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**JEE**  
**(Main)**

**PAPER-1 (B.E./B. TECH.)**

**2023**

**COMPUTER BASED TEST (CBT)**  
**Questions & Solutions**

**Date: 11 April, 2023 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)**

**Duration: 3 Hours | Max. Marks: 300**






**SUBJECT: PHYSICS**

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**PART : PHYSICS**

31. A transmitting antenna is kept on the surface of the earth. The minimum height of receiving antenna required to receive the signal in line of sight at 4 km distance from it is  $x \times 10^{-2}$  m. The value of x is \_\_\_\_.
- (Let, radius of earth  $R = 6400$  km)
- (1) 12.5                      (2) 1250                      (3) 125                      (4) 1.25

NTA Ans. (3)

Reso Ans. (3)

Sol.  $h = \frac{d^2}{2R} = 125 \times 10^{-2} \text{m}$

32. The free space inside a current carrying toroid is filled with a material of susceptibility  $2 \times 10^{-2}$ . The percentage increase in the value of magnetic field inside the toroid will be :
- (1) 1%                      (2) 0.2%                      (3) 0.1%                      (4) 2%

NTA Ans. (4)

Reso Ans. (4)

Sol.  $\frac{B_{\text{with material}}}{B_{\text{free space}}} = \frac{\mu}{\mu_0}$

$= \frac{\mu_0 [1 + X]}{\mu_0}$

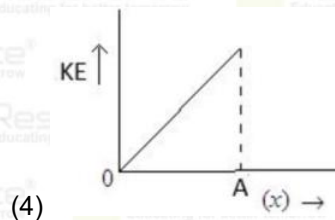
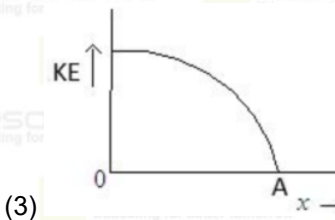
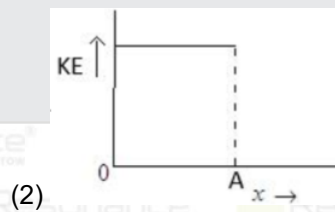
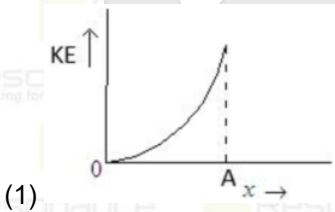
$\frac{B_{\text{with material}} - B_{\text{free space}}}{B_{\text{free space}}} \times 100$

$= X \times 100$

$= 2 \times 10^{-2} \times 100$

$= 2\%$

33. The variation of kinetic energy (KE) of a particle executing simple harmonic motion with the displacement (x) starting from mean position to extreme position (A) is given by :



NTA Ans. (3)

Reso Ans. (3)

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34. Two radioactive elements A and B initially have same number of atoms. The half life of A is same as the average life of B. If  $\lambda_A$  and  $\lambda_B$  are decay constants of A and B respectively, then choose the correct relation from the given options :

(1)  $\lambda_A \ln 2 = \lambda_B$

(2)  $\lambda_A = \lambda_B$

(3)  $\lambda_A = 2\lambda_B$

(4)  $\lambda_A = \lambda_B \ln 2$

NTA Ans. (4)

Reso Ans. (4)

Sol.  $\frac{\ln 2}{\lambda_A} = \frac{1}{\lambda_B}$

$\lambda_A = \lambda_B \ln 2$

35. Given below are two statements :

**Statements I :** Astronomical unit (Au), Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.

**Statement II :**  $Au < \text{Parsec (Pc)} < ly$

In the light of the above statements choose the most appropriate answer from the options given below :

(1) Both statements I and Statements II are correct

(2) Statements I is correct but statements II is incorrect

(3) Both Statements I and Statements II are incorrect.

(4) Statements I is incorrect but Statements II is correct.

