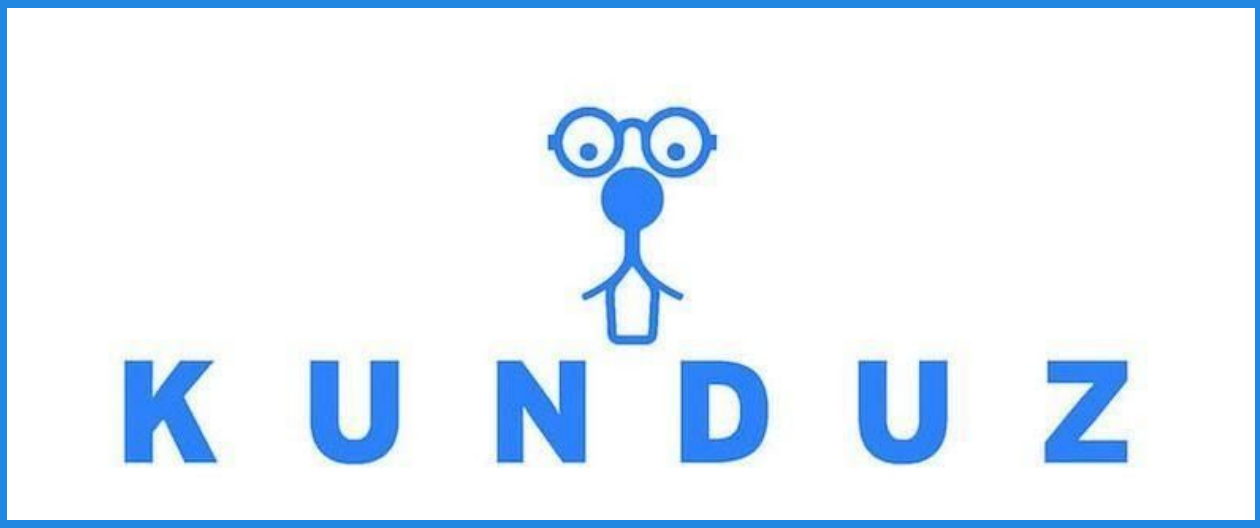
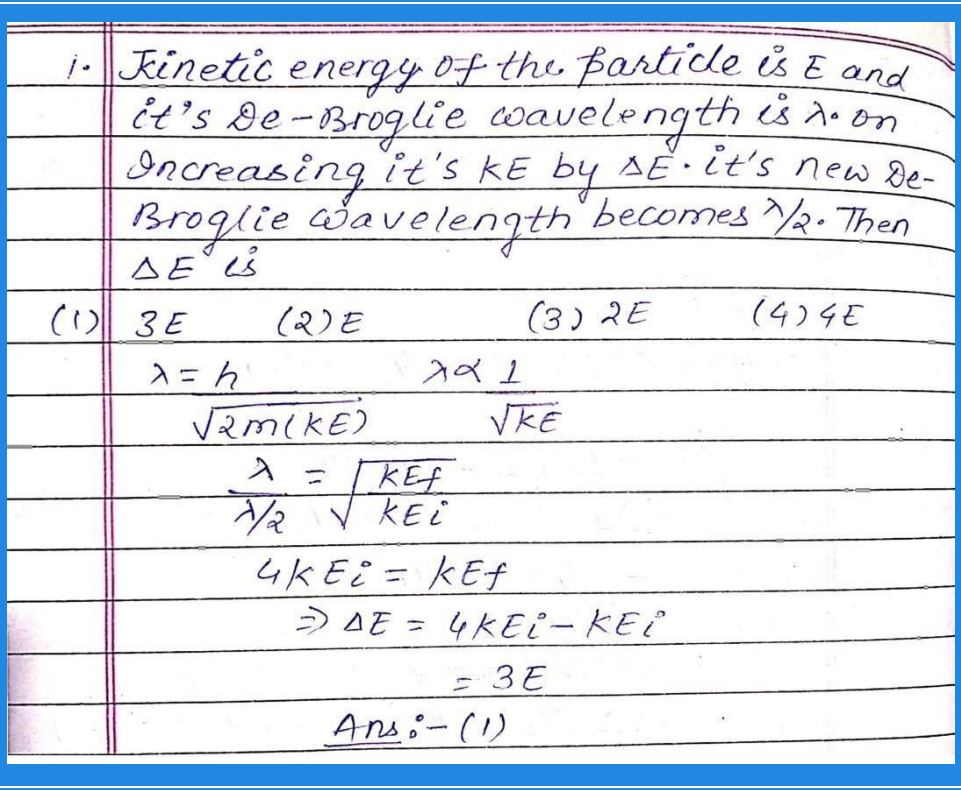
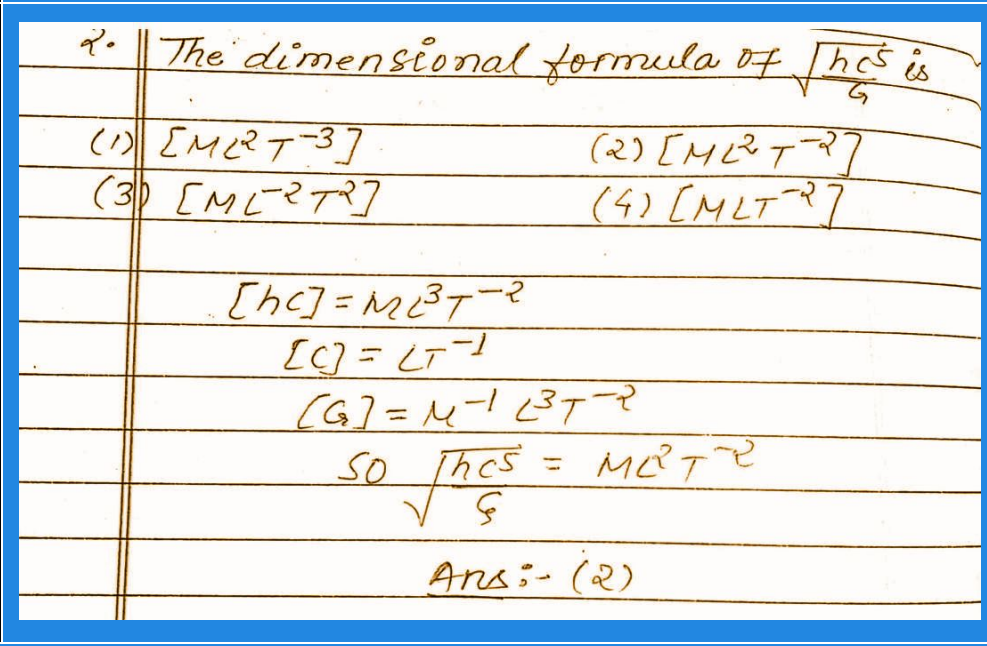


