CIRCULAR MOTION TUTORIAL.

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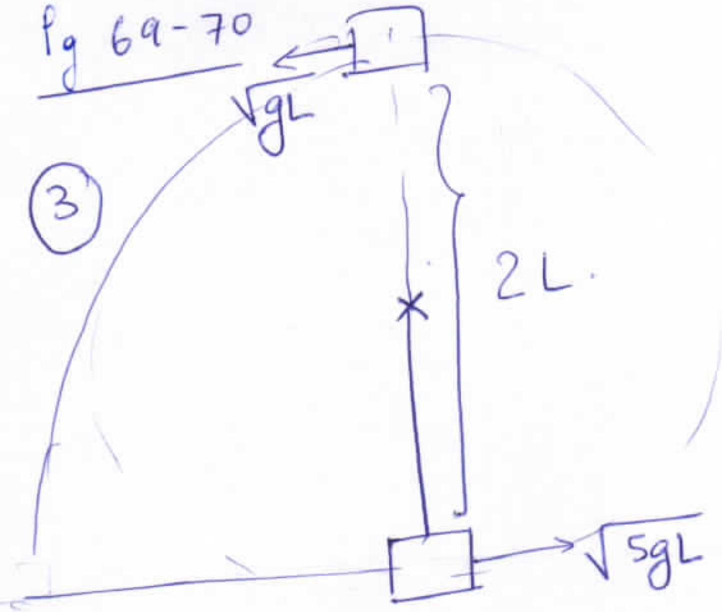
(3)



$$H = \frac{1}{2} g t^2$$

$$t = \sqrt{\frac{2H}{g}}$$

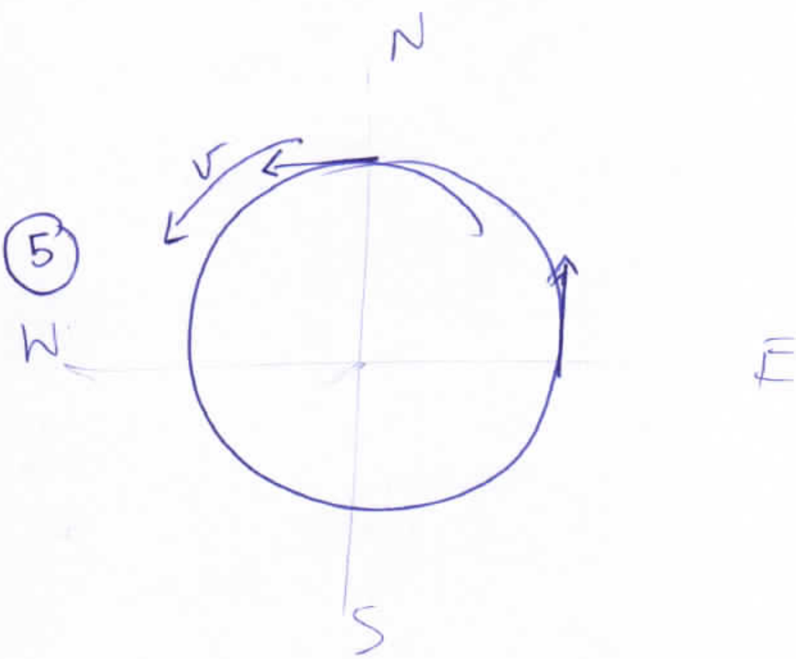
$$t = \sqrt{\frac{2 \times 2L}{g}}$$

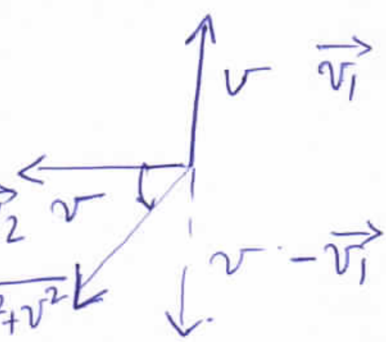
$$R = \sqrt{gL} \times t$$

$$= \sqrt{gL} \times \sqrt{\frac{4L}{g}}$$

$$= 2L$$

(5)





