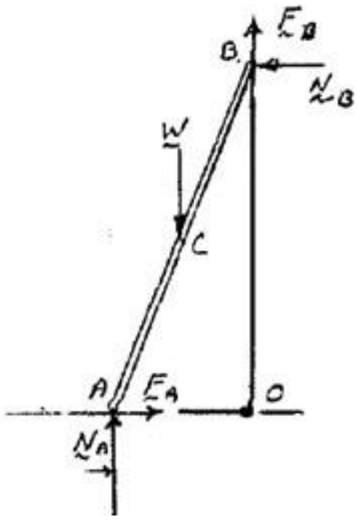
Answer on Question #45180-Physics-Mechanics-Kinematics-Dynamics

A uniform ladder weighing 330 Newton is leaning against a wall. The ladder slips when the angle with the floor is 50 degrees. Assuming the coefficient of the static friction at the wall and the floor are the same; obtain a value for static friction.

Solution



The sum of angular momentums across point B is zero:

$$W \cdot \frac{L}{2} \cdot \cos 50 + F_A L \sin 50 - N_A L \cos 50 = 0.$$

$$F_A = \mu N_A, F_B = \mu N_B.$$

$$\sum F_x = 0: F_A - N_B = 0 \rightarrow F_A = N_B.$$

$$\sum F_y = 0: N_A + F_B - W = 0 \rightarrow W = N_A + F_B.$$

So

$$(N_A + F_B) \cdot \frac{1}{2} \cdot \cos 50 + F_A \sin 50 - N_A \cos 50 = 0.$$

The sum of angular momentums across point A is zero:

$$W \cdot \frac{L}{2} \cdot \cos 50 - N_B L \sin 50 - F_B L \cos 50 = 0.$$

$$(N_A + F_B) \cdot \frac{1}{2} \cdot \cos 50 - N_B \sin 50 - F_B \cos 50 = 0.$$

We can subtract equations across two points:

$$(F_A + N_B) \sin 50 = (N_A - F_B) \cos 50.$$

But $N_B = F_A$; $F_B = \mu N_B = \mu F_A$. So

$$\tan 50 = \frac{N_A - F_B}{F_A + N_B} = \frac{N_A - \mu F_A}{2F_A} = \frac{\frac{F_A}{\mu} - \mu F_A}{2F_A} = \frac{\frac{1}{\mu} - \mu}{2}.$$

$$\mu^2 + 2\mu \tan 50 - 1 = 0.$$

$$\mu = \frac{-2\tan 50 \pm \sqrt{4(\tan^2 50 + 1)}}{2}.$$

The positive root is physically possible. Therefore,

$$\mu = -\tan 50 + \sqrt{(\tan^2 50 + 1)} = 0.36.$$

Answer: $\mathbf{0.36}$.