



DPP-3

Solution

1. $\mu = 0.5, R = 500 \text{ meter}$

$$V_{\max} = \sqrt{Rg\mu} = \sqrt{500 \times 10 \times 0.5}$$

$$V_{\max} = 50 \text{ m/s}$$

2. $\because T = \frac{mv^2}{R}$

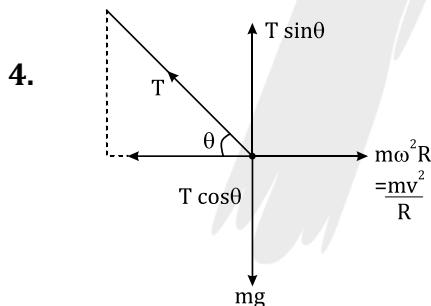
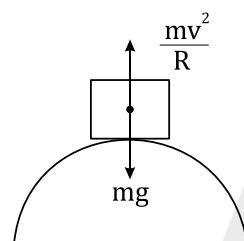
$$R = 0.1 \text{ meter}, m = 100 \text{ g} = 100 \times 10^{-3} \text{ kg}$$

$$T_{\max} = 100 \text{ N}$$

$$100 = \frac{100 \times 10^{-3}v^2}{0.1} \Rightarrow v = \sqrt{100} = 10 \text{ m/s}$$

$$\therefore \omega = \frac{V}{R} = \frac{10}{0.1} = 100 \text{ rad/sec}$$

3. Force exerted $= mg - \frac{mv^2}{r}$



$$T \cos \theta = \frac{mv^2}{R}$$

$$T \left(\frac{0.4}{0.5} \right) = \frac{10 \times 10^{-3}v^2}{0.4}$$

$$T = \frac{0.125}{4}v^2 \quad \dots (\text{i})$$

$$T \sin \theta = mg \Rightarrow T = 10 \times 10^{-3} \times 10 \times \left(\frac{0.5}{0.3} \right)$$

$$T = \frac{0.5}{3} \quad \dots (\text{ii})$$

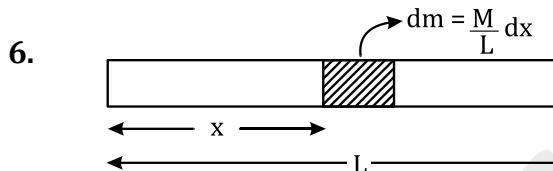


from (i) and (ii)

$$\frac{0.5}{3} = \frac{0.125}{4} v^2 \Rightarrow v^2 = \frac{4}{3} \times \frac{500}{125} = \frac{16}{3}$$

$$v = \frac{4}{\sqrt{3}} \quad \omega = \frac{v}{R} = \frac{4}{\sqrt{3} \times 0.4} \Rightarrow \omega = \frac{10}{\sqrt{3}} = \text{Rad/sec}$$

5. It is case of circular motion, as direction of velocity changing at every instant so velocity and acceleration is not constant. But speed will be constant so K.E. will be constant.

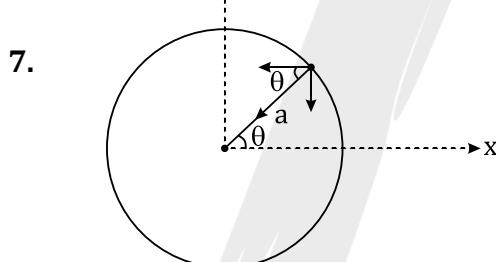


$$df = dm\omega^2x$$

$$\int dF = \int \frac{M}{L} dx \omega^2 x$$

$$F = \frac{M\omega^2}{L} \int_0^L x dx = \frac{M\omega^2}{L} \left[\frac{x^2}{2} \right]_0^L = \frac{M\omega^2 L^2}{2L}$$

$$F = \frac{M\omega^2 L}{2}$$



$$\bar{a} = a \cos \theta (-\hat{i}) + a \sin \theta (-\hat{j})$$

$$\bar{a} = -a \cos \theta \hat{i} - a \sin \theta \hat{j}$$

$$\bar{a} = -\frac{v^2}{R} \cos \theta \hat{i} - \frac{v^2}{R} \sin \theta \hat{j}$$

8. To be in balanced condition

$$\mu mg > m\omega^2 r$$

$$\mu g > \omega^2 r \Rightarrow r < \frac{\mu g}{\omega^2} \Rightarrow r < \frac{\mu g}{\omega^2}$$



9. for static condition

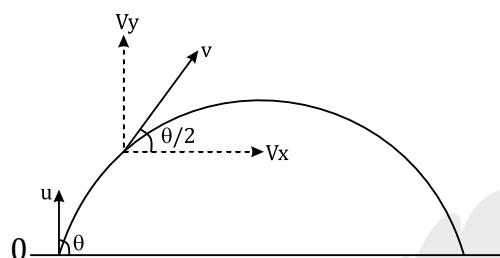
$$\mu m a = m \omega^2 R$$

$$\therefore a = \alpha R$$

$$\mu m \alpha R = m \omega^2 R$$

$$\mu = \frac{\omega^2}{\alpha} \Rightarrow \mu = \frac{\omega^2}{\alpha}$$

10.



$$\tan\left(\frac{\theta}{2}\right) = \frac{V_y}{V_x}$$

$$V^2 = V_x^2 + V_y^2$$

centripetal acceleration

$$a_c = \frac{V^2}{R} = g \cos\left(\frac{\theta}{2}\right)$$

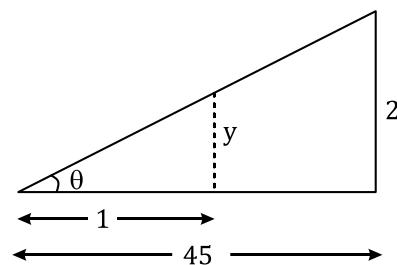
$$R = \frac{V^2}{g \cos\left(\frac{\theta}{2}\right)} = \frac{V_x^2 + V_y^2}{g \cos\left(\frac{\theta}{2}\right)} = \frac{V_x^2 \left[1 + \tan^2\left(\frac{\theta}{2}\right)\right]}{g \cos\left(\frac{\theta}{2}\right)}$$

$$\therefore V_x = V \cos \theta$$

$$R = \frac{V^2 \cos^2 \theta \sec^2\left(\frac{\theta}{2}\right)}{g \cos(\theta/2)} = \frac{V^2 \cos^2 \theta}{g \cos^2\left(\frac{\theta}{2}\right)}$$

$$R = \frac{V^2 \cos^2 \theta}{g \cos^2\left(\frac{\theta}{2}\right)}$$

11.



$$v_{\max} = 48 \text{ km/hr} = \frac{48 \times 1000}{60 \times 60}$$

$$v_{\max} = \frac{80}{6} = \frac{40}{3}$$



$$v_{\max} = \sqrt{Rg \tan \theta}$$

$$\frac{40}{3} = \sqrt{400 \times 10 \tan \theta}$$

$$\frac{40 \times 40}{3 \times 3} = 400 \times 10 \tan \theta$$

$$\tan \theta = \frac{2}{45}$$

$$\frac{y}{1} = \frac{2}{45}$$

$$y = \frac{2}{45} \text{ meter}$$