NTA Ans. (2)

Reso Ans. (2)

Sol. 1 Parsec. =  $2.06 \times 10^5$  AU = 3.26 light year

$AU < \text{Light Year} < \text{Parsec}$

36. A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the centre. If the angular velocity of the table is halved, it will just slip when placed at a distance of \_\_\_\_ from the centre L

(1) 2 cm

(2) 4 cm

(3) 1 cm

(4) 8 cm

NTA Ans. (2)

Reso Ans. (2)

Sol.  $m\omega^2 r = \mu mg$

$m\left(\frac{\omega}{2}\right)^2 r^1 = \mu mg$

$r = \frac{r^1}{4}$






$r^1 = 4 \text{ cm}$

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37. A parallel plate capacitor of capacitance  $2F$  is charged to a potential  $V$ , the energy stored in the capacitor is  $E_1$ . The capacitor is now connected to another uncharged identical capacitor in parallel combination. The energy stored in the combination is  $E_2$ . The ratio  $E_2/E_1$  is :
- (1) 1 : 2      (2) 2 : 1      (3) 1 : 4      (4) 2 : 3

NTA Ans. (1)

Reso Ans. (1)

Sol.  $E_1 = 1/2 CV^2$

$$E_2 = \frac{1}{2} \cdot 2C \cdot \left[ \frac{CV + 0}{C + C} \right]^2 = \frac{1}{4} CV^2 \quad \therefore \quad \frac{E_2}{E_1} = \frac{\frac{1}{4} CV^2}{\frac{1}{2} CV^2} = \frac{1}{2}$$

38. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafluoride (polyatomic). Arrange these on the basis of their root mean square speed ( $v_{rms}$ ) and choose the correct answer from the options given below :
- (1)  $v_{rms}(\text{mono}) = v_{rms}(\text{dia}) = v_{rms}(\text{poly})$       (2)  $v_{rms}(\text{dia}) < v_{rms}(\text{poly}) < v_{rms}(\text{mono})$   
 (3)  $v_{rms}(\text{mono}) > v_{rms}(\text{dia}) > v_{rms}(\text{poly})$       (4)  $v_{rms}(\text{mono}) < v_{rms}(\text{dia}) < v_{rms}(\text{poly})$

NTA Ans. (3)

Reso Ans. (3)

Sol.  $\sqrt{\frac{3RT}{M}}$

39. Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be :
- (1) 1 : 2      (2) 1 : 4      (3) 4 : 1      (4) 2 : 1

NTA Ans. (3)

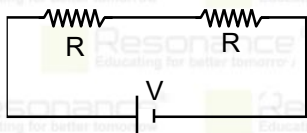
Reso Ans. (3)

Sol. Suppose resistance of each heater filament is  $R$

In Parallel

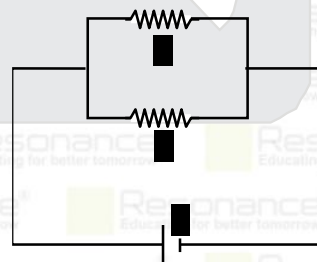
$$H_1 = \frac{V^2}{R_{eq}} \cdot t = \frac{V^2}{\frac{R}{2}} \cdot t = \frac{2V^2}{R} \cdot t$$

In series



$$H_2 = \frac{V^2}{R_{eq}} \cdot t = \frac{V^2}{2R} \cdot t$$

$$\therefore H_1/H_2 = 4/1$$



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40. The current sensitivity of moving coil galvanometer is increased by 25%. This increase is achieved only by changing in the number of turns of coils and area of cross section of the wire while keeping the resistance of galvanometer coil constant. The percentage change in the voltage sensitivity will be :  
 (1) -50%                      (2) +25%                      (3) zero                      (4) -25%

NTA Ans. (2)

Reso Ans. (2)

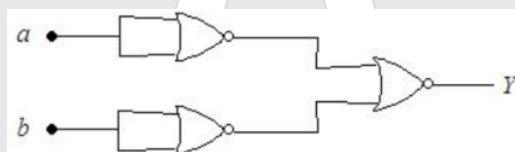
Sol.  $C.S = \frac{NBA}{K}$

and  $V.S = \frac{NBA}{KR}$

∴ R remains constant

∴ % change in V.S. is same as of C.S.

