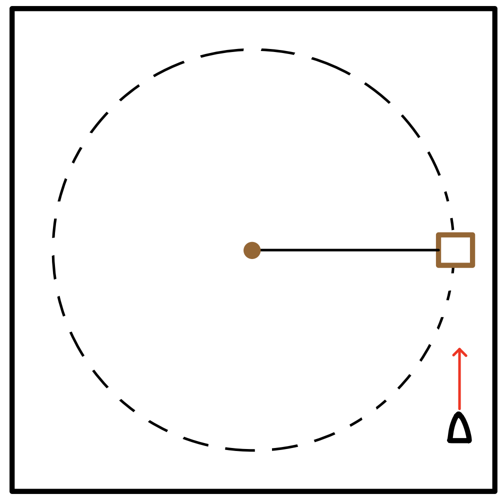
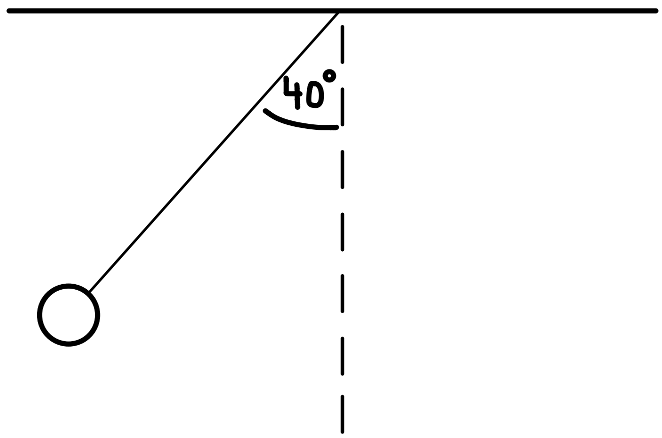
A 800 g wooden block is at rest on a frictionless table. A 40 cm string connects the block to a peg at the centre of the table. A 5 g bullet is fired towards the block at a speed of 700 m/s as shown. The bullet embeds itself in the block and the combined mass begins to revolve around the peg. Determine...

a) the period of revolution

b) the tension in the string



A thin thread of length 50 cm can withstand a maximum tension of 20 N before breaking. An object is released from rest at the position shown. What is the maximum mass of the object if the thread is not to break?



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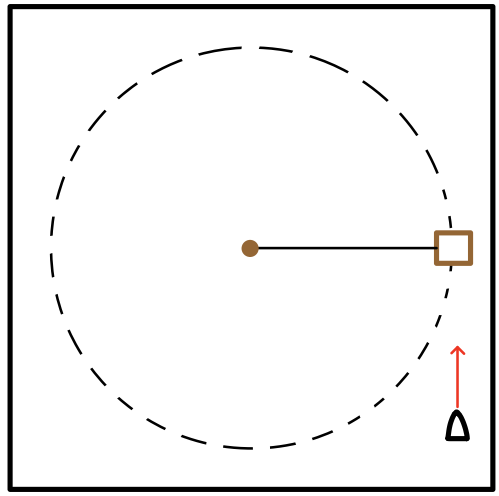


a)

$$p_i = p_f$$

$$p_{1i} + \cancel{p_{2i}}^{\,0} = p_f$$

$$m_1 v_{1i} = M v_f$$

$$v_f = \frac{m_1 v_{1i}}{M}$$

$$= \frac{(0.005)(700)}{0.805}$$

$$= 4.3478 \ \tfrac{m}{s}$$

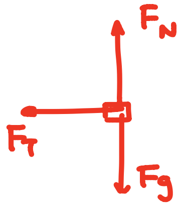
$$d = vt$$

$$t = \frac{d}{v} \longrightarrow T = \frac{2\pi R}{v}$$

$$= \frac{2\pi(0.4)}{4.3478}$$

$$= \boxed{0.578 \ s}$$

b)



$$F_c = m a_c$$

$$F_T = m \frac{v^2}{R}$$

$$= (0.805)\frac{(4.3478)^2}{0.4}$$

$$= \boxed{38.0 \ N}$$

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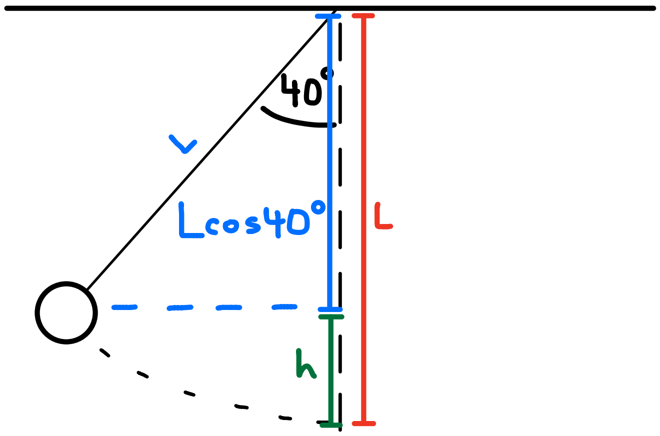
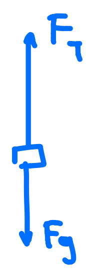


$$h = L - L\cos 40°$$
$$= L(1-\cos 40°)$$
$$= (0.5)(1-\cos 40°)$$
$$= 0.11698 \text{ m}$$

$$E_i = E_f$$
$$\cancel{E_{k_i}}^{0} + E_{p_i} = E_{k_f} + \cancel{E_{p_f}}^{0}$$
$$\cancel{m} g h_i = \frac{1}{2}\cancel{m} v_f^2$$
$$v_f = \sqrt{2gh_i}$$
$$= \sqrt{2(9.8)(0.11698)}$$
$$= 1.5142 \ \frac{m}{s}$$



$$F_c = ma_c$$
$$F_T - F_g = m\frac{v^2}{R}$$
$$F_T - mg = m\frac{v^2}{R}$$
$$F_T = mg + m\frac{v^2}{R}$$
$$F_T = m\left(g + \frac{v^2}{R}\right)$$
$$m = \frac{F_T}{g + \frac{v^2}{R}}$$
$$= \frac{20}{9.8 + \frac{1.5142^2}{0.5}}$$
$$= \boxed{1.39 \text{ kg}}$$