FY - 324

FIRST YEAR HIGHER SECONDARY MODEL EXAMINATION - 2021

PHYSICS

1) a) Optics

2) Gravitational force

3) Limiting friction / limiting static friction

4) Angular momentum.

5) $P = \frac{1}{3} nm\bar{v}^2$

6) a) Ampere (A)

b) radian (rad)

7) Distance $= \pi R$

$= 3.14 \times 10$

$= 31.4 m$

Displacement = diameter

$= 2R$

$= 2 \times 10 = 20 m.$

8) a) $-ve$

b) Zero

c) $+ve$

d) Zero

9) 4 times.

$V' = 2V$

$K' = \frac{1}{2} mV'^2 = \frac{1}{2} m (2V)^2$

$= 4 \times \frac{1}{2} mv^2 = 4K$

10) Statement OR $F \propto \frac{m_1 m_2}{r^2}$

11) a) Shearing strain / shearing angle

b) $\theta = \frac{\Delta x}{L}$ ~~OR θ = She~~

12) modulus of elasticity = $\frac{\text{Stress}}{\text{strain}}$

OR

within the elastic limit, the ratio of stress to strain is a constant, called modulus of elasticity.

unit - N/m^2 (OR) Pascal (Pa)

13) Efficiency, $\eta = 1 - \frac{T_2}{T_1}$

$= 1 - \frac{273}{373}$

$= 1 - 0.732$

$\eta = 0.268$

OR $\eta = 26.8\%$

14) Thermodynamic process with Volume constant

OR

$\Delta V =$ Zero.

$W = P\Delta V = 0$

15) Statement

OR

$\tau_{ext} = \frac{dL}{dt}$

If $\tau_{ext} = 0$, $L =$ Constant

16) $\vec{\tau} = \vec{r} \times \vec{F}$

$= (\hat{i} - \hat{j} + \hat{k}) \times (7\hat{i} + 3\hat{j} - 5\hat{k})$

$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -1 & 1 \\ 7 & 3 & -5 \end{vmatrix}$

$= (-1 \times -5 - 1 \times 3)\hat{i} + [1 \times -5 - 1 \times 7]\hat{j} + [1 \times 3 - -1 \times 7]\hat{k}$

$= (5-3)\hat{i} - (-5-7)\hat{j} + (3+7)\hat{k}$

$= 2\hat{i} + 12\hat{j} + 10\hat{k}$

17) $y = V_0 t - \frac{1}{2}gt^2$

$[y] = [M^0L^1T^0] = [L]$

$[V_0 t] = [M^0L^1T^{-1} \times T^1] = [L]$

$[\frac{1}{2}gt^2] = [gt^2] = [M^0L^1T^{-2} \times T^2] = [L]$

The equation is dimensionally correct

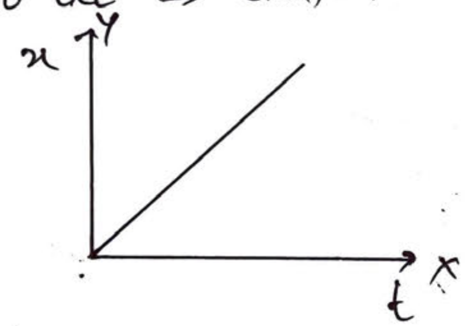
18) a) Average velocity is the ratio of total displacement to total time.

$$\text{Av. velocity} = \frac{\text{Total displacement}}{\text{time}}$$

Average speed is the ratio of total distance to total time.

$$\text{Av. speed} = \frac{\text{total distance}}{\text{time}}$$

b) Zero acc^n ⇒ uniform velocity



19) a) False

b) True

c) True

20) * Statement of II law

OR

$F \propto \frac{dp}{dt}$

* $F \propto \frac{dp}{dt}$

$F = k\frac{dp}{dt}$

$= km\frac{dv}{dt}$

$= kma$

Value of $k = 1$

$\underline{\underline{F = ma}}$

21) a) Torque

b) Rotational effect of linear force is called Torque. It depends on magnitude of force and the perpendicular distance between Fixed point (origin) and line of application of force.

i.e., $\vec{\tau} = \vec{r} \times \vec{F}$

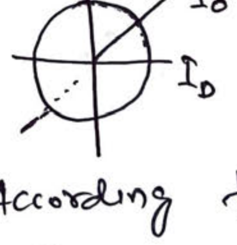
when we apply force on the hinges, $r \approx 0 \Rightarrow \tau \approx 0$

$\Rightarrow$ No rotation

This cannot produce rotation.

