PHYSICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. A travelling wave is described by the equation

   $y(x, t) = [0.05 \sin (8x - 4t)]$ m

   The velocity of the wave is : [all the quantities are in SI unit]

   (1) 8 ms^{-1} (2) 0.5 ms^{-1}

   (3) 4 ms^{-1} (4) 2 ms^{-1}

Answer (2)

Sol. $\because \quad y(x, t) = [0.05\sin(8x - 4t)]$ m

$$\text{Speed of wave } = \left|\frac{\text{Coefficient of } t}{\text{Coefficient of } x}\right|$$

$$= \frac{4}{8} = 0.5 \text{ ms}^{-1}$$

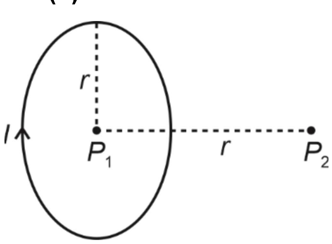
2. A circular loop of radius r is carrying current I A. The ratio of magnetic field at the center of circular loop and at a distance r from the center of the loop on its axis is:

   (1) $2\sqrt{2} : 1$ (2) $1 : 3\sqrt{2}$

   (3) $3\sqrt{2} : 2$ (4) $1 : \sqrt{2}$

Answer (1)

Sol.



$$B_{P_1} = \frac{\mu_0 I}{2r}$$

$$B_{P_2} = \frac{\mu_0 I r^2}{2(r^2 + r^2)^{3/2}} = \frac{\mu_0 I}{2^{5/2} r}$$

$$\therefore \quad \frac{B_{P_1}}{B_{P_2}} = \frac{\frac{\mu_0 I}{2r}}{\frac{\mu_0 I}{2^{5/2} r}} = \frac{2\sqrt{2}}{1}$$

3. Consider the following radioactive decay process

   $${}^{218}_{84}A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\gamma} A_3 \xrightarrow{\alpha} A_4 \xrightarrow{\beta^+} A_5 \xrightarrow{\gamma} A_6$$

   The mass number and the atomic number of A_6 are given by:

   (1) 210 and 80 (2) 210 and 82

   (3) 210 and 84 (4) 211 and 80

Answer (1)

Sol. ${}^{218}_{84}A \xrightarrow{\alpha} {}^{214}_{82}A_1 \xrightarrow{\beta^-} {}^{214}_{83}A_2 \xrightarrow{\gamma} {}^{214}_{83}A_3 \xrightarrow{\alpha} {}^{210}_{81}A_4 \xrightarrow{\beta^+} {}^{210}_{80}A_5 \xrightarrow{\gamma} {}^{210}_{80}A_6$

Mass number = 210

Atomic number = 80

4. The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is (given, radius of earth R_e = 6400 km):

   (1) 8 N (2) 19.6 N

   (3) 9.8 N (4) 4.9 N

Answer (1)

Sol. W_{earth} = 18 N

mg_{earth} = 18

$$\text{Also } mg_h = mg_{\text{earth}}\left(\frac{R}{R+h}\right)^2$$

$$= 18\left(\frac{6400}{6400+3200}\right)^2$$

$$= 18 \times \frac{4}{9} = 8$$

5. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

   Assertion A : Photodiodes are preferably operated in reverse bias condition for light intensity measurement.

   Reason R : The current in the forward bias is more than the current in the reverse bias for a $p - n$ junction diode.

   In the light of the above statements, choose the ***correct*** answer from the options given below:

   (1) Both **A** and **R** are true and **R** is the correct explanation of **A**

   (2) **A** is false but **R** is true

   (3) **A** is true but **R** is false

   (4) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

Answer (4)

Sol. Photodiodes are preferably operated in reverse bias condition for light intensity measurement because it increases the width of depletion layer, therefore both are correct but not the correct explanation.

6. Given below are two statements :

Statement I : If the Brewster's angle for the light propagating from air to glass is θ_B, then the Brewster's angle for the light propagating from glass to air is $\frac{\pi}{2} - \theta_B$

Statement II : The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.