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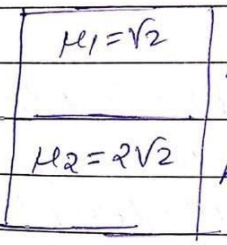
Question no.	Questions and Answers
1	
2	

3

3. Two immiscible liquids of Refractive index $\sqrt{2}$ and $2\sqrt{2}$ are filled with equal height h in a vessel. Then apparent depth of bottom surface of the container given that outside medium is air :-

(1) $\frac{3\sqrt{2}h}{4}$ (2) $\frac{3h}{4}$

(3) $\frac{3h}{2}$ (4) $\frac{3h}{4\sqrt{2}}$

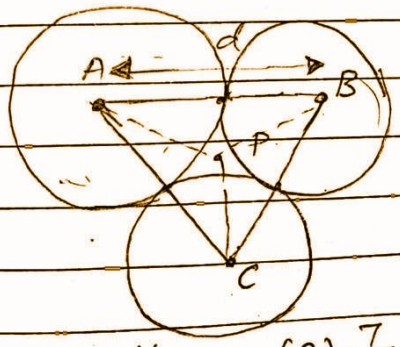


$$d = \frac{h}{\sqrt{2}} + \frac{h}{2\sqrt{2}}$$

$$= \frac{3\sqrt{2}h}{4}$$

4

4. Three identical solid spheres each having mass m and diameter d are touching each other as shown in figure. Calculate ratio of moment of inertia about an axis (⊥ to plane of paper) passing through Point P and B as shown in figure. Given P is Centroid of triangle ABC.