22) a) $I = MK^2 = \frac{MR^2}{2} \Rightarrow K^2 = \frac{R^2}{2}$

Radius of gyration, $K = \frac{R}{\sqrt{2}}$ //

b) 

According to $\perp r$ axis theorem

$I_z = I_x + I_y$

Here, $I_z = I_0 = \frac{MR^2}{2}$

$I_x = I_y = I_D$, about diameter

$\therefore \frac{MR^2}{2} = I_D + I_D$

$= 2I_D$

M.I about diameter

$I_D = \frac{MR^2}{4}$

23) a) speed of satellite in an orbit

b) Centripetal force for the satellite is provided by gravitational force.

$$\frac{\cancel{m}V_0^2}{r} = \frac{GM\cancel{m}}{r^2}$$

$$V_0^2 = \frac{GM}{r}$$

$$V_0 = \sqrt{\frac{GM}{r}}$$

OR $V_0 = \sqrt{\frac{GM}{R+h}}$ | $V_0 = \sqrt{\frac{gR^2}{R+h}}$

24) (i) All molecules are in a state of random motion, in all possible directions. During this motion, they collide with each other and also with the walls of the container.

(ii) The collisions are perfectly elastic.

(iii) The pressure exerted by the gas is due to the collision of the gas molecules with the walls of the container.

(iv) The average KE of a molecule is proportional to absolute temperature of the gas.

$\therefore \overline{KE} \propto T$

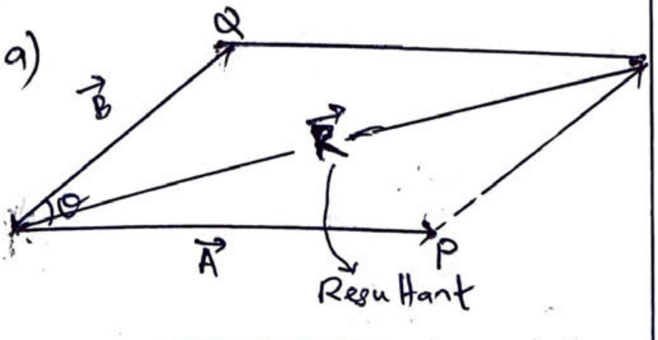
(OR)

Any 2 postulates.

b) $\overline{KE} = \frac{3}{2}K_BT$ | $\overline{KE} = \frac{3}{2}\frac{RT}{N_A}$

25)

a)



b) $R = \sqrt{A^2+B^2+2AB\cos\theta}$

c) $A = 6N$

$B = 8N$

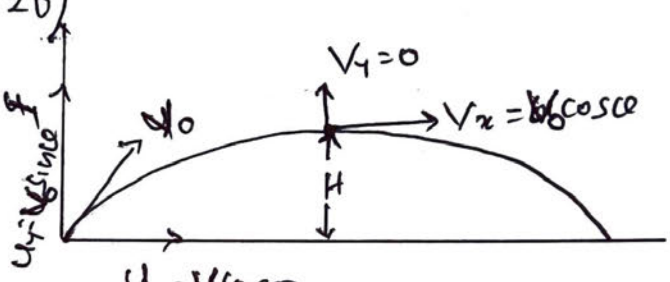
$\theta = 90°$

$F = \sqrt{A^2+B^2}$

$= \sqrt{6^2+8^2}$

$= \underline{10N}$

26)



(i) Max. height (H)

for Maximum height, $u_y = V_0\sin\theta$

$V_y = 0$

$a_y = -g$

$S = H$

Then, $V^2 = u^2 + 2as$

$V_y^2 = u_y^2 + 2a_yS$

$0 = V_0^2\sin^2\theta + 2\times -gH$

$2gH = V_0^2\sin^2\theta$

$$\boxed{H = \frac{V_0^2\sin^2\theta}{2g}}$$

(ii) Time of flight (T)