In the light of the above statements, choose the **correct** answer from the options given below:

(1) Both statement I and Statement II are true

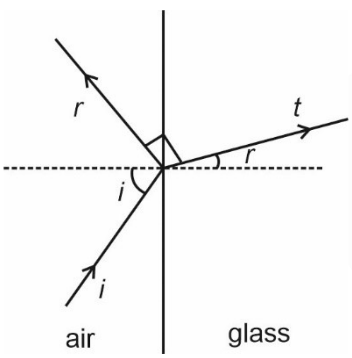
(2) Both statement I and statement II are false

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

Answer (3)

Sol. Case I :



Transmitted is ⊥ to reflected.

$i + r = 90°$

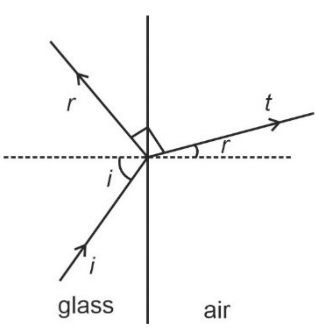
Snell's law

$\mu_a \sin i = \mu_g \sin r$

$$\tan i = \frac{\mu_g}{\mu_a}$$

$$i = \tan^{-1}\left(\frac{\mu_g}{\mu_a}\right) = \theta_B$$

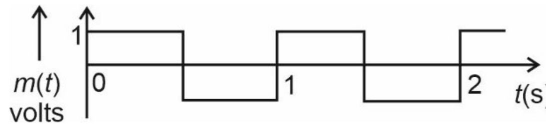
Case II :



$i + r = 90°$ as transmitted is ⊥ to reflected.

$$\tan i = \frac{\mu_a}{\mu_g} \Rightarrow i = \tan^{-1}\frac{\mu_a}{\mu_g} = \frac{\pi}{2} - \theta_B$$

7. A modulating signal is a square wave, as shown in the figure.



If the carrier wave is given as $c(t) = 2\sin(8\pi t)$ volts, the modulation index is:

(1) $\frac{1}{2}$

(2) $\frac{1}{4}$

(3) 1

(4) $\frac{1}{3}$

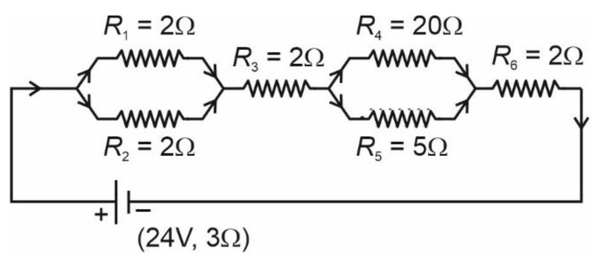
Answer (1)

Sol. A_m = Amplitude of modulating wave = 1 volt

A_c = Amplitude of carrier wave = 2 volt

Modulation index = $\frac{A_m}{A_c} = \frac{1}{2} = \frac{1}{2}$

8. As shown in the figure, a network of resistors is connected to a battery of 24V with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are:



(1) $I_4 = \frac{8}{5}$ A and $I_5 = \frac{2}{5}$ A

(2) $I_4 = \frac{24}{5}$ A and $I_5 = \frac{6}{5}$ A

(3) $I_4 = \frac{2}{5}$ A and $I_5 = \frac{8}{5}$ A

(4) $I_4 = \frac{6}{5}$ A and $I_5 = \frac{24}{5}$ A

Answer (3)

Sol. $R_{eq} = \frac{R_1R_2}{R_1+R_2} + R_3 + \frac{R_4R_5}{R_5+R_4} + R_6 + r$

= (1 + 2 + 4 + 2 + 3)

= 12 Ω

$I = \frac{24}{12} = 2\text{ A}$

$I_4 = \left(\frac{R_5}{R_4+R_5}\right)I = \frac{5}{25}\times 2 = \frac{2}{5}\text{A}$

$I_5 = \frac{R_4 I}{R_4+R_5} = \frac{20}{25}\times I = \frac{8}{5}\text{A}$

9. Given below are two statements :

Statement I : The temperature of a gas is –73°C. When the gas is heated to 527°C, the root mean square speed of the molecules is doubled.