41. The logic performed by the circuit shown in figure is equivalent to :



- (1) NAND                      (2) OR                      (3) NOR                      (4) AND

NTA Ans. (4)

Reso Ans. (4)

Sol. AND

42. On a temperature scale 'X', the boiling point of water is 65°X and the freezing point is -15°X. Assume that the X scale is linear. The equivalent temperature corresponding to -95°X on the Fahrenheit scale would be  
 (1) -112°F                      (2) -148°F                      (3) -63°F                      (4) -48°F

NTA Ans. (2)

Reso Ans. (2)

Sol.  $\frac{C - 0}{100 - 0} = \frac{X - (-15)}{65 - (-15)} = \frac{F - 32}{212 - 32}$

If  $X = 65 \Rightarrow F = ?$

$\frac{65 + 15}{80} = \frac{F - 32}{180}$

$F = -148^\circ\text{F}$

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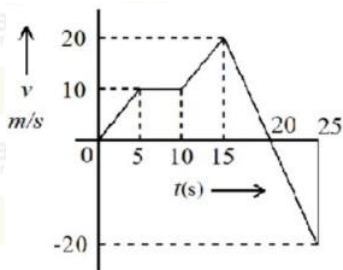
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43. From the v-t graph shown, the ratio of distance to displacement in 25s of motion is :



- (1) 3/5                      (2) 1/2                      (3) 5/3                      (4) 1

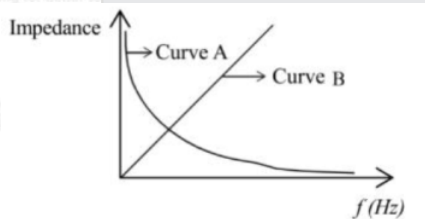
NTA Ans. (3)

Reso Ans. (3)

Sol. Distance = 25 + 50 + 75 + 50 + 50 = 250  
Displacement = 25 + 50 + 75 + 50 - 50 = 150

$$\Rightarrow \frac{250}{150} = \frac{5}{3}$$

44.



As per the given graph, choose the correct representation for curve A and curve B.

{Where  $X_C$  = reactance of pure capacitive circuit connected with A.C. source

$X_L$  = reactance of pure inductive circuit connected with A.C. source.

$R$  = impedance of pure resistive circuit connected with A.C. source.

$Z$  = Impedance of the LCR series circuit}

- (1) A =  $X_L$ , B =  $Z$                       (2) A =  $X_C$ , B =  $R$                       (3) A =  $X_L$ , B =  $R$                       (4) A =  $X_C$ , B =  $X_L$

NTA Ans. (4)

Reso Ans. (4)

Sol. If  $Z = X_C = \frac{1}{\omega C}$   
 $= \frac{1}{2\pi f C} = \frac{1}{(2\pi f)C}$

$Z \propto 1/C$

Curve A represent this relationship.

If  $Z = X_L = \omega L = 2\pi f L = (2\pi L)f$

Curve B represent this relationship.

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45. 1 kg of water at 100°C is converted into steam at 100°C by boiling at atmospheric pressure. The volume of water changes from  $1.00 \times 10^{-3} \text{ m}^3$  as a liquid to  $1.671 \text{ m}^3$  as steam. The change in internal energy of the system during the process will be : (Given latent heat of vaporisation = 2257 kJ/kg. Atmospheric pressure =  $1 \times 10^5 \text{ Pa}$ )

- (1) - 2426 kJ      (2) -2090 kJ      (3) + 2476 kJ      (4) +2090 kJ

NTA Ans. (4)

Reso Ans. (4)

Sol.  $W = P\Delta V = 1 \times 10^5 [1.671 - 0.001]$

$$= 1 \times 10^5 \times 1.670$$

$$= 167 \text{ kJ}$$

$$\Delta Q = mL$$

$$= 1 \times 2257 \text{ kJ}$$

$$= 2257 \text{ kJ}$$

$$\therefore \Delta U = \Delta Q - W$$

$$= 2090 \text{ kJ}$$

46. The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are  $\rho$  and  $\rho/3$  respectively. The ratio of acceleration due to gravity at their surface ( $g_A : g_B$ ) will be

- (1) 1 : 16      (2) 3 : 16      (3) 4 : 3      (4) 3 : 4

Ans. (4)

Sol.  $g = \frac{4}{3} \pi G \rho R$

$$\frac{g_1}{g_2} = \frac{\rho_1}{\rho_2} \times \frac{R_1}{R_2} = 3 \times \frac{1}{4} = \frac{3}{4}$$

47. A metallic surface is illuminated with radiation of wavelength  $\lambda$ , the stopping potential is  $V_0$ . If the same surface is illuminated with radiation of wavelength  $2\lambda$ , the stopping potential becomes  $V_0/4$ . The threshold wavelength for this metallic surface will be :

