans. (i) This arrangment of gear is used where gain in speed is required.

(ii) Given : number of pulleys = 3, L = 120 N, E = 50 N

$$\text{Mechanical advantage} = \frac{L}{E} = \frac{120}{50} = \mathbf{2{\cdot}4}$$

$$\text{Velocity ratio} = \text{number of pulleys} = \mathbf{3}$$

$$\text{Efficiency} = \frac{\text{mechanical advantage}}{\text{velocity ratio}} = \frac{2{\cdot}4}{3} = \mathbf{0{\cdot}8\ (or\ 80\%)}$$

Question 6

(a) (i) What is the principle of method of mixtures ?

(ii) What is the other name given to it ?

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

Ans. (i) When two bodies at different temperatures are mixed together, heat flows from the body at high temperature to the body at low temperature till both attain the same temperature. The amount of heat lost by the hot body is equal to the amount of heat gained by the cold body (if there is no loss of heat).

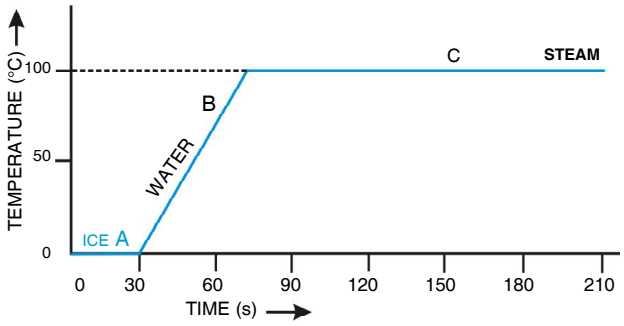
(ii) Principle of calorimetry.

(iii) The law of conservation of energy.

* Not included in syllabus for 2019

(b) Some ice is heated at a constant rate and its temperature is recorded after every few seconds, till steam is formed at 100°C. Draw a temperature-time graph to represent the change. Label the two phase changes in your graph. **[3]**

Ans. The temperature-time graph is shown below.



In Fig.,

A – Phase change from 0°C ice to 0°C water

C – Phase change from 100°C water to 100°C steam

(c) A copper vessel of mass 100 g contains 150 g of water at 50°C. How much ice is needed to cool it to 5°C ?

Given : Specific heat capacity of copper = 0·4 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}

Ans. Let m g ice is needed

Heat is lost by copper vessel and water when their temperature fall from 50°C to 5°C. Therefore

total heat lost = mass of copper vessel × specific heat capacity of copper × fall in temperature + mass of water × specific heat capacity of water × fall in temperature

$= 100 \times 0{\cdot}4 \times (50 - 5) + 150 \times 4{\cdot}2 \times (50 - 5) = 1800 + 28350 = 30150$ J ...(i)

Heat is gained by the ice in melting at 0°C and then in increase in its temperature from 0°C to 5°C. Therefore

total heat gained = mass of ice × specific latent heat of ice + mass of melted ice × specific heat capacity of water × rise in temperature

$= m \times 336 + m \times 4{\cdot}2 \times (5 - 0) = 336\ m + 21\ m = 357\ m$ J ....(ii)

By the principle of calorimetry,

total heat gained = total heat lost

or $357\ m = 30150$

$\therefore \quad m = \dfrac{30150}{357} =$ **84·45 g**

Question 7

(a) (i) Write a relationship between the angle of incidence and angle of refraction for a given pair of media.

(ii) When a ray of light enters from one medium to another having different optical densities, it bends. Why does this phenomenon occur ?

(iii) Write *one* condition where it does not bend when entering a medium of different optical density.

Ans. (i) $\dfrac{\text{sine of angle of incidence}}{\text{sine of angle of refraction}}$ = refractive index of the media.

(ii) The bending is due to change in speed of light when it passes from one medium to the other medium of different optical density.

(iii) When angle of incidence is zero (*i.e.*, when light is normally incident on the boundary of two media).

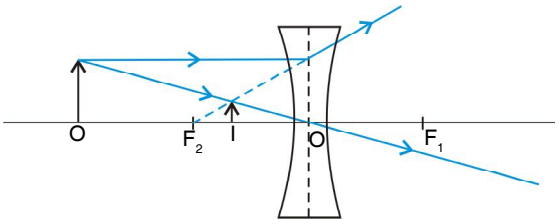
(b) A lens produces a virtual image between the object and the lens.

(i) Name the lens.

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

Ans. (i) Concave lens.

(ii) The ray diagram is given alongside in which I is the image for the object O.



(c) What do you understand by the term scattering of light ? Which colour of white light is scattered the least and why ? **[4]**

Ans. Scattering of light is the process of absorption and then re-emission of light energy by the air molecules of size smaller than the wavelength of incident light.

The red colour light is scattered the least because the intensity of scattered light $I \propto 1/\lambda^4$ and the wavelength λ of red light is maximum.