(1) $\frac{13}{23}$ (2) $\frac{11}{19}$ (3) $\frac{7}{9}$ (4) $\frac{13}{11}$

M.I about $P = 3\left[\frac{2}{5}M\left(\frac{d}{2}\right)^2 + M\left(\frac{d}{\sqrt{3}}\right)^2\right] = \frac{13}{10}Md^2$

M.I about $B = 2\left[\frac{2}{5}M\left(\frac{d}{2}\right)^2 + M(d)^2\right] + \frac{2}{5}M\left(\frac{d}{2}\right)^2$

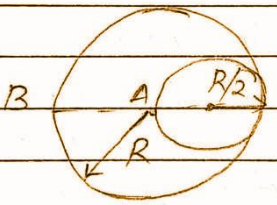
$= \frac{23}{10}Md^2$

Now Ratio $= \frac{13}{23}$

Ans :- (1)

5

5. A solid sphere having radius R and uniform charge density ρ has a cavity of radius R/2 as shown in figure. find the ratio of magnitude of electric field at point A and B i.e. $\left|\frac{E_A}{E_B}\right|$



(1) 18/19 (2) 11/17 (3) 9/17 (4) 9/19

For a solid sphere

$$E = \frac{\rho r}{3\epsilon_0}$$

$$E_A = -\frac{\rho R}{2(3\epsilon_0)} \qquad |E_A| = \frac{\rho R}{6\epsilon_0}$$

Electric field at point B = $E_B = E_{1A} + E_{2A}$

$$E_{1A} = \frac{\rho R}{3\epsilon_0} \qquad E_{2A} = -\frac{\rho R}{54\epsilon_0}$$

$$E_B = E_{1A} + E_{2A} = \frac{\rho R}{3\epsilon_0} - \frac{\rho R}{54\epsilon_0} = \frac{17\rho R}{54\epsilon_0}$$

$$\left|\frac{E_A}{E_B}\right| = \frac{9}{17}$$

Ans :- (3)

6

6. Consider an infinitely long current carrying cylindrical straight wire having radius a. Then the ratio of magnetic field at distance a/3 ~~from~~ 2a from axis of wire is :-

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



$$B_A = \frac{\mu_0 i r}{2\pi a^2} = \frac{\mu_0 i}{6\pi a}$$

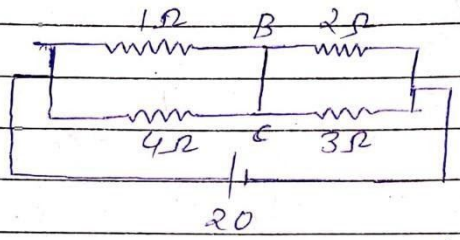
$$B_B = \frac{\mu_0 i}{2\pi(2a)}$$

$$\frac{B_A}{B_B} = \frac{4}{6} = \frac{2}{3}$$

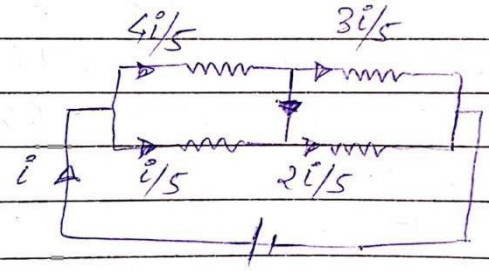
Ans :- (2)

7

7. find current in the wire BC.



(1) 1.6A (2) 2A (3) 2.4A (4) 3A



$R_{eff} = \frac{4}{5} + \frac{6}{5}$

$= 2\Omega$

$i = \frac{20}{2} = 10\ A$

$I = \frac{4i}{5} = \frac{3i}{5} = \frac{i}{5} = 2A$

8

8. Two electromagnetic waves are moving in free space whose electric field Vectors are given by $\vec{E_1} = E_0 \hat{j} \cos(kx - \omega t)$ & $\vec{E_2} = E_0 \hat{k} \cos(ky - \omega t)$. A charge q is moving with velocity $\vec{v} = 0.8c\hat{j}$. find the net lorentz force on this charge at $t = 0$ and when it is at origin.