Statement II : The product of pressure and volume of an ideal gas will be equal to translational kinetic energy of the molecules.

In the light of the above statements, choose the **correct** answer from the options given below:

(1) Both statement I and statement II are true

(2) Statement I is false but statement II is true

(3) Both statement I and statement II are false

(4) Statement I is true but statement II is false

Answer (4)

Sol. $T_i = 200\text{K}$ $\quad v_{rms} \propto \sqrt{T}$

$T_f = 800\text{K}$

$\frac{V_i}{V_f} = \sqrt{\frac{T_i}{T_f}} = \sqrt{\frac{200}{800}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

$V_f = 2V_i$

Translational K.E. $= \left(\frac{3}{2}PV\right)$

10. Two long straight wires P and Q carrying equal current 10A each were kept parallel to each other at 5 cm distance. Magnitude of magnetic force experienced by 10 cm length of wire P is F_1. If distance between wires is halved and currents on them are doubled, force F_2 on 10 cm length of wire P will be:

(1) $10F_1$ (2) $8F_1$

(3) $\frac{F_1}{10}$ (4) $\frac{F_1}{8}$

Answer (2)

Sol. $\frac{F_1}{l} = \frac{\mu_0 i_1}{2\pi r} i_2 = \frac{\mu_0 i_1 i_2}{2\pi r}$

If i_1 and i_2 both are doubled, if $r_f = \left(\frac{r}{2}\right)$

$\frac{F_f}{l} = \frac{\mu_0(2i_1)(2i_2)}{2\pi\left(\frac{r}{2}\right)} = \frac{8\mu_0 i_1 i_2}{2\pi r}$

$F_f = 8F_1$

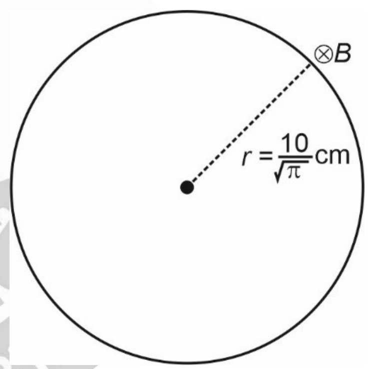
11. A conducting circular loop of radius $\frac{10}{\sqrt{\pi}}$ cm is placed perpendicular to a uniform magnetic field of 0.5 T. The magnetic field is decreased to zero in 0.5 s at a steady rate. The induced emf in the circular loop at 0.25 s is:

(1) emf = 1 mV (2) emf = 5 mV

(3) emf = 100 mV (4) emf = 10 mV

Answer (4)

Sol.



$\varepsilon_{ind} = \left|-\frac{d\phi}{dt}\right|$

$= \left(\frac{dB}{dt}\right)A$

$= \left(\frac{0.5}{0.5}\right)\pi\left(\frac{1}{10\sqrt{\pi}}\right)^2$

$= 1\times\frac{1}{100}\text{V}$

= 0.01 V

= 10 mV

12. 1 g of a liquid is converted to vapour at 3×10^5 P_a pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be:

(1) 4800 J (2) 432000 J

(3) 4.32×10^8 J (4) 4320 J

Answer (4)

Sol. $\Delta Q = \Delta U + \Delta W$

$10\,\Delta W = \Delta W + \Delta W$

$\Delta U = 9\,\Delta W$

$= 9 \times (3 \times 10^5)\left[1600 \times \frac{1}{10^6}\right]$

= 4320 J

13. If two charges q_1 and q_2 are separated with distance 'd' and placed in a medium of dielectric constant K. What will be the equivalent distance between charges in air for the same electrostatic force?