$= \sqrt{2}v$ $\sqrt{v^2+v^2}$

$$\vec{v_2} - \vec{v_1}$$

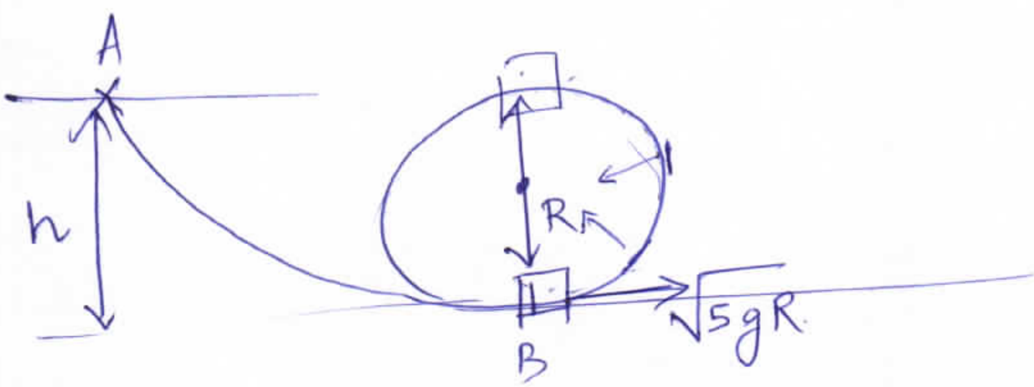
$$\vec{v_2} + (-\vec{v_1})$$

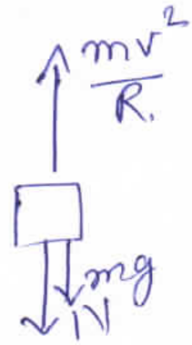
$$\sqrt{v_1^2 + v_2^2 + 2v_1v_2 \cos\theta}.$$

$$= \sqrt{v^2+v^2+2vv\cos 90}$$

$$= \sqrt{v^2+v^2} \qquad = \sqrt{2}v \quad \text{South west.}$$

⑥





$$N = \frac{mv^2}{R} - mg$$

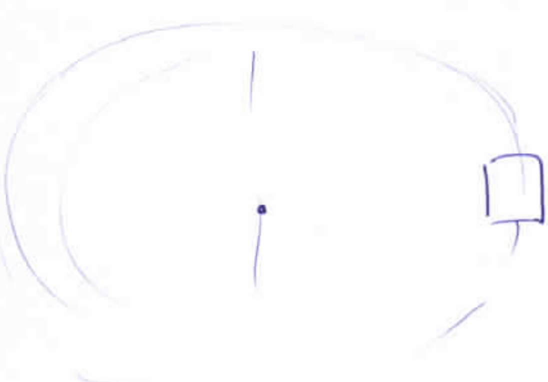
A $\qquad\qquad$ B

$$mgh + \frac{1}{2}m(0)^2 = 0 + \frac{1}{2}m(\sqrt{5gR})^2$$

$$\cancel{m}gh = \frac{1}{2}\cancel{m} \times 5\cancel{g}R.$$

$$h = \frac{5}{2}R = \frac{5}{2} \times 5 = 12.5\,m.$$

Comprehension:



$$\alpha \propto \sqrt{\omega}$$

$$\alpha = -k\sqrt{\omega}$$

$$\frac{d\omega}{dt} = -k\sqrt{\omega}$$

$\omega_0 \longrightarrow 0$

$0 \longrightarrow t$

$$\int_{\omega_0}^{0} \frac{d\omega}{\sqrt{\omega}} = -\int_0^t k\,dt$$

$$\int_{w_0}^{0} w^{-1/2}\, dw = -k\int_{0}^{t} 1\, dt \qquad x^n = \frac{x^{n+1}}{n+1}$$

$$\left.\frac{w^{1/2}}{1/2}\right]_{w_0}^{0} = -kt\Big]_0^t$$

$$\frac{0^{1/2}}{1/2} - \frac{w_0^{1/2}}{1/2} = -k(t-0)$$

$$\cancel{-}2w_0^{1/2} = \cancel{-}kt$$

$$4w_0 = k^2t^2 \Rightarrow t^2 = 4\frac{w_0}{k^2}$$

$$\lambda = 4 \qquad D$$

$$\alpha = w\frac{dw}{d\theta} \qquad a = v\frac{dv}{ds} \qquad a = \frac{dv}{dt}$$

$$w\frac{dw}{d\theta} = -k\sqrt{w}$$

$$\frac{w\,dw}{\sqrt{w}} = -k\,d\theta \Longrightarrow \int_{w_0}^{0}\sqrt{w}\,dw = -\int_{0}^{\theta} k\,d\theta$$

$$\left.\frac{\omega^{3/2}}{3/2}\right]_{\omega_0}^{0} = \left.-k\theta\right]_0^{\theta}$$