- (1)  $3\lambda$       (2)  $4\lambda$       (3)  $\frac{3}{2}\lambda$       (4)  $\frac{\lambda}{4}$

NTA Ans. (1)

Reso Ans. (1)

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**Sol.** Let  $\lambda_0$  is the threshold wavelength

$$eV = hc \left( \frac{1}{\lambda} - \frac{1}{\lambda_0} \right)$$

$$eV_0 = hc \left( \frac{1}{\lambda} - \frac{1}{\lambda_0} \right) \dots(1)$$

$$\frac{eV_0}{4} = hc \left( \frac{1}{2\lambda} - \frac{1}{\lambda_0} \right) \dots(2)$$

eq (1)/eq (2)

$$= \frac{hc \left( \frac{1}{\lambda} - \frac{1}{\lambda_0} \right)}{hc \left( \frac{1}{2\lambda} - \frac{1}{\lambda_0} \right)}$$

$$\left( \frac{1}{2\lambda} - \frac{1}{\lambda_0} \right) = \left( \frac{1}{\lambda} - \frac{1}{\lambda_0} \right)$$

$$\frac{24}{\lambda} - \frac{4}{\lambda_0} = \frac{1}{\lambda} - \frac{1}{\lambda_0}$$

$$\frac{2}{\lambda} - \frac{1}{\lambda} = \frac{4}{\lambda_0} - \frac{1}{\lambda_0}$$

$$\frac{2-1}{\lambda} = \frac{4-1}{\lambda_0}$$

$$\frac{1}{\lambda} = \frac{3}{\lambda_0}$$

$$\lambda_0 = 3\lambda$$

threshold wavelength in terms of  $\lambda_0 = 3\lambda$

**48.** The critical angle for a denser-rarer interface is  $45^\circ$ . The speed of light in rarer medium is  $3 \times 10^8$  m/s. The speed of light in the denser medium is :

- (1)  $\sqrt{2} \times 10^8$  m/s      (2)  $2.12 \times 10^8$  m/s      (3)  $3.12 \times 10^7$  m/s      (4)  $5 \times 10^7$  m/s

**NTA Ans. (2)**

**Reso Ans. (2)**

**Sol.**  $\sin C = 1/\mu$

$$\sin 45^\circ = 1/\mu \Rightarrow \mu = \sqrt{2}$$

$$\therefore v = \frac{\text{light speed in vacuum}}{\mu} = \frac{3 \times 10^8}{\sqrt{2}} \text{ m/s} = 2.12 \times 10^8 \text{ m/s}$$

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49. An average force of 125 N is applied on a machine gun firing bullets each of mass 10 g at the speed of 250 m/s to keep it in position. The number of bullets fired per second by the machine gun is :

- (1) 5 (2) 100 (3) 25 (4) 50

NTA Ans. (4)

Reso Ans. (4)

Sol.  $F = \frac{\Delta P}{\Delta t} = \frac{N}{t} \times \frac{10}{1000} \times 250$

$$125 = \frac{5}{2} \times \frac{N}{t} \Rightarrow \frac{N}{t} = 50$$

50. The electric field in an electromagnetic wave is given as  $\vec{E} = 20 \sin \omega \left( t - \frac{x}{c} \right) \hat{j} \text{NC}^{-1}$  where  $\omega$  and  $c$  are angular frequency and velocity of electromagnetic wave respectively. The energy contained in a volume of  $5 \times 10^{-4} \text{ m}^3$  will be (Given  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$ )

- (1)  $17.7 \times 10^{-13} \text{ J}$  (2)  $28.5 \times 10^{-13} \text{ J}$  (3)  $88.5 \times 10^{-13} \text{ J}$  (4)  $8.85 \times 10^{-13} \text{ J}$

NTA Ans. (4)

Reso Ans. (4)

Sol.  $U = \left( \frac{1}{2} \epsilon_0 E^2 \right) \times V$

where  $E = 20 \text{ N/C}$

$V = 5 \times 10^{-3} \text{ m}^3$

$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$

$U = 8.85 \times 10^{-13} \text{ J}$

51. The equation of wave is given by  $Y = 10^{-2} \sin 2\pi(160t - 0.5x + \pi/4)$  where  $x$  and  $Y$  are in m and  $t$  in s. The speed of the wave is \_\_\_\_  $\text{km h}^{-1}$ .

