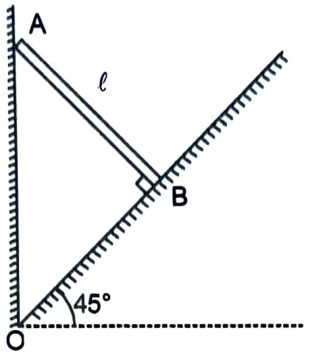
At the bottom edge of a smooth wall, an inclined plane is kept at an angle of 45°. A uniform ladder of length ℓ and mass M rests on the inclined plane against the wall such that it is perpendicular to the incline.



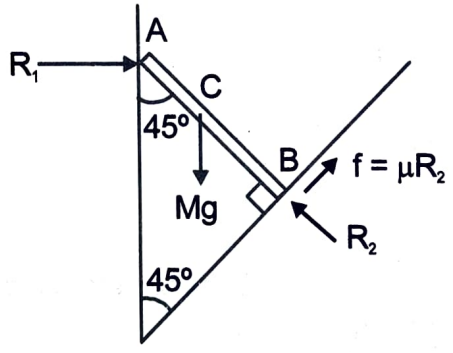
a. If the plane is also smooth, which way will the ladder slide ?

b. What is the minimum coefficient of friction necessary so that the ladder does not slip on the incline.

Solution :

a. The ladder has tendency to slip by rotating clockwise about the point A

b. The free-body diagram of the ladder is shown is fig.



Balacing torque about point A, $f\ell = Mg\left(\frac{\ell}{2}\sin 45°\right)$

$$\therefore\ f = \frac{Mg}{2\sqrt{2}} \qquad \text{...(i)}$$

Balancing forces in the vertical direction,

$$Mg = R_2 \cos 45° + f \sin 45° \qquad \text{...(ii)}$$

From Eqs. (i) and (ii), we get

$$R_2 = \frac{3Mg}{2\sqrt{2}}$$

As, $f = \mu R_2$

$$\text{or}\quad \frac{Mg}{2\sqrt{2}} = \frac{3Mg}{2\sqrt{2}}\mu \quad \text{or} \quad \mu = \frac{1}{3}$$