$$\frac{0^{3/2}}{3/2} - \frac{\omega_0^{3/2}}{3/2} = -k(\theta - 0)$$

$$\cancel{-}\frac{2\omega_0\sqrt{\omega_0}}{3} = \cancel{-}k\theta$$

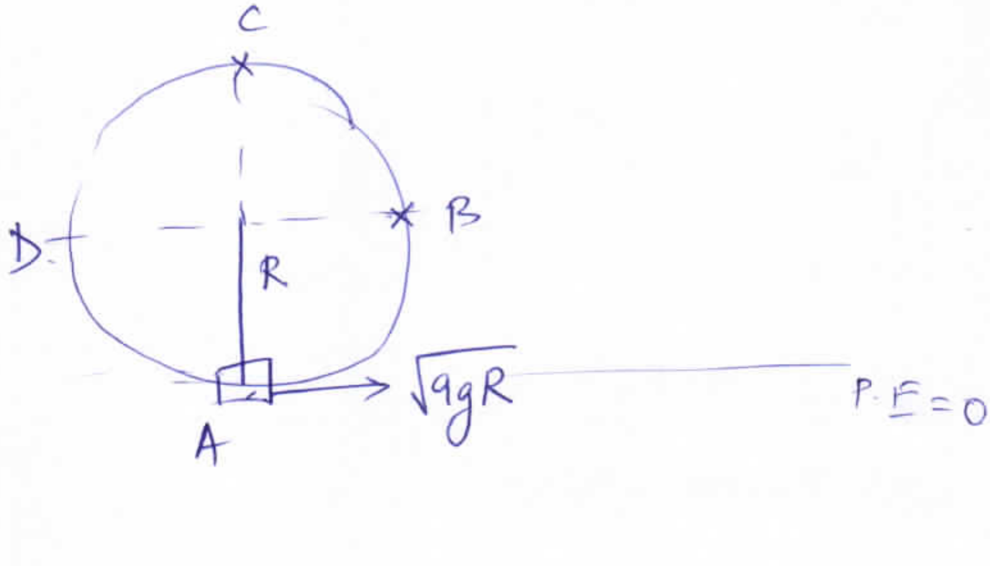
$$\omega_0^{3/2} = \omega_0^{1+1/2} = \omega_0\,\omega_0^{1/2} = \omega_0\sqrt{\omega_0}$$

$$\theta = \frac{2\omega_0\sqrt{\omega_0}}{3k} \quad \text{(B)}$$

$$\langle\omega\rangle = \frac{\text{total angular displacement}}{\text{total time}}$$

$$= \frac{\dfrac{\cancel{2}\omega_0\cancel{\sqrt{\omega_0}}}{3\cancel{k}}}{\dfrac{\cancel{2}\cancel{\sqrt{\omega_0}}}{\cancel{k}}} = \frac{\omega_0}{3} \quad \text{(A)}$$

Pg 71 Matrix



T.E B = T.E A.

$$\frac{1}{2}mv_B^2 + mgR = \frac{1}{2}m(\sqrt{9gR})^2 + 0$$

$$\frac{1}{2}mv_B^2 + mgR = \frac{9}{2}mgR.$$

$$\frac{1}{\cancel{2}}\cancel{m}v_B^2 = \frac{7\cancel{m}gR}{\cancel{2}}.$$

$$v_B = \sqrt{7gR}$$

$A \longrightarrow R.$

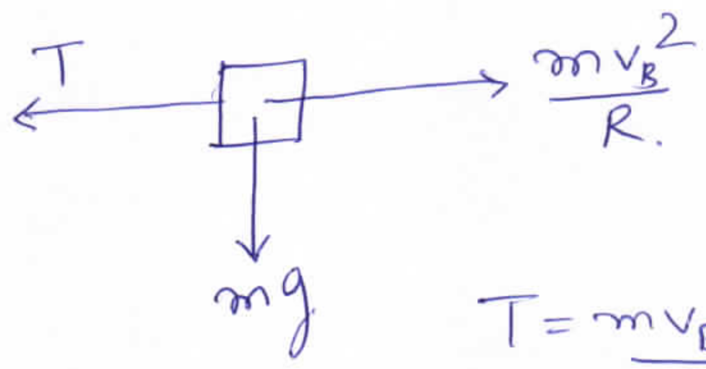
T.E C. T.E. A.