For time of flight, vertical displacement $y = 0$

$S = ut + \frac{1}{2}at^2$

$y = u_yT + \frac{1}{2}a_yT^2$

$0 = V_0\sin\theta \times T + \frac{1}{2}\times -gT^2$

$$\frac{1}{2} g T^2 = V_0 \sin\theta \times T$$

$$\boxed{T = \frac{2 V_0 \sin\theta}{g}}$$

27) a) Impulsive force is a large force acting for a short period of time.

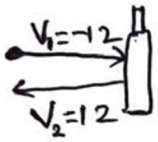
eg:- i) Nail hitting with hammer

ii) A cricket ball hitting with a bat.

b) $V_1 = -12\ m/s$

$V_2 = +12\ m/s$

$m = 0.15\ kg$



$I =$ Change in momentum

$= \Delta P$

$= mV_2 - mV_1$

$= m(V_2 - V_1)$

$= 0.15(12 - {}^{-}12)$

$= \underline{3.6\ Ns}$

28) a) If the force is conservative, Total mechanical energy is conserved.

i.e., $KE + PE =$ Constant

b) At A, $u = 0$

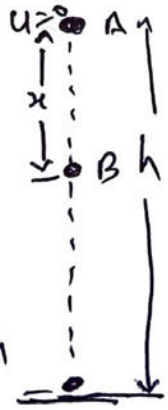
$KE_A = 0$

height $= h$

$PE_A = mgh.$

Total energy, $\cancel{E_T} =$

$E_A = KE_A + PE_A = mgh$



At B $\quad V_B^2 = u^2 + 2aS$

$= 0 + 2gx = 2gx$

$KE_B = \frac{1}{2} m V_B^2 = \frac{1}{2} m \times 2gx$

$= mgx$

height $= (h - x)$

$PE_B = mg(h - x)$

$E_B = KE_B + PE_B$

$= mgx + mg(h - x)$

$= mgh$

At C

height $= 0$

$PE_C = 0$

$V_c^2 = u^2 + 2aS$

$= 0 + 2gh$

$\therefore KE_c = \frac{1}{2} m V_c^2 = \frac{1}{2} m \times 2gh$

$= \underline{mgh}$

i.e., $\underline{E_A = E_B = E_C}$

29) In a stretched spring, the restoring force, $F = -kx$

The applied force, $F = +kx$

For a small displacement dx, workdone, $dW = F\,dx$

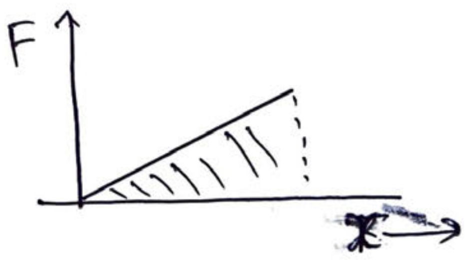
$= kx\,dx$

Total work, $W = \int_0^x kx\,dx$

$= k\left(\frac{x^2}{2}\right)_0^x$

$U_P = \underline{\frac{1}{2} k x^2}$

OR



workdone = potential energy = Area

$= \frac{1}{2} x \times F$

$= \frac{1}{2} x \times kx$

$= \frac{1}{2} k x^2$

30) a) $g = \frac{GM}{R^2}$

b) $g = \frac{GM}{R^2}$

$= \frac{G \times \frac{4}{3}\pi R^3 \rho}{R^2}$

$= G \times \frac{4}{3}\pi R \rho$ — (1)

At a depth d,

$g_d = G \times \frac{4}{3}\pi (R-d)\rho$

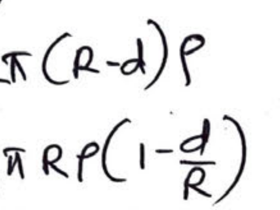
$= G \times \frac{4}{3}\pi R\rho\left(1-\frac{d}{R}\right)$

$$\boxed{g_d = g\left(1-\frac{d}{R}\right)}$$

31) a) Statement – For a continuous flow of liquid in equilibrium, the pressure applied at any point is equally distributed at all points.