(1) $q E_0 (0.4\hat{i} + 0.2\hat{j} + 0.2\hat{k})$ (2) $q E_0 (0.8\hat{i} + \hat{j} + 0.2\hat{k})$

(3) $q E_0 (.0.6\hat{i} + \hat{j} + 0.2\hat{k})$ (4) $q E_0 (0.8\hat{i} + \hat{j} + \hat{k})$

Magnetic field Vectors associated with this electromagnetic wave are given by

$\vec{B_1} = \frac{E_0}{c}\hat{k}\cos(kx-\omega t)$ & $\vec{B_2} = \frac{E_0}{c}\hat{i}\cos(ky-\omega t)$

$\vec{F} = q\vec{E} + q(\vec{v}\times\vec{B})$

$= q(\vec{E_1}+\vec{E_2}) + q(\vec{v}\times(\vec{B_1}+\vec{B_2}))$

by putting value of E_1, E_2, B_1 & B_2.

Net Lorentz $= qE_0[0.8\hat{i}+\hat{j}+0.2\hat{k}]$

Ans :- (2).

9

9. Two ideal di-atomic gases A and B. A is rigid, B has an extra degree of freedom due to vibration, Mass of A is m and Mass of B is $m/4$. The ratio of molar specific heat of A to B at Constant Volume

(1) 7/9 (2) 5/9 (3) 5/11 (4) 5/7 Ans :-

Molar Heat Capacity of A at Constant Volume = $5R/2$

Molar Heat Capacity of B at Constant Volume = $7R/2$

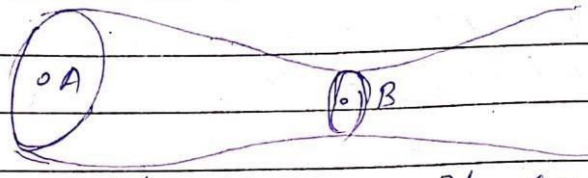
Dividing both,

$\frac{(C_V)_A}{(C_V)_B} = \frac{5}{7}$

Ans :- (4)

10

10. An ideal liquid (water) flowing through a tube of non-uniform cross section area at A and B are 40 cm^2 and 20 cm^2 respectively. If pressure difference between A and B is 700 N/m^2. then volume flow rate is :-



(1) 2732 cm^3/s (2) 2142 cm^3/s (3) 1832 cm^3/s (4) 3218 cm^3/s.

using equation of Continuity

$$40 V_A = 20 V_B$$

$$\Rightarrow 2 V_A = V_B$$

using Bernoullies equation

$$P_A + \frac{1}{2} \rho V_A^2 = P_B + \frac{1}{2} \rho V_B^2$$

$$P_A - P_B = \frac{1}{2} \rho (V_B^2 - V_A^2)$$

$$\Delta P = 500 \times \frac{3 V_B^2}{4}$$

$$V_B = \sqrt{\frac{(\Delta P) \times 4}{1500}} = \sqrt{\frac{700 \times 4}{1500}}$$

Volume flow rate = 2732 cm^3/s.

Ans :- (1)

11

11. A screw gauge advances by 3 mm in 6 rotations. There are 50 divisions on circular scale. find least Count of screw gauge?

(1) 0.002 cm (2) 0.001 cm

(3) 0.01 cm (4) 0.02 cm

pitch = 3/6 = 0.5 mm

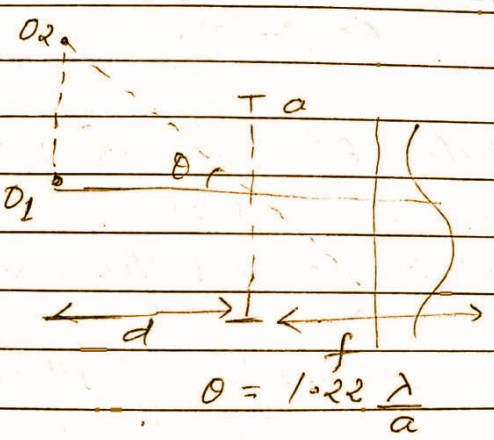
L.C = 0.5/50 = 0.001 cm

Ans :- (2)

12

12. A telescope of aperture diameter 5m is used to observe the moon from the earth. Distance between the moon and earth is 4×10^5 km. Determine the minimum distance between two point on the moon's surface which can be resolved using this telescope.

