Lecture 15

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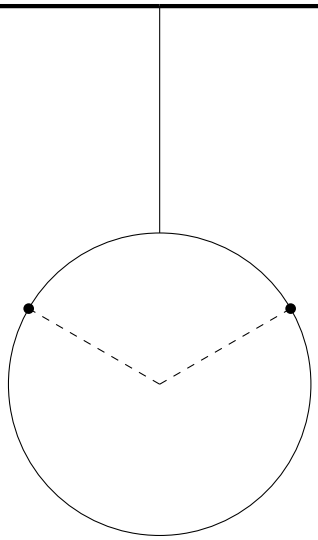
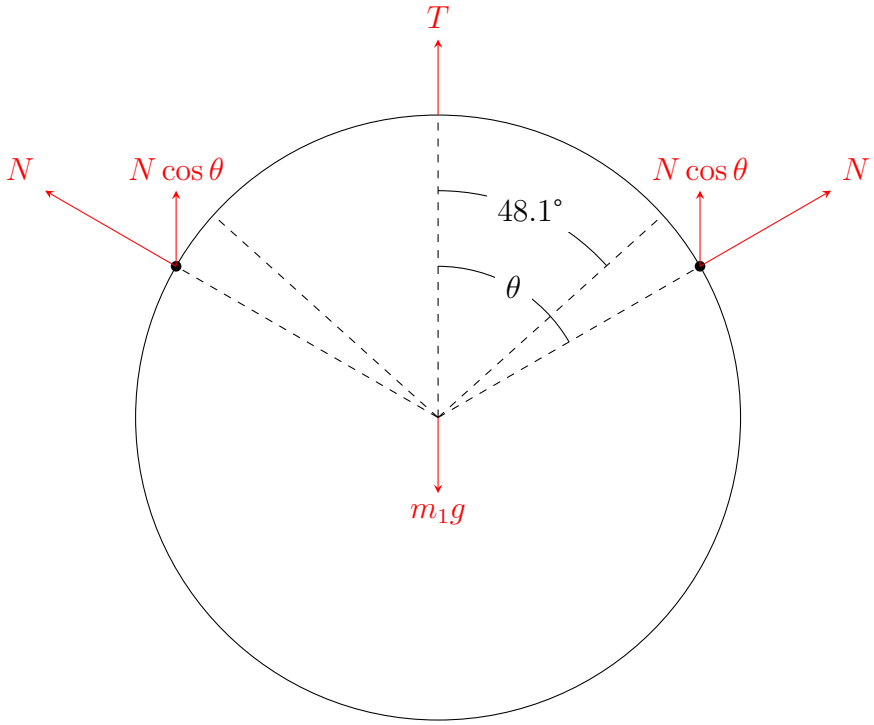
Contents

1 Circular Motion Dynamics

Example 1. Find condition on m_1 and m_2 so that the loop will not jump up when the beads are released from rest from the top.



Solution.



The loop will jump up if

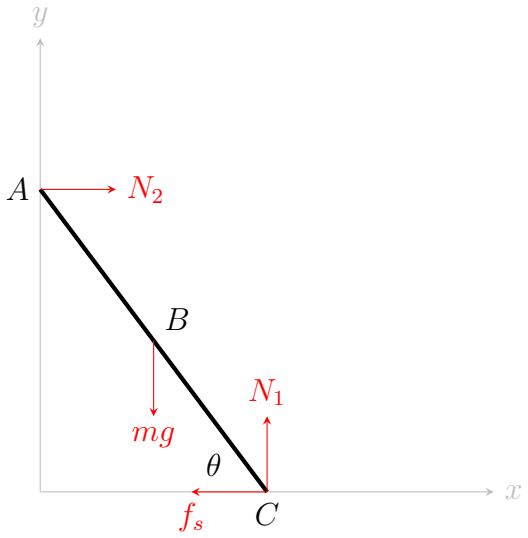
$$2N\cos\theta > m_1 g$$

Therefore, for the loop to not jump up,

$$2N\cos\theta - m_1 g > 0$$
$$\therefore \frac{m_1}{m_2} < 4\cos\theta - 6\cos^2\theta$$

2 Rigid Body Mechanics

Example 2. A ladder is kept between 2 walls as shown. Find the maximum angle for which the ladder does not slide.



Solution.

$$\sum \overrightarrow{F_{\text{ext}}} = 0$$

Therefore,

$$N_1 = mg$$
$$N_2 = f_s$$

$$\sum \overrightarrow{\tau_{\text{ext},C}} = 0$$

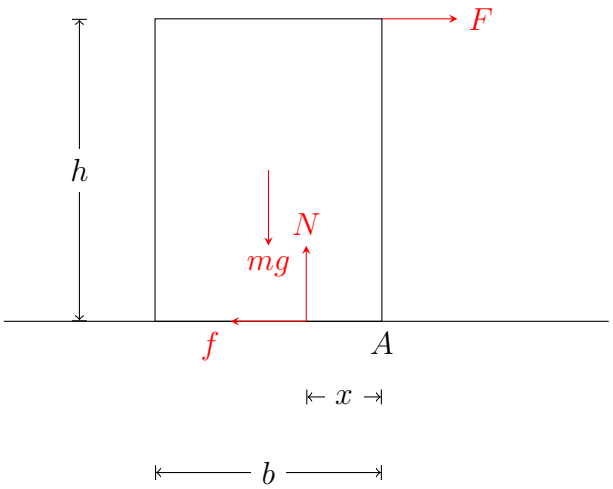
Therefore,

$$\frac{L}{2}\cos\theta mg - L\sin\theta N_2 = 0$$

Solving,

$$\cot\theta \leq 2\mu_s$$

Example 3. A box is kept on a surface and a force F is applied to the top corner. Assuming the box does not slide, find the force required for the box to topple.



Solution.

$$\sum \overrightarrow{F_{\text{ext}}} = 0$$

Therefore,

$$N = mg$$
$$F = f$$

$$\sum \overrightarrow{\tau_{\text{ext},A}} = 0$$

Therefore,

$$-Nx + \frac{b}{2}mg - hF = 0$$

Solving,

$$F = \frac{mg}{h}\left(\frac{b}{2} - x\right)$$

The box will topple when $x = 0$, i.e. when

$$F = \frac{mgb}{2h}$$