(1) $2d\sqrt{k}$ (2) $d\sqrt{k}$

(3) $1.5d\sqrt{k}$ (4) $k\sqrt{d}$

Answer (2)

Sol. q_1 ——— d ——— q_2

dielectric constant = K

$$F_{\text{medium}} = \frac{1}{4\pi(K\varepsilon_0)} \times \frac{q_1 q_2}{d^2}$$

$\because$ $F_{\text{air}} = F_{\text{medium}}$

$$\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{(d_{\text{air}})^2} = \frac{1}{4\pi(K\varepsilon_0)}\frac{q_1 q_2}{d^2}$$

$\therefore$ $\boxed{d_{\text{air}} = \sqrt{K}d}$

14. Given below are two statements:

Statement I: An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.

Statement II: Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

In the light of the above statements, choose the ***correct*** answer from the options given below:

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are true

(3) Statement I is false but Statement II is true

(4) Both statement I and Statement II are false

Answer (1)

Sol. **Statement I** is correct, because lift is moving with zero acceleration.

Statement II is incorrect as force exerted will be less than the weight.

15. In $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by:

(ω – angular frequency):

(1) $\frac{1}{\omega}(\vec{K} \times \vec{E})$ (2) $\omega(\vec{E} \times \vec{K})$

(3) $\vec{K} \times \vec{E}$ (4) $\omega(\vec{K} \times \vec{E})$

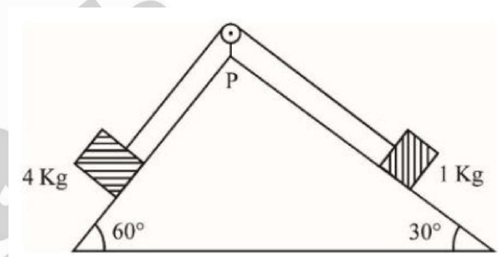
Answer (1)

Sol. $\vec{E} \Rightarrow$ electric field

$\vec{K} \Rightarrow$ propagation vector

$\boxed{\vec{B} = \frac{1}{\omega}(\vec{K} \times \vec{E})}$

16. As per given figure, a weightless pulley P is attached on a double inclined frictionless surfaces. The tension in the string (massless) will be (if g = 10 m/s^2)

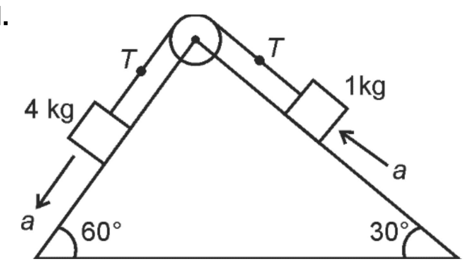


(1) $(4\sqrt{3} + 1)N$ (2) $(4\sqrt{3} - 1)N$

(3) $4(\sqrt{3} + 1)N$ (4) $4(\sqrt{3} - 1)N$

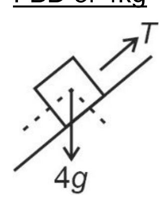
Answer (3)

Sol.



Let's consider T tension in string and a acceleration of blocks.

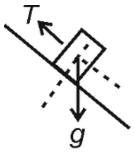
FBD of 4kg



$4g\sin\theta - T = 4a$

$$\frac{4g\sqrt{3}}{2} - T = 4a \qquad \ldots(1)$$

FBD of 1kg



$T - g\sin 30° = a$

$$T - \frac{g}{2} = a \qquad \ldots(2)$$

From (1) and (2)

$T = 4\left(1+\sqrt{3}\right)N$

17. Match List I with List II

LIST I		LIST II	
A.	Planck's constant (h)	I.	$[M^1L^2T^{-2}]$
B.	Stopping potential (V_s)	II.	$[M^1L^1T^{-1}]$
C.	Work function (ϕ)	III.	$[M^1L^2T^{-1}]$
D.	Momentum (p)	IV.	$[M^1L^2T^{-3}A^{-1}]$

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-I, D-II

(2) A-I, B-III, C-IV, D-II

(3) A-II, B-IV, C-III, D-I

(4) A-III, B-I, C-II, D-IV

Answer (1)

Sol. $[h] = [ML^2T^{-1}] \rightarrow$ A-III

$[V_s] = [ML^2T^{-3}A^{-1}] \rightarrow$ B-IV

$[\phi] = [ML^2T^{-2}] \rightarrow$ C-I

$[p] = [MLT^{-1}] \rightarrow$ D-II

18. From the photoelectric effect experiment, following observations are made. Identify which of these are correct.

A. The stopping potential depends only on the work function of the metal.

B. The saturation current increases as the intensity of incident light increases.

C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.