$$\frac{1}{2}mv_C^2 + mg(2R) = \frac{9}{2}mgR$$

$$\frac{1}{\cancel{2}}\cancel{m}v_C^2 = \frac{5\cancel{m}gR}{\cancel{2}}.$$

$$v_C = \sqrt{5gR}$$

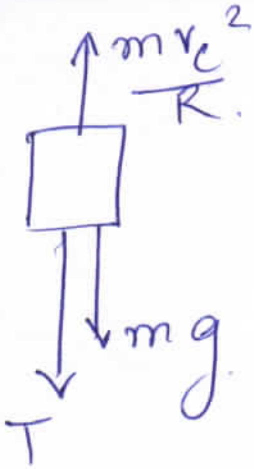
$B \longrightarrow Q.$



$$T = \frac{mv_B^2}{R}.$$

$$= \frac{m(\sqrt{7gR})^2}{R} = 7mg$$

$C \longrightarrow P.$



$$T + mg = \frac{mv_c^2}{R}$$

$$T = \frac{mv_c^2}{R} - mg$$

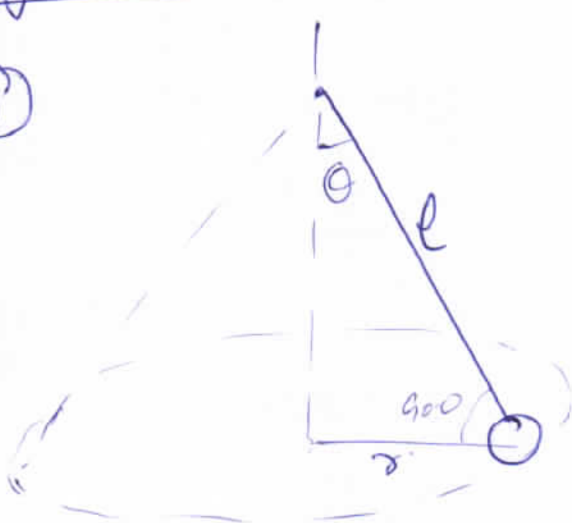
$$= \frac{m(\sqrt{5gR})^2}{R} - mg$$

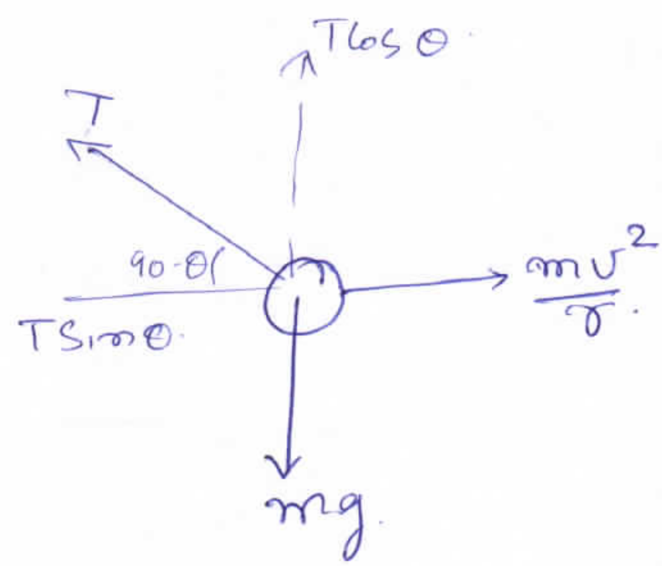
$$= 4mg$$

D $\longrightarrow$ T

Pg 72–75

(1)