NTA Ans. 1152

Reso Ans. 1152

Sol. Comparing with  $y = A \sin 2\pi \left[ ft - \frac{x}{\lambda} + \phi \right]$

$f = 160 / \text{sec}$

and  $1/\lambda = 0.2 \Rightarrow \lambda = 2\text{m}$

$\therefore u = f\lambda = 320 \text{ m/s}$

$= 1152 \text{ km/h}$

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52. A projectile fired at  $30^\circ$  to the ground is observed to be at same height at time 3s and 5s after projection, during its flight. The speed of projection of the projectile is \_\_\_\_\_  $\text{ms}^{-1}$ . (Given  $g = 10 \text{ ms}^{-2}$ )

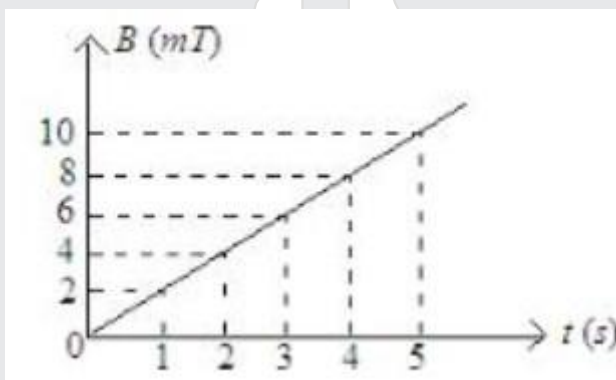
NTA Ans. (80)

Reso Ans. (80)

Sol.  $8 = \frac{2u \sin 30^\circ}{g}$

$u = 80 \text{ m/s}$

53. The magnetic field  $B$  crossing normally a square metallic plate of area  $4\text{m}^2$  is changing with time as shown in figure. The magnitude of induced emf in the plate during  $t = 2\text{s}$  to  $t = 4\text{s}$ , is \_\_\_\_\_  $\text{mV}$ .



NTA Ans. 8

Reso Ans. 8

Sol.  $e = A \cdot \Delta B / \Delta t$

$= 4 \frac{(8-4) \times 10^{-3}}{(4-2)} \text{ volt}$

$= 8 \times 10^{-3} \text{ volt} = 8 \text{ mV}$

54. A monochromatic light is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. The frequency of incident light is  $x \times 10^{15} \text{ Hz}$ . The value of  $x$  is \_\_\_\_\_. (Given  $h = 4.25 \times 10^{-15} \text{ eVs}$ )

NTA Ans. 3

Reso Ans. 3

Sol. For getting 6 different wavelengths, electron should be in 4<sup>th</sup> orbit.

$\therefore$  Energy of incident light  $E = \left[ -\left(\frac{13.6}{4^2}\right) - (13.6) \right] \text{eV}$

$h\nu = 12.75 \text{ eV}$

After taking  $h = 4.25 \times 10^{-15} \text{ eV}\cdot\text{s}$

We get  $\nu = 3 \times 10^{15} \text{ Hz}$

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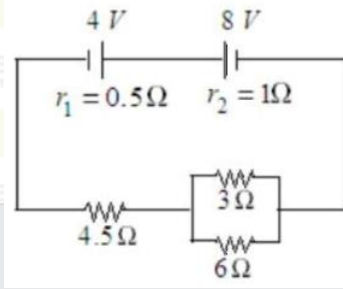
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55. In the circuit diagram shown in figure given below, the current flowing through resistance  $3\Omega$  is  $\frac{x}{3}$  A. The value of x is \_\_\_\_\_



NTA Ans. 1

Reso Ans. 1

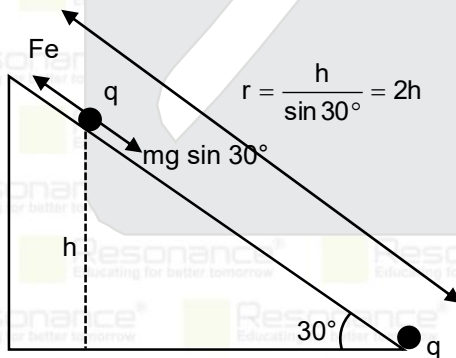
Sol.  $i = \frac{4}{8} = \frac{1}{2}$   
 $i_1 = \frac{1}{2} \times \frac{2}{3} = \frac{1}{3}$  A

56. As shown in the figure, a configuration of two equal point charges ( $q_0 = +2\mu\text{C}$ ) is placed on an inclined plane. Mass of each point charge is 20g. Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height  $h = x \times 10^{-3}$  m. The value of x is \_\_\_\_\_ (Take  $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2 \text{ C}^{-2}$ ,  $g = 10 \text{ ms}^{-2}$ )

NTA Ans. 300

Reso Ans. 300

Sol.