D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below:

(1) A, B, D only

(2) A, C, D only

(3) B only

(4) B, C only

Answer (3)

Sol. (A) From Einstein's equation

$K_{max} = eV_s = h\nu - \phi$

Form the stopping potential (V_s) depends on ϕ & ν.

(B) Saturation current is proportional to intensity, *i.e.*, number of incident photons.

(C) K_{max} only depends on nature of photon and ϕ.

(D) Einstein used particle behaviour of photon to explain photon electric effect.

Only B is correct.

19. The maximum vertical height to which a man can throw a ball is 136 m. The maximum horizontal distance upto which he can throw the same ball is:

(1) 272 m

(2) 68 m

(3) 192 m

(4) 136 m

Answer (1)

Sol. For vertical throw,

$$h = \frac{v^2}{2g}$$

$$v = \sqrt{2gh} = \sqrt{2g \times 136} \qquad \ldots(1)$$

For max range, $\theta = 45°$

$$R_{max} = \frac{v^2}{g} \qquad \ldots(2)$$

From (1) and (2)

$$R_{max} = \frac{v^2}{g} = \frac{2g \times 136}{g}$$

$= 272$ m

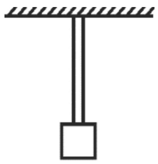
20. A 100 m long wire having cross-sectional area 6.25×10^{-4} m^2 and Young's modulus is 10^{10} Nm^{-2} is subjected to a load of 250 N, then the elongation in the wire will be:

(1) 6.25×10^{-6} m (2) 6.25×10^{-3} m

(3) 4×10^{-3} m (4) 4×10^{-4} m

Answer (3)

Sol. $\Delta l = \dfrac{Fl}{AY}$



250 N

F= 250 N

l = 100 m

$A = 6.25 \times 10^{-4}$ m^2

$Y = 10^{10}$

$\therefore \quad \Delta l = 4 \times 10^{-3}$ m

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE.** For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, –00.33, –00.30, 30.27, –27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. A hole is drilled in a metal sheet. At 27°C, the diameter of hole is 5 cm. When the sheet is heated to 177°C, the change in the diameter of hole is $d \times 10^{-3}$ cm. The value of d will be _______ if coefficient of linear expansion of the metal is 1.6×10^{-5}/°C.

Answer (12)

Sol. $\Delta D = D\alpha\Delta t$

$= 5 \times 1.6 \times 10^{-5} (177 - 27)$

= 0.012 cm

$= 12 \times 10^{-3}$ cm

so, d = 12

22. 

A block of a mass 2 kg is attached with two identical springs of spring constant 20 N/m each. The block is placed on a frictionless surface and the ends of the springs are attached to rigid supports (see figure). When the mass is displaced from its equilibrium position, it executes a simple harmonic motion. The time period of oscillation is $\dfrac{\pi}{\sqrt{x}}$ in SI unit. The value of x is _______.

Answer (5)

Sol. Both the springs are in parallel so net spring constant is $K_{net} = K_1 + K_2 = 40$ N/m

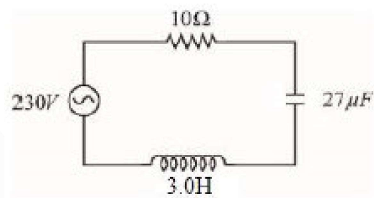
So $T = 2\pi\sqrt{\dfrac{m}{K_{net}}}$

$= 2\pi\sqrt{\dfrac{2}{40}}$

$= \dfrac{\pi}{\sqrt{5}}$

$x = 5$

23. In the circuit shown in the figure, the ratio of the quality factor and the band width is ________ s.



Answer (10)

