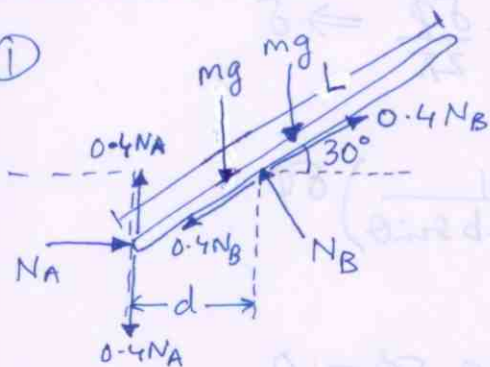


P. ①



Case(A): Impending slip downward.
So use upward pointing friction forces,
and mg acting at L/2 which is left
of pt. B.

Case(B): Impending slip upward. Use
downward pointing friction forces, and
mg acting at L/2 which is right of B.

3 eqns, 3 unknowns |
($N_A, N_B, L/d$) |

$$\pm 0.4 N_A - mg + N_B \cos 30^\circ \pm 0.4 N_B \sin 30^\circ = 0 \quad \rightarrow \textcircled{1}$$

$$N_A \pm 0.4 N_B \cos 30^\circ - N_B \sin 30^\circ = 0 \quad \rightarrow \textcircled{2}$$

$$N_A (d \tan 30^\circ) \mp 0.4 N_A (d) \pm mg \left(\pm d \mp \frac{L}{2} \cos 30^\circ \right) = 0 \quad \rightarrow \textcircled{3}$$

Top sign for Case(A),
bottom sign for Case(B)

② in ① $\rightarrow \left[\pm 0.4 (\sin 30^\circ \mp 0.4 \cos 30^\circ) + \cos 30^\circ \pm 0.4 \sin 30^\circ \right] N_B = mg$

$$N_B = \left(\frac{1}{0.84 \cos 30^\circ \pm 0.88 \sin 30^\circ} \right) mg$$

$$N_A = \left(\frac{\sin 30^\circ \mp 0.4 \cos 30^\circ}{0.84 \cos 30^\circ \pm 0.88 \sin 30^\circ} \right) mg$$

③ $\rightarrow \frac{L}{2} \cos 30^\circ - d = \frac{N_A d (\tan 30^\circ \mp 0.4)}{mg}$

$$\Rightarrow \frac{L}{d} = \frac{2}{\cos 30^\circ} \left[1 + \left(\frac{\sin 30^\circ \mp 0.4 \cos 30^\circ}{0.84 \cos 30^\circ \pm 0.88 \sin 30^\circ} \right) (\tan 30^\circ \mp 0.4) \right]$$

= 2.3652 for impending downward slip
& 8.1435 for impending upward slip.

\Rightarrow Bar in equilibrium for $2.3652 < L/d < 8.1435$

P.2 Let ϕ be rotation of screw and y be measured from bottom to mass m . The AFD is the figure itself. Let x be dist AB.

$$\delta U = M \delta \phi + (-mg) \delta y = 0$$

$y = 4b \sin \theta, x = 2b \cos \theta$, from geometry.

Also $\delta x = -L \delta \phi / 2\pi$ from given information on lead of screw.

P.2 (contd.) $\Rightarrow \delta y = 4b \cos \theta \delta \theta$

$\delta x = -2b \sin \theta \delta \theta = -L \frac{\delta \phi}{2\pi}$

$\Rightarrow \delta \phi = \left(\frac{2\pi}{L} 2b \sin \theta \right) \delta \theta$

$\delta y = 4b \cos \theta \left(\frac{L}{2\pi} \frac{1}{2b \sin \theta} \right) \delta \phi$
 $= \frac{L}{\pi} \cot \theta \delta \phi$

$\delta U = 0 \Rightarrow M \delta \phi + (mg) \frac{L}{\pi} \cot \theta \delta \phi = 0$

$\Rightarrow M = mg \frac{L}{\pi} \cot \theta$



Handwritten notes in the left margin, including circled numbers 1, 2, 3 and some illegible text.

$\frac{d}{dt} \left[\frac{\partial L}{\partial \dot{\theta}} \right] - \frac{\partial L}{\partial \theta} = 0$

$\frac{d}{dt} \left[\frac{1}{2} m v^2 \right] = m g h$

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Handwritten notes at the bottom, including a list of values: 5.2125, 8.1122, 8.1122.

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$0 = M \delta \phi + (mg) \frac{L}{\pi} \cot \theta \delta \phi$

$\frac{d}{dt} \left[\frac{\partial L}{\partial \dot{\theta}} \right] - \frac{\partial L}{\partial \theta} = 0$

$\frac{d}{dt} \left[\frac{\partial L}{\partial \dot{\theta}} \right] - \frac{\partial L}{\partial \theta} = 0$