~~tan~~ $\sin\theta = \frac{r}{l}$

$= \frac{0.5}{1} = \frac{1}{2}$

$\theta = 30^\circ$

$T\cos\theta = mg$

$T\sin\theta = \frac{mv^2}{r}$

$\tan\theta = \frac{v^2}{rg}$

$$\tan 30^\circ = \frac{v^2}{rg}$$

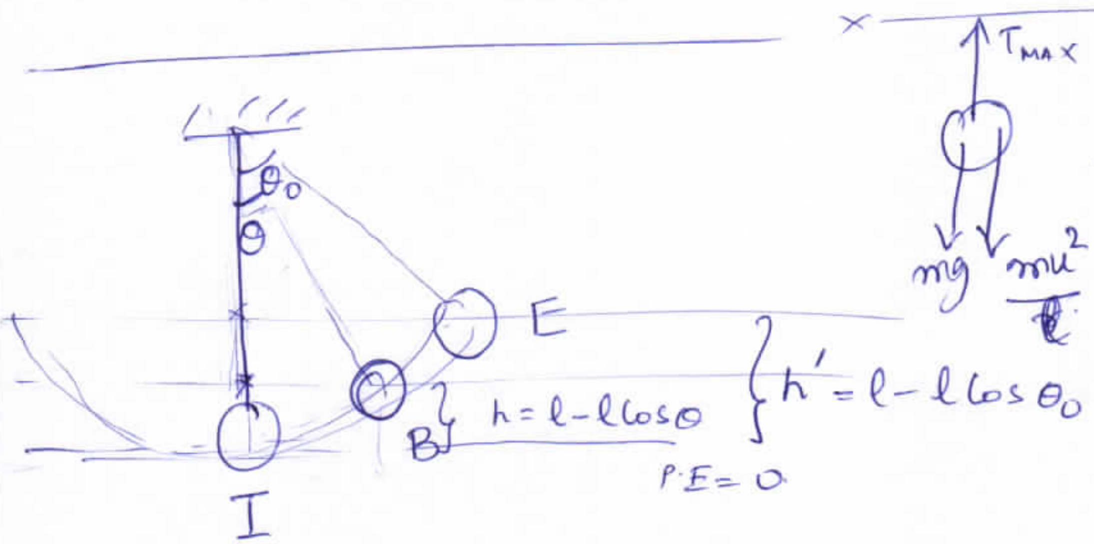
$$\frac{1}{\sqrt{3}} = \frac{v^2}{0.5\times 10} \Rightarrow v^2 = \frac{5}{\sqrt{3}}$$

$$T = \frac{2\pi r}{v} = \frac{2\times 3.14\times 0.5}{\sqrt{\frac{5}{\sqrt{3}}}} = 1.8 \text{ seconds.}$$

$$T\cos\theta = mg$$

$$T\times\frac{\sqrt{3}}{2} = 0.5\times 10$$

$$T = \frac{2\times 5}{\sqrt{3}} = \frac{10}{\sqrt{3}}\ N$$



$$T_{MAX} = mg + \frac{mu^2}{l}.$$

B I. E.

$$\frac{1}{2}mv^2 + mgl(1-\cos\theta) = \frac{1}{2}mu^2 + 0 = \frac{1}{2}m(0)^2 + mgl(1-\cos\theta)$$

$$\frac{mu^2}{l} = \frac{mv^2}{l} + \frac{2mg\cancel{l}(1-\cos\theta)}{\cancel{l}}$$

$$T_{MAX} = \frac{mu^2}{l} + mg$$

$$= \left\{\frac{mv^2}{l} + 2mg(1-\cos\theta)\right\} + mg$$

$$= \frac{mv^2}{l} + 3mg - 2mg\cos\theta$$

$$= \frac{mv^2}{l} + mg(3-2\cos\theta)$$

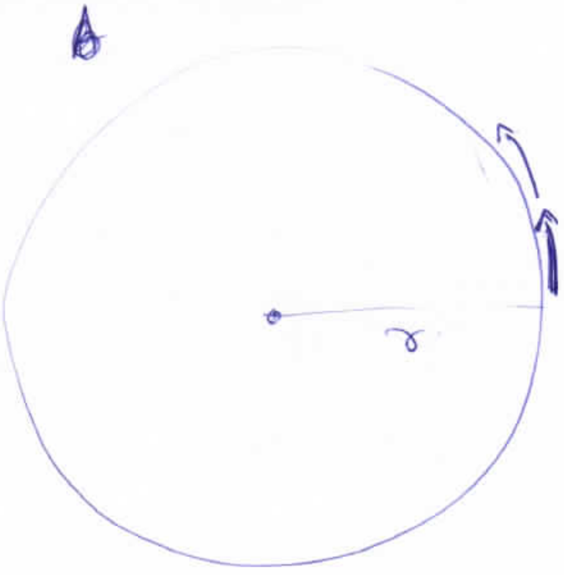
$$\frac{1}{2}\cancel{m}v^2 + \cancel{m}gl(1-\cos\theta) = \cancel{m}gl(1-\cos\theta_0)$$

$$\frac{v^2}{2} + \cancel{gl} - gl\cos\theta = \cancel{gl} - gl\cos\theta_0$$

$$\cos\theta_0 = \cos\theta - \frac{v^2}{2gl}$$

$$\theta_0 = \cos^{-1}\left(\cos\theta - \frac{v^2}{2gl}\right)$$

(22)