For Equilibrium

$$F_e = mg$$

$$K \cdot \frac{q^2}{r^2} = mg$$

$$9 \times 10^9 \frac{(2 \times 10^{-6})^2}{(2h)^2} = (20 \times 10^{-3}) \times 10$$

$$h = 0.3 \text{ m} = 300 \times 10^{-3} \text{ m}$$

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57. The radius of curvature of each surface of a convex lens having refractive index 1.8 is 20 cm. The lens is now immersed in a liquid of refractive index 1.5. The ratio of power of lens in air to its power in the liquid will be  $x : 1$ . The value of  $x$  is \_\_\_\_\_.

NTA Ans. 4

Reso Ans. 4

$$\text{Sol. } P_{\text{air}} = \frac{1}{f_{\text{air}}} = \left( \frac{1.8}{1} - 1 \right) \left[ \frac{1}{R_1} - \frac{1}{R_2} \right] \dots\dots(1)$$

$$P_{\text{water}} = \frac{1}{f_{\text{water}}} = \left( \frac{1.8}{1.5} - 1 \right) \left[ \frac{1}{R_1} - \frac{1}{R_2} \right] \dots\dots(2)$$

$$(1) / (2)$$

$$\frac{P_{\text{air}}}{P_{\text{water}}} = \frac{4}{1}$$

58. The length of a wire becomes  $l_1$  and  $l_2$  when 100 N and 120N tensions are applied respectively. If  $10l_2 = 11l_1$ , the natural length of wire will be  $\frac{1}{x}l_1$ . Here the value of  $x$  is \_\_\_\_\_.

NTA Ans. 2

Reso Ans. 2

$$\text{Sol. } 100 = K (l_1 - l_0)$$

$$120 = K (l_2 - l_0)$$

$$\frac{6}{5} = \frac{l_2 - l_0}{l_1 - l_0}$$

$$\Rightarrow 6l_1 - 6l_0 = 5l_2 - 5l_0$$

$$\Rightarrow 6l_1 - 5l_2 = l_0 \quad \Rightarrow 6l_1 - \frac{11}{2}l_1 = l_0 \quad \Rightarrow \frac{1}{2}l_1 = l_0$$

59. A force  $\vec{F} = (2 + 3x)\hat{i}$  acts on a particle in the x-direction where  $F$  is in newton and  $x$  is in meter. The work done by this force during a displacement from  $x = 0$  to  $x = 4\text{m}$ , is \_\_\_\_\_ J.

NTA Ans. 32

Reso Ans. 32

$$\text{Sol. } W = \int_{x=0}^{x=4} F dx = 2x + \frac{3x^2}{2}$$

$$= 2(4) + \frac{3}{2}(16) = 8 + 24 = 32 \text{ J}$$

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60. A solid sphere of mass 500g and radius 5 cm is rotated about one of its diameter with angular speed of 10 rad/s. If the moment of inertia of the sphere about its tangent is  $x \times 10^{-2}$  times its angular momentum about the diameter. Then the value of  $x$  will be \_\_\_\_\_.

NTA Ans. 35

Reso Ans. 35

Sol.  $I_{\text{tan}} = \frac{7}{5}MR^2$  = about tangent

$$\frac{I_{\text{tan}}}{L} = x \times 10^{-2} \quad \dots(1)$$

$$L = I_{\text{dia}}\omega = \frac{2}{5}MR^2 \times 10 \quad \dots(2)$$

From (1) and (2)

$$\frac{\frac{7}{5}MR^2}{\frac{2}{5}MR^2 \times 10} = x \times 10^{-2}$$

$$\frac{7}{20 \times 10^{-2}} = x$$

$$x = \frac{700}{20} = 35 \text{ Ans}$$

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