b) $M = 3000\,kg$

$A = 425\,cm^2$



$P_1 = P_2$

$\frac{F_1}{a} = \frac{F_2}{A}$

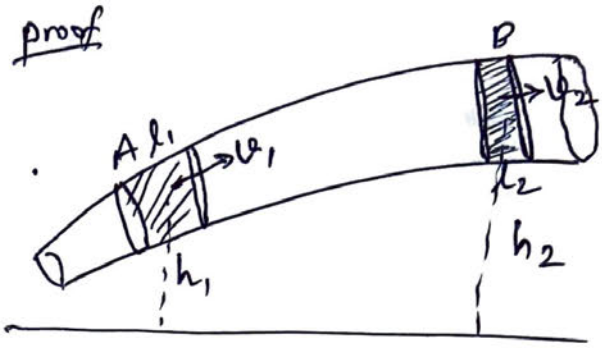
$P_1 = \frac{F_2}{A} = \frac{Mg}{A} = \frac{3000 \times 9.8}{425 \times 10^{-4}}$

$= 6.92 \times 10^5\,Pa$

32) Statement

For a streamline flow of an incompressible liquid/fluid, the sum of pressure energy, kinetic energy and potential energy at any cross section is a constant.

proof



At point A

workdone on the system,

$W_1 = F_1 l_1$ $\qquad P_1 = \frac{F}{a}$

$= P_1 a_1 l_1$

$= P_1 \Delta V$

where ΔV is the volume of liquid flowing in a time Δt

At point B.

workdone by the system,

$W_2 = F_2 l_2$

$= P_2 a_2 l_2$

$= P_2 \Delta V$

Since $a_1 v_1 = a_2 v_2$, equation of continuity

$a_1 \frac{l_1}{\Delta t} = a_2 \frac{l_2}{\Delta t}$

$a_1 l_1 = a_2 l_2 = \Delta V$ is the same at ~~A~~ points A and B.

Net workdone on the system,

$W = W_1 - W_2$

$= (P_1 - P_2)\Delta V$ — (1)

This workdone is used to increase the kinetic energy and potential energy.

$\Delta KE = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$ $\qquad \rho = \frac{m}{\Delta V}$

$= \frac{1}{2}\Delta V \rho (v_2^2 - v_1^2)$ — (2)

$$\Delta PE = mgh_2 - mgh_1$$
$$= \Delta V \rho g(h_2 - h_1) \quad \text{--- (3)}$$

Using work-energy theorem

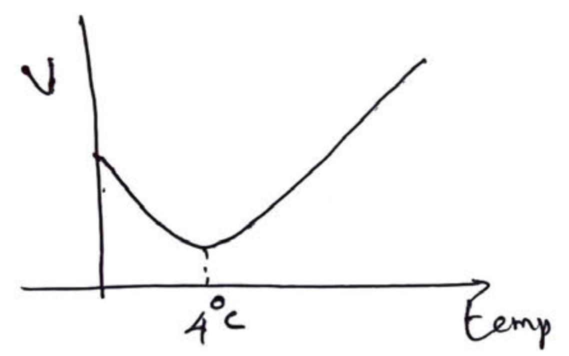
$$W = \Delta KE + \Delta PE$$

$$(P_1 - P_2)\Delta V = \frac{1}{2}\Delta V \rho (V_2^2 - V_1^2) + \Delta V \rho g(h_2 - h_1)$$

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

ie, $P + \frac{1}{2}\rho V^2 + \rho g h = \text{Constant}$

33) a) As the temperature of water increases from 0°c to higher temperature, its volume decreases upto 4°c reaches minimum volume and maximum density. For temperature above 4°c, water expands, and density decreases continuously.

