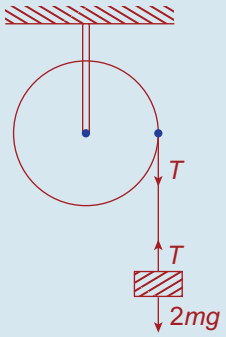
$$\Rightarrow 10v^2 + 5v^2 = 12gs$$
$$\Rightarrow 15v^2 = 12gs$$
$$\Rightarrow v^2 = \frac{4gs}{5}$$
$$v^2 = u^2 + 2as$$
$$\Rightarrow \frac{4gs}{5} = 0 + 2as$$
$$\Rightarrow 4g = 10a$$
$$\Rightarrow a = \frac{2}{5}g$$

(ii) On the point of slipping

$$\Rightarrow mg\sin\theta - F = ma$$
$$\Rightarrow \cancel{m}\cancel{g}\left(\frac{3}{\cancel{5}}\right) - \mu\cancel{m}\cancel{g}\left(\frac{4}{\cancel{5}}\right) = \cancel{m}\left(\frac{\cancel{2}g}{\cancel{5}}\right)$$
$$\Rightarrow \mu = \frac{1}{4} \quad \textbf{QED}$$

Q. 3. Forces:



Firstly, we find the speed of the $2m$ mass after it has fallen a distance h.

Gain in K.E. = Loss in P.E.

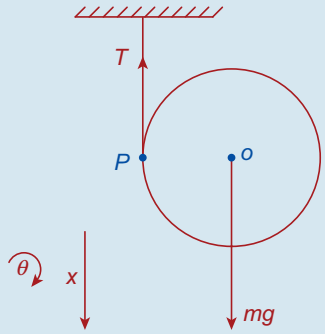
$$\Rightarrow \underset{\text{mass}}{\frac{1}{2}mv^2} + \underset{\text{disc}}{\frac{1}{2}I\omega^2} = \underset{\text{mass}}{mgh}$$
$$\Rightarrow \frac{1}{2}(2m)v^2 + \frac{1}{2}\left(\frac{1}{2}mr^2\right)\left(\frac{v^2}{r^2}\right) = 2mgh$$
$$\Rightarrow v^2 + \frac{1}{4}v^2 = 2gh$$
$$\Rightarrow \frac{5}{4}v^2 = 2gh$$
$$\Rightarrow v^2 = \frac{8gh}{5}$$
$$v^2 = u^2 + 2as$$
$$\Rightarrow a = \frac{v^2 - u^2}{2s}$$
$$= \frac{\frac{8gh}{5} - 0}{2h}$$
$$= \frac{4}{5}g \text{ ms}^{-2}$$

Looking at the forces on the $2m$ mass:

$F = ma$

$$\Rightarrow 2mg - T = 2m\left(\frac{4g}{5}\right)$$
$$\Rightarrow 10mg - 5T = 8mg$$
$$\Rightarrow 5T = 2mg$$
$$\Rightarrow T = \frac{2}{5}mg \text{ N}$$

Q. 4.



(i) Gain in K.E. = Loss in P.E.

$$\Rightarrow \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = mgs$$
$$\Rightarrow \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{1}{2}mr^2\right)\left(\frac{v^2}{r^2}\right) = mgs$$
$$\Rightarrow \frac{1}{2}v^2 + \frac{1}{4}v^2 = gs$$
$$\Rightarrow \frac{3}{4}v^2 = gs$$
$$\Rightarrow v^2 = \frac{4}{3}gs$$
$$\Rightarrow v = \sqrt{\frac{4}{3}gs}$$

(ii) $v^2 = u^2 + 2as$

$$\Rightarrow a = \frac{v^2 - u^2}{2s} = \frac{\frac{4}{3}gs - 0}{2s} = \frac{2}{3}g$$

(iii) $F = ma$

$$\Rightarrow mg - T = m\left(\frac{2}{3}g\right)$$
$$\Rightarrow 3mg - 3T = 2mg$$
$$\Rightarrow 3T = mg$$
$$\Rightarrow T = \frac{1}{3}mg$$

Q. 5. (i) $R = 2$ and $r = 1$

$$\therefore I = \frac{1}{2}m(4 + 1) = \frac{5}{2}m$$