$v = \beta\sqrt{s}$ $\quad \frac{dv}{ds} = \frac{\beta}{2\sqrt{s}}$

$a_c = \frac{v^2}{r} = \frac{\beta^2 s}{r}$

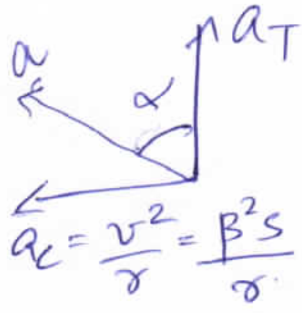
$a_T = v\frac{dv}{ds} = (\beta\cancel{\sqrt{s}})\frac{\beta}{2\cancel{\sqrt{s}}} = \frac{\beta^2}{2}$

$v^2 = 2as$

$v = \sqrt{2as}$

$= \sqrt{2a}\sqrt{s} \Rightarrow \beta = \sqrt{2a}.$

$\frac{\beta^2}{2} = a_T$



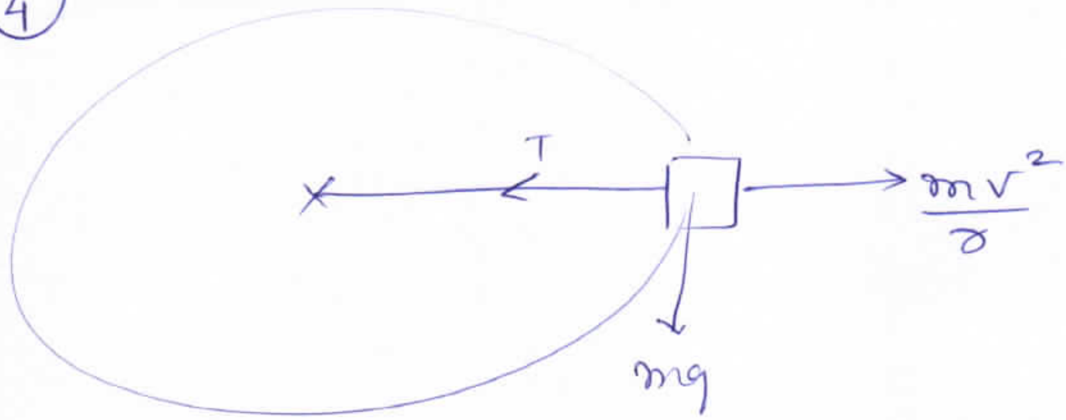
$\tan\alpha = \frac{a_c}{a_T} = \frac{\cancel{\beta^2} s/r}{\cancel{\beta^2}/2} = \frac{2s}{r}.$

$\alpha = \tan^{-1}\frac{2s}{r}$

$a = \sqrt{a_T^2 + a_c^2} = \sqrt{\frac{\beta^4}{4} + \frac{\beta^4 s^2}{r^2}}$

$= \beta^2\sqrt{\frac{r^2+4s^2}{4r^2}}$

(4)



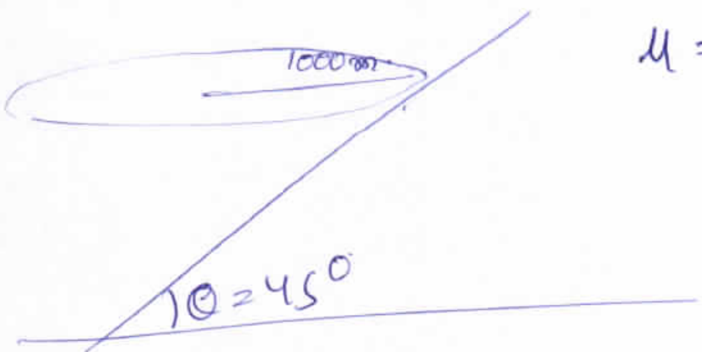
$$T = \frac{mv^2}{r}.$$

$$v = \sqrt{\frac{Tr}{m}}.$$

$$v_{MAX} = \sqrt{\frac{T_{MAX}\, r}{m}} = \sqrt{\frac{25 \times 1.96}{0.25}}$$

$$= \sqrt{196} = 14 \text{ m/s}$$

(5)