(1) 60 m (2) 20 m (3) 600 m (4) 200 m



$\theta = 1.22 \frac{\lambda}{a}$

distance $O_1O_2 \simeq 58$ mm

So Ans :- (1)

13

13. A particle of mass m is revolving around a planet in a circular orbit of radius R. At the instant the particle has velocity $\vec{v}$, another particle of mass $\frac{m}{2}$ moving at velocity $\vec{v}$ collides perfectly in-elastically with the first particle. The new path of the combined body will take is :-

(1) Circular (2) Elliptical

(3) Straight line (4) Fall directly below on the ground.

Conserving the momentum

$$\frac{m}{2} \cdot \frac{v}{2} + mv = \left(m + \frac{m}{2}\right) v_f$$

$$v_f = \frac{5mv}{2 \times \frac{3m}{2}} = \frac{5v}{6}$$

$v_f < v_{orb} = (v)$ thus combined mass will go to an elliptical path

Ans :- (2).

14

14. Two particles of same mass m moving with velocities $\vec{v_1} = v\hat{i}$ and $\vec{v_2} = v/2\,\hat{i} + v/2\,\hat{j}$ collide in-elastically. find the loss in kinetic energy.

(1) $mv^2/8$ (2) $5mv^2/8$ (3) $mv^2/4$ (4) $3mv^2/8$

Conserving momentum

$$m v \hat{i} + m\left(\frac{v}{2}\hat{i} + \frac{v}{2}\hat{j}\right) = 2m(v_1 \hat{i} + v_2 \hat{j})$$

on solving

$$v_1 = \frac{3v}{4} \quad \text{and} \quad v_2 = \frac{v}{4}$$

Change in K.E :-

$$\left[\frac{1}{2}mv^2 + \frac{1}{2}m\left(\frac{v}{2}\sqrt{2}\right)^2\right] - \frac{1}{2}(2m)\left[\frac{9v^2}{16} + \frac{v^2}{16}\right]$$

$$= \frac{3mv^2}{4} - \frac{5mv^2}{8}$$

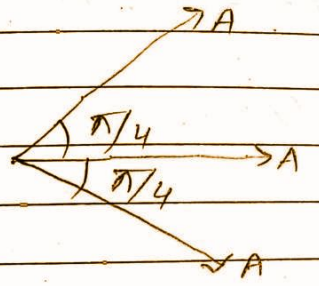
$$= \frac{mv^2}{8}$$

Ans :- (1)

15

15. Three waves of same intensity (I_0) having initial phases $0, \pi/4, -\pi/4$ rad respectively interfere at a point. find the resultant intensity

(1) I_0 (2) 0 (3) $5.8\ I_0$ (4) $0.2\ I_0$



$A_{res} = (\sqrt{2}+1)A$

$I_{res} = (\sqrt{2}+1)^2 I_0$

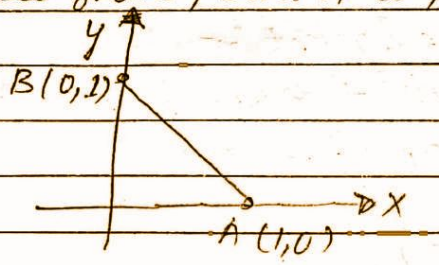
$= (3+2\sqrt{2})I_0$

$= 5.8\ I_0$

Ans :- (3).