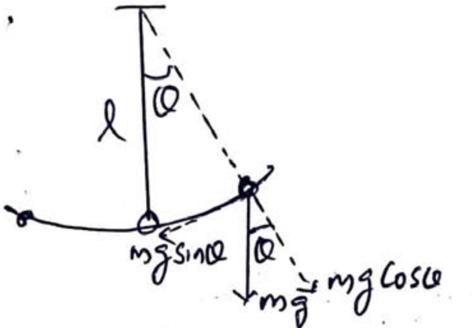


b) $Q = mL$

$= 10 \times 22.6 \times 10^5$

$= 22.6 \times 10^6 \text{ J}$

34)



For SHM, the restoring force,

$$F = -kx \quad \text{--- (1)}$$

Here the component of gravitational force, $mg\sin\theta$ act as restoring force.

$$F = mg\sin\theta.$$

For small oscillation, $\sin\theta \simeq \theta = \frac{x}{l}$

Since, x is away from mean position,

$$F = -mg\theta$$
$$ma = -mg\frac{x}{l}$$

$$a = -\frac{g}{l}x \quad \text{--- (2)}$$

But we have, for SHM,

$$a = -\omega^2 x \quad \text{--- (3)}$$

ie, $\omega^2 = g/l$

$$\omega = \frac{2\pi}{T} = \sqrt{g/l}$$
$$T = 2\pi\sqrt{l/g}$$

35) $y_{(x,t)} = 0.005\sin(80x - 3t)$

general equation,

$$y_{(x,t)} = A\sin(kx - \omega t)$$

a) Amplitude, $A = 0.005$ m. (1)

b) $k = \frac{2\pi}{\lambda} = 80$ rad/m (1½)

$$\lambda = \frac{2\pi}{80} = \frac{2 \times 3.14}{80} = 0.0785 \text{ m}$$

c) $\omega = \frac{2\pi}{T} = 3$ (1½)

$$T = \frac{2\pi}{3} = \frac{2 \times 3.14}{3} = 2.09 \text{ second}$$

36) a) The dimensions of each terms on either side of an equation are same.

b) $K \propto m^x v^y$

$$K = C m^x v^y \quad \text{— ①}$$

$$[K] = [M^1 L^2 T^{-2}] \quad \text{— ②}$$

$$[C m^x v^y] = [m^x v^y]$$

$$= [(M^1 L^0 T^0)^x (M^0 L^1 T^{-1})^y]$$

$$= [M^x L^y T^{-y}] \quad \text{— ③}$$

From ② and ③ ⇒

$$x = 1$$

$$y = 2$$

$$\therefore \text{①} \Rightarrow K = C m^1 v^2$$

$$K = C m v^2$$

37) method 1

Average velocity $\bar{V} = \frac{x}{t}$ — ①

Also, 〃 〃 $\bar{V} = \frac{V_t + V_0}{2}$ — ②

$$\therefore \frac{x}{t} = \frac{V_t + V_0}{2}$$

But, $V_t = V_0 + at$

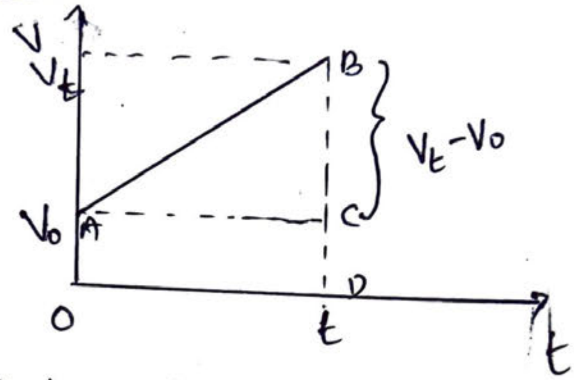
$$\therefore \frac{x}{t} = \frac{V_0 + at + V_0}{2}$$

$$= \frac{2V_0 + at}{2}$$

$$\therefore x = \frac{(2V_0 + at)t}{2}$$

$$= V_0 t + \frac{1}{2} a t^2$$

method 2 (graphical)



displacement = Area under v-t graph.