Question 8

(a) (i) Name the waves used for echo depth sounding.

(ii) Give *one* reason for their use for the above purpose.

(iii) Why are the waves mentioned by you not audible to us ? **[3]**

Ans. (i) Ultrasonic waves.

(ii) The ultrasonic waves can travel undeviated through a long distance.

(iii) Their frequency is above 20,000 Hz (*i.e.*, above the audible limit), so they are not audible.

(b) (i) What is an echo ?

(ii) State *two* conditions for an echo to take place. **[3]**

Ans. (i) An echo is the sound heared after reflection from a distant object when the original sound has ceased.

(ii) (a) The distance of reflector from the source of sound must be more than 17 m in air so that it takes a time more than 0·1 s for echo to reach the source.

(b) The reflector must be big in size.

(c) (i) Name the phenomenon involved in tuning a radio set to a particular station.

(ii) Define the phenomenon named by you in part (i) above.

(iii) What do you understand by loudness of sound ?

(iv) In which unit is the loudness of sound measured ? **[4]**

Ans. (i) Resonance.

(ii) The phenomena when a body vibrates with a very large amplitude, under a periodic force of frequency exactly equal to the natural frequency of vibrations of the body, is called resonance.

(iii) The loudness is that characteristic of sound which distinguishes a loud sound from a faint sound of same pitch and same quality.

(iv) Unit of loudness is phon.

Question 9

(a) (i) Which particles are responsible for 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 ?

Ans. (i) Free electrons.

(ii) Earth wire.

(iii) Live wire.

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* Not included in syllabus for 2019

(b) (i) Name the transformer used in the power transmitting station of a power plant.

(ii) What type of current is transmitted from the power station ?

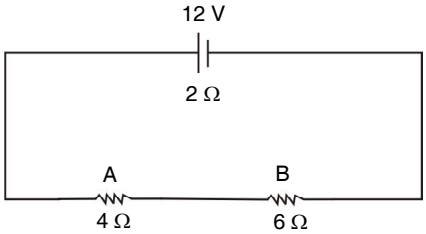
(iii) At what voltage is this current available to our household ? **[3]**

Ans. (i) Step up transfomer.

(ii) Alternating current (a.c.).

(iii) 220 volt.

(c) A battery of emf 12 V and internal resistance 2 Ω is connected with two resistors A and B of resistance 4 Ω and 6 Ω respectively joined in series.



Find :

(i) current in the circuit,

(ii) the terminal voltage of the battery,

(iii) the potential difference across 6 Ω resistor, and

(iv) electrical energy spent per minute in 4 Ω resistor.

Ans. Given : $\varepsilon = 12$ V, $r = 2\ \Omega$, $R_A = 4\ \Omega$, $R_B = 6\ \Omega$, $t = 1$ min $= 60$ s

(i) Total resistance of circuit $R = R_A + R_B + r = 4 + 6 + 2 = 12\ \Omega$

Current in the circuit $I = \dfrac{\varepsilon}{R} = \dfrac{12\text{ V}}{12\,\Omega} =$ **1 A**

(ii) Terminal voltage of the battery $V = \varepsilon - IR = 12 - 1 \times 2 =$ **10 V**

(iii) p.d. across the resistor B (of 6 Ω) $V_B = IR_B = 1 \times 6 =$ **6 V**

(iii) Electrical energy spent in resistor A (= 4 Ω) $= I^2R_At = (1)^2 \times 4 \times 60 =$ **240 J**

Question 10

(a) Arrange α, β and γ rays in ascending order with respect to their

(i) penetrating power. (ii) ionising power. (iii) biological effect. **[3]**

Ans. (i) Penetrating power — $\alpha < \beta < \gamma$

(ii) Ionising power — $\gamma < \beta < \alpha$

(iii) Biological effect — $\alpha < \beta < \gamma$

*(b) (i) In a cathode ray tube what is the function of anode ?

(ii) State the energy conversion taking place in a cathode ray tube.

(iii) Write *one* use of the cathode ray tube. **[3]**

Ans. (i) The function of anode is to accelerate and focus the cathode rays.

(ii) In a cathode ray tube, the electrical energy changes into the light energy.

(iii) **Use :** In T.V. as a picture tube.

(c) (i) Represent the change in the nucleus of a radioactive element when a β-particle is emited.

(ii) What is the name given to elements with same mass number and different atomic number ?

(iii) Under which condition does the nucleus of an atom tend to be radioactive ?

Ans. (i) Due to emission of a β-particle, atomic number increases by 1, but mass number is unchanged

$$^{A}_{Z}\text{X} \longrightarrow {}_{Z+1}{}^{A}\text{Y} + {}^{0}_{-1}\beta$$

(ii) The elements with same mass number but different atomic number are called **isobars**.

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

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