16

16. Particle moves from point A to point B along the line shown in figure under the action of force. $\vec{F} = -x\hat{i} + y\hat{j}$. Determine the work done on the particle by $\vec{F}$ in moving the particle from point A to point B



(A) 1J (2) 1/2 J (3) 2J (4) 3J

$$W = \int \vec{F} \cdot d\vec{s}$$

$$= (-x\hat{i} + y\hat{j}) \cdot (dx\hat{i} + dy\hat{j})$$

$$= \int_1^0 -x\,dx + \int_0^1 y\,dy$$

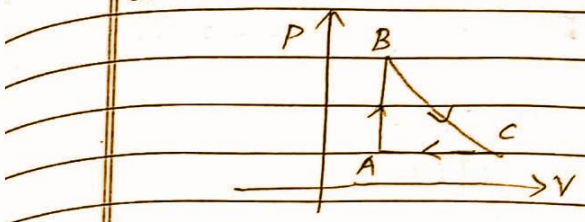
$$= -\frac{x^2}{2}\Big]_1^0 + \frac{y^2}{2}\Big]_0^1$$

$$= \left(0 + \frac{1}{2}\right) + \frac{1}{2} = 1J$$

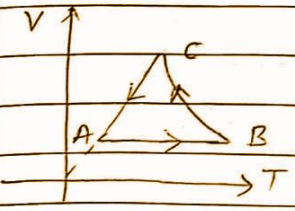
Ans :- (A)

17

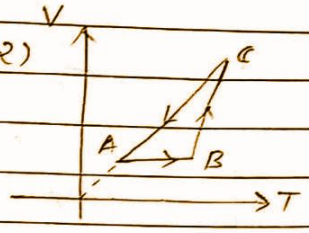
17. for the given P-V graph for an ideal gas, Choose the Correct V-T graph. Process BC is adiabatic.



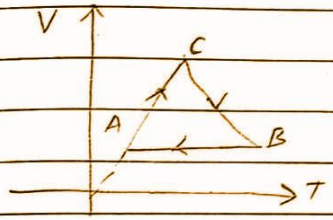
(1)



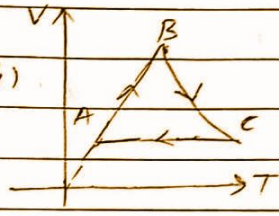
(2)



(3)



(4)



for Process A-B ; Volume is constant;

$PV = nRT$; as P increases T increases

for process B-C;

$PV^{\gamma} = \text{Constant}$;

$TV^{\gamma-1} = \text{Constant}$

for process C-A ; pressure is Constant

$V = kT$

Ans :- (1)

18

18. Given $\vec{p} = -\hat{i} - 3\hat{j} + 2\hat{k}$ and $\vec{r} = \hat{i} + 3\hat{j} + 5\hat{k}$. find vector parallel to electric field at position $\vec{r}$.

(1) $\hat{i} + 3\hat{j} - 2\hat{k}$ (2) $3\hat{i} + \hat{j} + 2\hat{k}$

(3) $-3\hat{i} - \hat{j} - 2\hat{k}$ (4) $-\hat{i} + 3\hat{j} + 2\hat{k}$

Since $\vec{p} \cdot \vec{r} = 0$.

$\vec{A} = a\hat{i} + b\hat{j} + c\hat{k}$.

$\vec{A} \parallel \vec{E}$

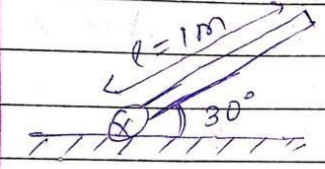
$$\frac{a}{\lambda} = \frac{b}{3\lambda} = \frac{c}{-2\lambda} = k$$

$\vec{A} = \lambda k (\hat{i} + 3\hat{j} - 2\hat{k})$.

Ans :- (1)

21

21. A rod of length 1 m is released from rest as shown in the figure. Below



of ω of rod is $\sqrt{n}$ at the moment it hits the ground then find n.

$$mg\frac{l}{2}\sin 30^\circ = \frac{1}{2}\frac{ml^2}{3}\omega^2$$

$\omega^2 = 15$

$\omega = \sqrt{15}$

Ans :- 15

22

22. If reversible voltage of 200V is applied across an inductor, current in it reduces from 0.25 A to 0A in 0.025 ms. Find inductance of inductor (in mH).