Sol. Bandwidth $\Delta\omega = \dfrac{R}{L}$

Quality factor $Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

So $\dfrac{Q}{\Delta\omega} = \dfrac{\dfrac{1}{R}\sqrt{\dfrac{L}{C}}}{\dfrac{R}{L}}$

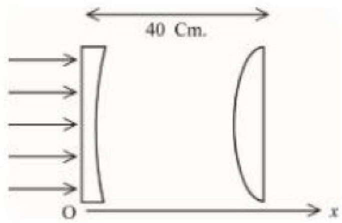
$= \dfrac{L^{\frac{3}{2}}}{R^2\sqrt{C}}$

$= \dfrac{3^{\frac{3}{2}}}{10^2(27 \times 10^{-6})^{\frac{1}{2}}}$

$= \dfrac{3\sqrt{3}}{100(3\sqrt{3} \times 10^{-3})}$

= 10

24. As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity. The radius of curvature of both the lenses is 30 cm and refraction index of the material for both the lenses is 1.75. Both the lenses are placed at distance of 40 cm from each other. Due to the combination, the image of the object is formed at distance x = ____ cm, from concave lens.



Answer (120)

Sol. $\frac{1}{f_{concave}} = (1.75-1)\left(\frac{1}{\infty} - \frac{1}{+30}\right) = -\frac{0.75}{30}$

$f_{concave} = -40$ cm

$\frac{1}{f_{convex}} = (1.75-1)\left(\frac{1}{30} - \frac{1}{\infty}\right) = \frac{0.75}{30}$

$f_{convex} = 40$ cm

Let the first image is formed at v_1 so

$\frac{1}{v_1} - \frac{1}{\infty} = \frac{1}{f_{concave}} = -\frac{1}{40}$

$\Rightarrow \quad v_1 = -40$ cm

for second image

$\frac{1}{x-40} - \frac{1}{-80} = \frac{1}{40}$

$\Rightarrow \quad x = 120$ cm

25. A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5th second. The force acted on the body is _____ N.

Answer (40)

Sol. Let the force be F so acceleration $a = \frac{F}{m}$

So displacement $S = \frac{1}{2}at^2 = \frac{Ft^2}{2m}$

So work done $W = F.S = \frac{F^2t^2}{2m}$

From work energy Theorem

$\Delta KE = W$

$W = \frac{F^2t^2}{2m} = 10000$

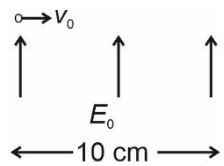
$F = \sqrt{\frac{10000 \times 2 \times 2}{5^2}}$

$F = 40$ N

26. A stream of a positively charged particles having $\frac{q}{m} = 2 \times 10^{11}\frac{C}{kg}$ and velocity $\vec{v}_0 = 3 \times 10^7 \hat{i}\ m/s$ is deflected by an electric field $1.8\hat{j}$ kV/m. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is ____ mm.

Answer (2)

Sol.



$F_y = \frac{qE_y}{m}$

$a_y = 2 \times 10^{11} \times 1800$

$= 36 \times 10^{13}$ m/s^2

Time = $= \frac{10 \times 10^{-2}}{v_0} = \frac{0.1}{3 \times 10^7} = \left(\frac{1}{3} \times 10^{-8}\right)$sec.

$\therefore \quad y = \frac{1}{2}at^2$

$\Rightarrow y = \frac{1}{2} \times 36 \times 10^{13} \times \left(\frac{1}{3} \times 10^{-8}\right)^2$

$= \quad 2 \times 10^{-3}$ m

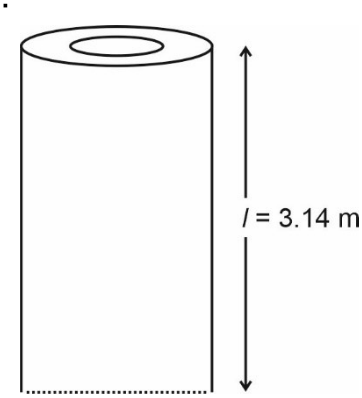
$= \quad 2$ mm

27. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n \times 10^{-3}\,\Omega$.