$\mu = 0.5.$

$$v_{MAX} = \sqrt{\frac{rg(\mu + \tan\theta)}{1 - \mu\tan\theta}}.$$

$$= \sqrt{1000 \times 10 \left(\frac{0.5+1}{1-0.5}\right)}$$

$$= \sqrt{10^4 \times 3}.$$

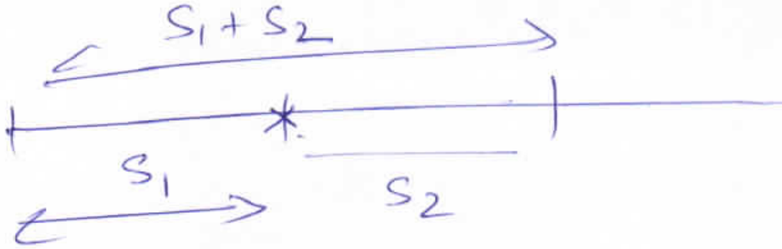
$$= \sqrt{3} \times 100$$

$$= 1.732 \times 100 = 173.2 \text{ m/s}$$

(A)

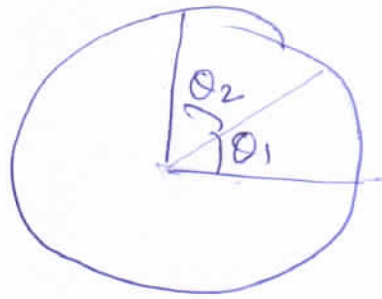
Pg 80-81

(9) $\alpha = \text{const}$.
ω is changing.



$t : 0 \rightarrow 2 \quad \theta_1$

$t : 0 \rightarrow 4 \quad \theta_1 + \theta_2$



$\omega_0 = 0$

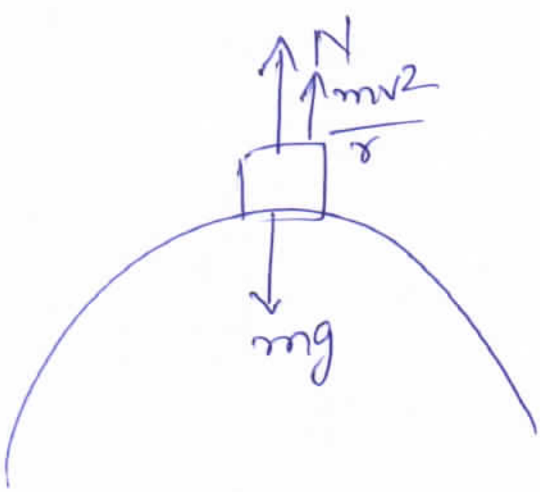
$\theta_1 = \underbrace{\cancel{\omega_0 t}}_{0} + \frac{1}{2}\alpha(2)^2 \Rightarrow \theta_1 = 2\alpha$.

$\theta_1 + \theta_2 = \underbrace{\cancel{\omega_0 t}}_{0} + \frac{1}{2}\alpha(4)^2 \Rightarrow \theta_1 + \theta_2 = 8\alpha$.

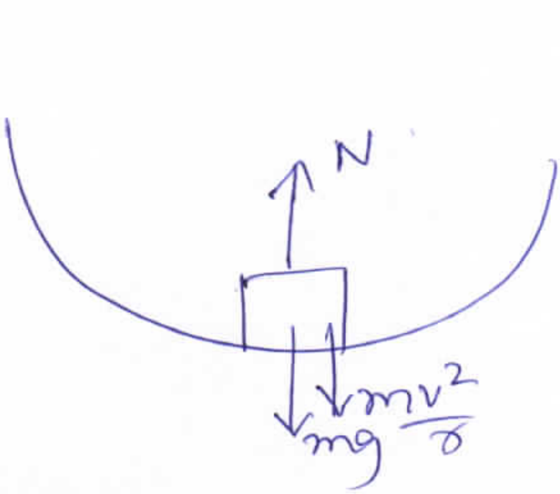
$\theta_2 = 6\alpha$.

$\frac{\theta_2}{\theta_1} = \frac{6\alpha}{2\alpha} = 3$

(11)



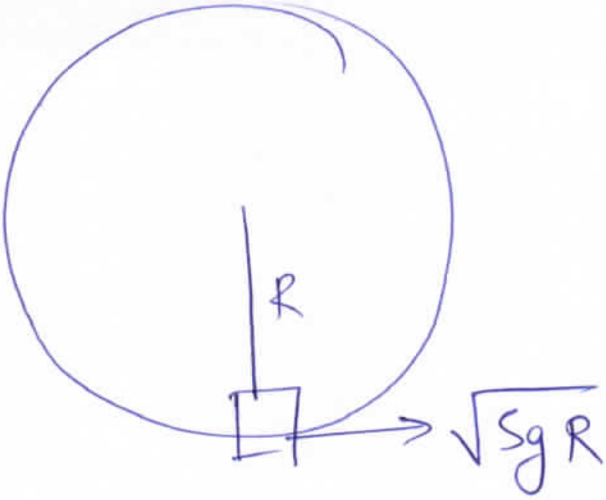
$N = mg - \frac{mv^2}{r}$



$N = mg + \frac{mv^2}{r}$

(A)