$$200 = \frac{L(0.25) \times 10^3}{0.025}$$

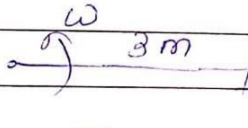
$$L = 200 \times 10^{-4} H$$

$$= 20 \text{ mH}$$

Ans :- 20

23

23. A wire of length $l = 3m$ and area of cross section $10^{-2} cm^2$ and breaking stress $4.8 \times 10^7 N/m^2$ is attached with block of mass 10kg. find the maximum possible value of angular velocity with which block can be moved in circle with string fixed at one end.



$$\frac{T}{A} = \sigma \quad \text{---(1)}$$

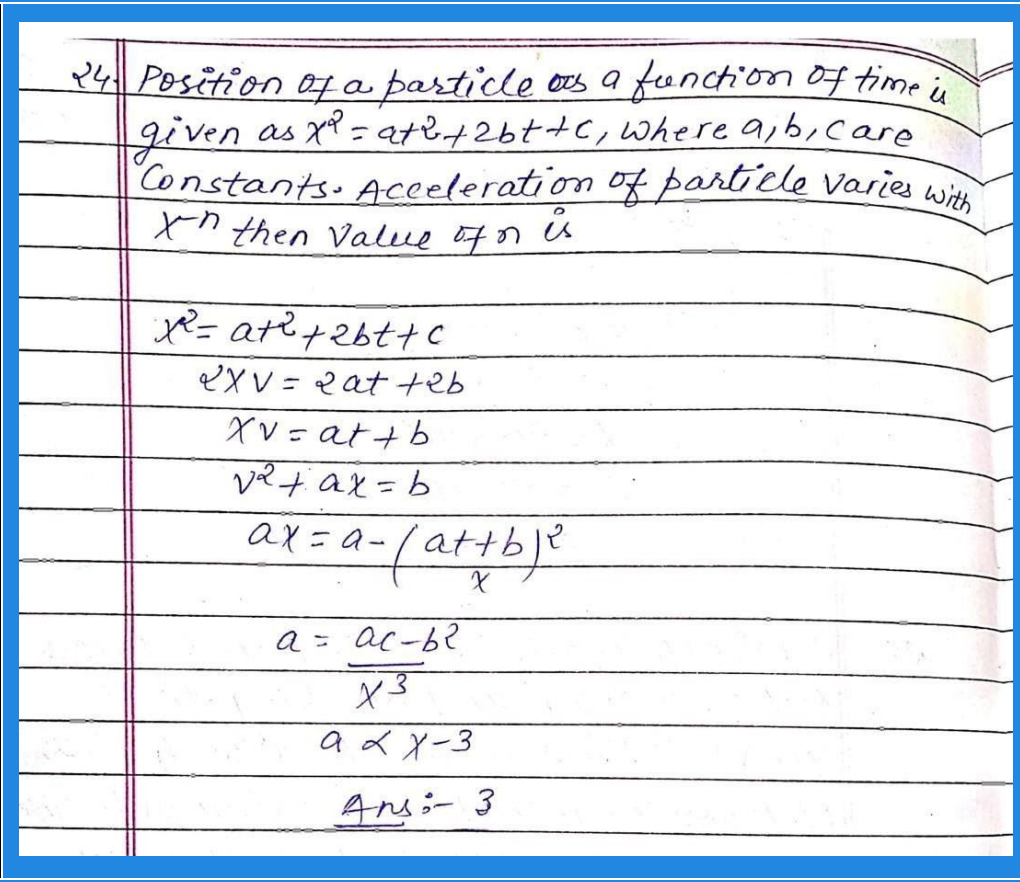
$$T = m\omega^2 l \quad \text{---(2)}$$

Solving

$\omega = 4$ rad/s.

Ans :- (4).

24



24. Position of a particle as a function of time is given as $x^2 = at^2 + 2bt + c$, where a, b, c are constants. Acceleration of particle varies with x^{-n} then value of n is

$x^2 = at^2 + 2bt + c$

$2xv = 2at + 2b$

$xv = at + b$

$v^2 + ax = b$

$ax = a - \frac{(at+b)^2}{x}$

$a = \frac{ac - b^2}{x^3}$

$a \propto x^{-3}$

Ans:- 3

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