If the resistivity of the material is 2.4×10^{-8} Ωm. The value of n is ______.

Answer (2)

Sol.



$$R = \frac{\rho l}{A} = \frac{2.4 \times 10^{-8} \times 3.14}{\pi(16-4) \times 10^{-6}}$$

$$= \frac{2.4}{12} \times 10^{-2}$$

$$= \frac{24}{12} \times 10^{-3}$$

$$= 2 \times 10^{-3} \Omega$$

value of n is 2.

28. Assume that protons and neutrons have equal masses. Mass of a nucleon is 1.6×10^{-27} kg and radius of nucleus is $1.5 \times 10^{-15} A^{1/3}$ m. The approximate ratio of the nuclear density and water density is $n \times 10^{13}$. The value of n is _____.

Answer (11)

Sol. Radius = $1.5 \times 10^{-15} A^{1/3}$

Volume $= \frac{4\pi}{3} r^3$

Mass of nucleus = (1.6×10^{-27}) A kg

Density of nucleus $= \dfrac{1.6 \times 10^{-27} \times A}{\frac{4}{3} \times \pi \times \left(1.5 \times 10^{-15} A^{\frac{1}{3}}\right)^3}$

$$= \frac{1.6 \times 3 \times 8 \times 10^{18}}{4\pi \times 27}$$

$$= \frac{32}{9\pi} \times 10^{17}$$

Density of water = 1000 kg/m^3

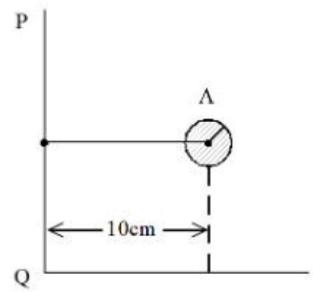
$$\frac{\text{Density of nucleus}}{\text{Density of water}} = \frac{\frac{32}{9\pi} \times 10^{17}}{1000}$$

$$= \frac{320}{9\pi} \times 10^{13}$$

= 11.32×10^{13}

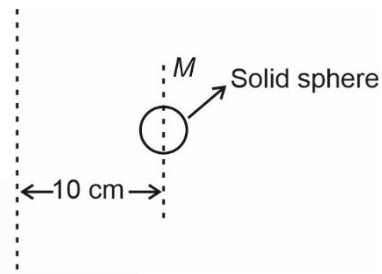
$\boxed{\text{value of } n = 11}$

29. Solid sphere A is rotating about an axis PQ. If the radius of the sphere is 5 cm then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is _______.



Answer (110)

Sol.



$$I = I_{cm} + Md^2$$

$$\Rightarrow \quad MK^2 = \frac{2}{5} MR^2 + Md^2$$

$$K = \sqrt{\frac{2}{5} R^2 + d^2}$$

$$K = \sqrt{\frac{2}{5} \times 5^2 + 10^2} \text{ cm}$$

$$K = \sqrt{110} \text{ cm}$$

Value of $\boxed{x = 110}$.

30. Vectors $a\hat{i} + b\hat{j} + \hat{k}$ and $2\hat{i} - 3\hat{j} + 4\hat{k}$ are perpendicular to each other when $3a + 2b = 7$, the ratio of a to b is $\frac{x}{2}$. The value of x is _______.

Answer (1)

Sol. $(a\hat{i} + b\hat{j} + \hat{k}) \cdot (2\hat{i} - 3\hat{j} + 4\hat{k}) = 0$

$2a - 3b + 4 = 0$

$(2a - 3b = -4 \times) \, 7$ … (1)

also, $(3a + 2b = 7 \times) \, 4$ … (2)

adding (1) and (2)

$14a + 12a - 21b + 8b = 0$

$26a - 13b = 0$

$$\frac{a}{b} = \frac{13}{26} = \frac{1}{2}$$

Value of $\boxed{x = 1}$.