(17)



$v_{MIN} = \sqrt{5gR}$

$= \sqrt{5 \times 10 \times 6.4}$

$= \sqrt{320}$

$= 17.7\ m/s.$

(19)

$a_c = \frac{v^2}{r}$ $= v \cdot \frac{v}{r} = v \cdot \omega$ (A) (C)

$= \frac{\omega^2 r^2}{r} = \omega^2 r$

$\omega = \frac{v}{r}$

$v = \omega r$

$\omega = 2\pi f$

$= (2\pi f)^2 r$

$T = \frac{1}{f}$

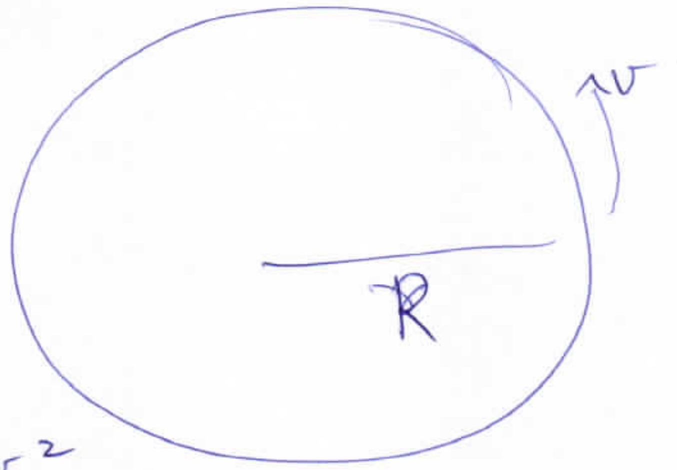
$= 4\pi^2 f^2 r$ (B)

$= 4\pi^2 \left(\frac{1}{T}\right)^2 r$

$= \frac{4\pi^2}{T^2} r$ (D)

ABCD

Pg 82 Comp 1



$K \cdot E = \frac{1}{2} m v^2$

$K = a s^2$

$\frac{1}{2} m v^2 = a s^2$

$v^2 = \frac{2a}{m} s^2$

(27)

$v = \sqrt{\frac{2a}{m}}\, s$

(28) (C)

$\frac{dv}{ds} = \sqrt{\frac{2a}{m}}$

$F_c = \frac{m v^2}{R}$

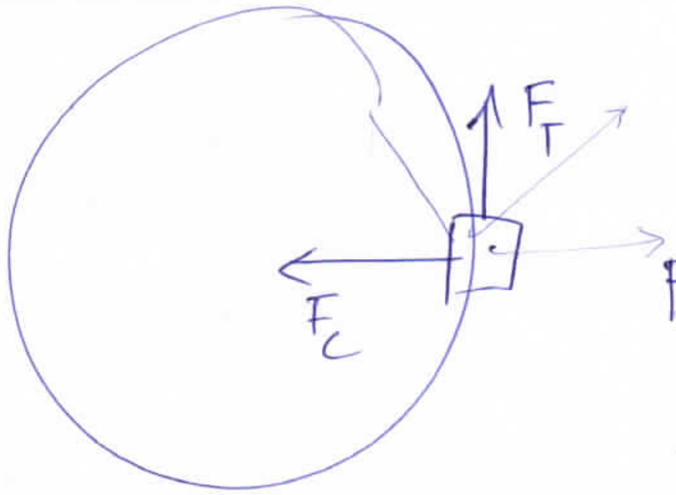
$= \frac{\cancel{m} \times \frac{2a}{\cancel{m}} s^2}{R}$

$= \frac{2as^2}{R}$ (C)

(29) $F_T = m a_T$

$= m v \frac{dv}{ds} = m \times \sqrt{\frac{2a}{m}}\, s \times \sqrt{\frac{2a}{m}}$

$= \cancel{m} \times \frac{2a}{\cancel{m}} \times s = 2as$ (D)



$$F = \sqrt{F_C^{\,2} + F_T^{\,2}}$$

$$= \sqrt{\left(\frac{2as^2}{R}\right)^2 + (2as)^2}$$

$$= 2as\sqrt{\left(\frac{s}{R}\right)^2 + 1}.$$

30

C