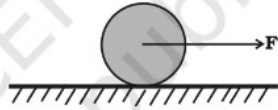


QUES 08:-

A uniform disc of radius R , is resting on a table on its rim. The coefficient of friction between disc and table is μ (Fig 7.12). Now the disc is pulled with a force \mathbf{F} as shown in the figure. What is the maximum value of \mathbf{F} for which the disc rolls without slipping?



SOL:-

⇒ We have to do force and torque analysis

Force analysis

$$F - f_r = ma$$

$$v = at$$

$$v_{cm} = \left(\frac{F - f_r}{m} \right) t$$



Torque analysis (about CoM)

$$\Rightarrow \tau = f_r \cdot R \text{ (c.w.)}$$

$$w = \left(\frac{F - f_r}{I} \right) t$$

Condition of rolling is ($v_{cm} = wR$)

$$\Rightarrow \left(\frac{F - f_r}{m} \right) t = \left(\frac{f_r \cdot R \cdot t}{I} \right) R$$

$$\Rightarrow \left(\frac{F - f_r}{m} \right) = \left(\frac{f_r \cdot R^2}{I} \right) \quad \left\{ I = \frac{mR^2}{2} \dots \text{disc} \right\}$$

$$\Rightarrow \frac{F - f_r}{m} = \frac{f_r \cdot R^2}{\left(\frac{mR^2}{2} \right)}$$

$$\Rightarrow F - f_r = 2f_r$$

$$\Rightarrow F = 3f_r$$

$$\boxed{\frac{f_r}{I} = f_r}$$

$$0 < f_r \leq \mu mg$$

$$0 < \frac{F}{3} \leq \mu mg$$

$$\boxed{0 < F \leq 3\mu mg}$$

a.c.w. → anti clock
-wise

C.w. → clockwise