$$x = \text{Area } OACD + \text{Area } ABC$$

$$= (OA \times OD) + \frac{1}{2} AC \times BC$$

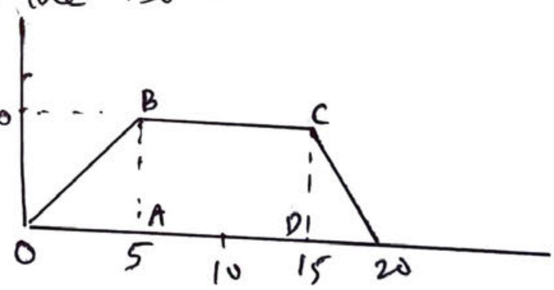
$$= V_0 t + \frac{1}{2} t \times (V_t - V_0)$$

$$= V_0 t + \frac{1}{2} t \times (at)$$

$$x = V_0 t + \frac{1}{2} a t^2$$

Any of the above method

37 b)



Displacement in time interval 5 to 15 s.

$$S = \text{Area } ABCD$$

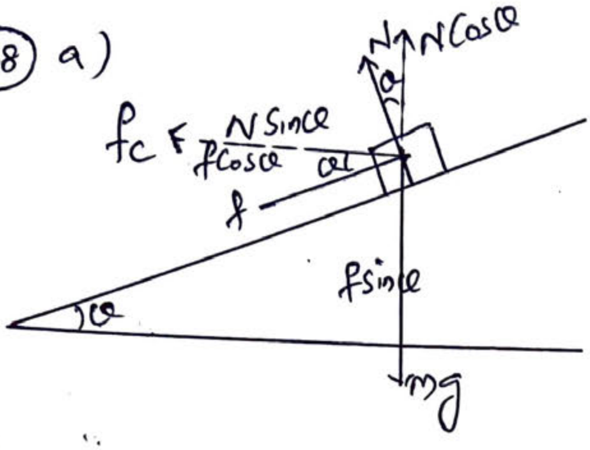
$$= AB \times AD$$

$$= 20 \times (15 - 5)$$

$$= 20 \times 10$$

$$= 200 \text{ m}$$

(38) a)



(b) At equilibrium (Car is not skidding)

$$mg + f\sin\theta = N\cos\theta$$

$$mg = N\cos\theta - f\sin\theta \quad \text{—} ①$$

Centripetal force,

$$f_c = N\sin\theta + f\cos\theta$$

$$\frac{mv^2}{r} = N\sin\theta + f\cos\theta \quad \text{—} ②$$

$$\frac{②}{①} \Rightarrow \frac{mv^2/r}{mg} = \frac{N\sin\theta + f\cos\theta}{N\cos\theta - f\sin\theta}$$

$\div$ ing Nr and Dr of RHS by $N\cos\theta$

$$\frac{v^2}{rg} = \frac{\left(\frac{N\sin\theta}{N\cos\theta} + \frac{f\cos\theta}{N\cos\theta}\right)}{\left(\frac{N\cos\theta}{N\cos\theta} - \frac{f\sin\theta}{N\cos\theta}\right)}$$

$$= \frac{\tan\theta + f/N}{1 - \frac{f}{N}\tan\theta} \quad \text{—} ③$$

But limiting friction $f \propto N$

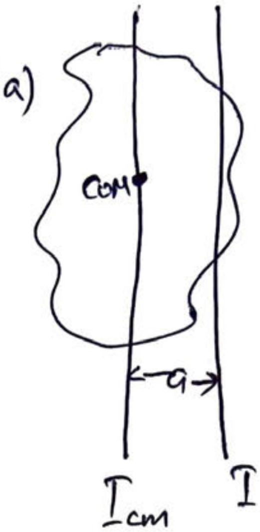
or, $f = \mu N$

$$\frac{f}{N} = \mu.$$

$$③ \Rightarrow \frac{v^2}{rg} = \frac{\tan\theta + \mu}{1 - \mu\tan\theta}$$

$$v = \sqrt{rg\left(\frac{\mu + \tan\theta}{1 - \mu\tan\theta}\right)}$$

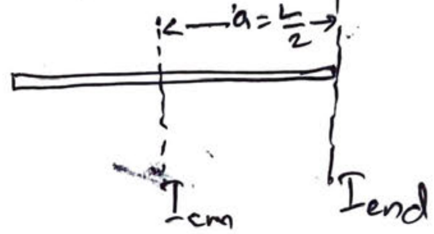
39) a)



'statement' (OR)

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

b)



M·I of a rod about an axis passing through centre ⊥r length,

$$I_{cm} = \frac{ML^2}{12}$$

For the axis passing through one end ⊥r to length is,

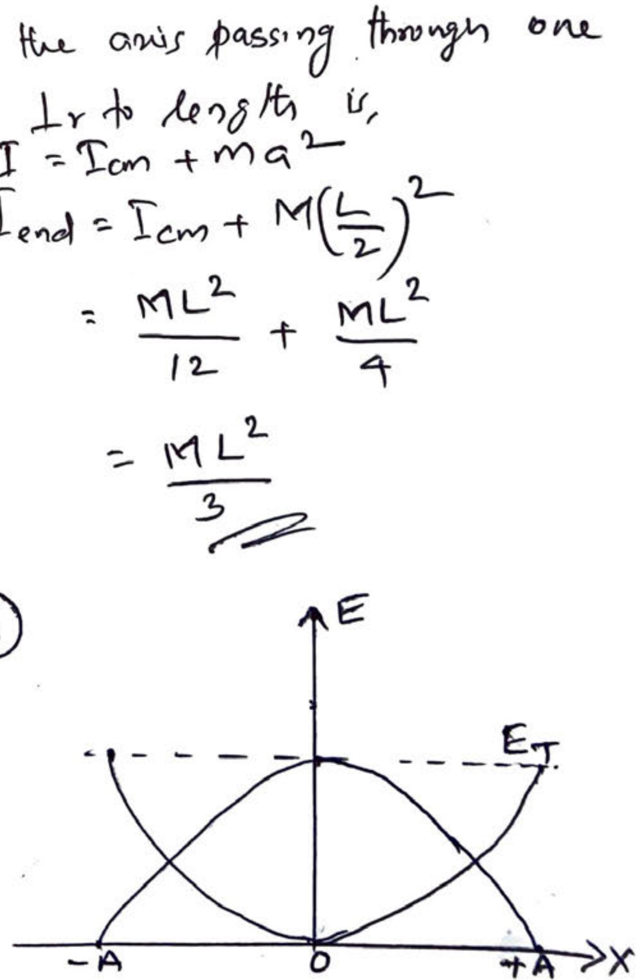
$$I = I_{cm} + ma^2$$

$$I_{end} = I_{cm} + M\left(\frac{L}{2}\right)^2$$

$$= \frac{ML^2}{12} + \frac{ML^2}{4}$$

$$= \frac{ML^2}{3}$$

(29) (b)



40 a) On the surface

$$g = \frac{GM}{R^2} \quad \text{--- (1)}$$

At a height h,

$$g_h = \frac{GM}{(R+h)^2} \quad \text{--- (2)}$$

$$= \frac{GM}{R^2\left(\cancel{R}1+\frac{h}{R}\right)^2}$$

$$= \frac{g}{(1+h/R)^2}$$

$$= g\left(1+\frac{h}{R}\right)^{-2}$$

For small height, $h << R$

then $\left(1+\frac{h}{R}\right)^{-2} \simeq \left(1+ -2\frac{h}{R}\right)$

$$= 1 - \frac{2h}{R}$$

(Hint. $(1+x)^n = 1+nx$, if $x << 1$)

$$\therefore \boxed{g_h = g\left(1-\frac{2h}{R}\right)}$$

b) $h = R/2$

Here $\frac{h}{R} = \frac{1}{2}$ is not very less than 1

So, do not use $g_h = g\left(1-\frac{2h}{R}\right)$

we use,

$$g_h = \frac{GM}{(R+h)^2}$$

$$g_h = \frac{GM}{(R+R/2)^2}$$

$$= \frac{GM}{R^2\left(1+\frac{1}{2}\right)^2}$$

$$= \frac{g}{(3/2)^2}$$

$$= \frac{4}{9}g$$

Compiled by

Lalan.V.M

HSST PHYSICS

GMBHSS Haripad

9496520070