Name________________________

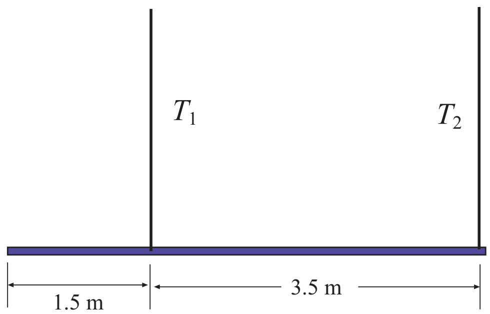
Nov. 23, 2005

Quiz #3 — Fall 2005

Phys 2010, NSCC

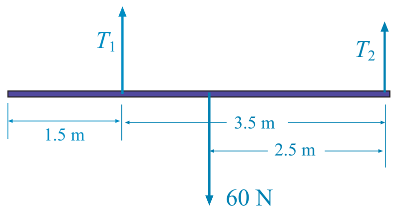
1. A uniform rod of length 5.0 m and weight 60.0 N is supported at its right end by a vertical cable and at a point 1.5 m from the left end by another vertical cable, as shown.

Find the tension in both cables.



Forces on the rod are as shown at the right.

If we put the rotation axis on the right side of the rod then the total torque on the rod is



$$\tau_{\text{net}} = -T_1(3.5 \text{ m}) + (60 \text{ N})(2.5 \text{ m}) = 0$$

(Total torque is zero because the rod is static.) Solve for T_1:

$$T_1 = \frac{(60 \text{ N})(2.5 \text{ m})}{(3.5 \text{ m})} = 42.9 \text{ N}$$

Since the sum of the forces on the rod is zero, we get:

$$T_1 + T_2 - 60 \text{ N} = 0$$

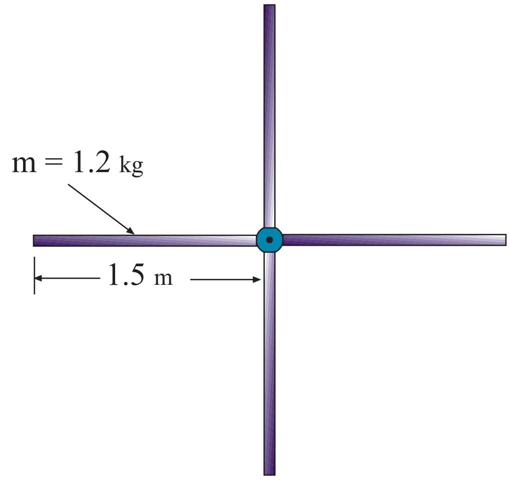
Since we have T_1, we can solve for T_2:

$$T_2 = 60 \text{ N} - T_1 = 60 \text{ N} - 42.9 \text{ N} = 17.1 \text{ N}$$

So $\boxed{T_1 = 42.9 \text{ N}}$ and $\boxed{T_2 = 17.1 \text{ N}}$.

2. We construct a rotating object from four uniform rods (lying in the same plane), each of mass 1.2 kg and length 1.5 m joined at their ends to a central axle.

The object is intially at rest; a net torque of 20.0 N·m is applied to it for 5.0 s.



a) What is the moment of inertia of the object?

Each rod turns about its end and so has a moment of intertia of $I = \frac{1}{3}ML^2$. But there are 4 rods, so

$$I_{\rm obj} = 4\left(\tfrac{1}{3}ML^2\right) = \tfrac{4}{3}(1.2\ \mathrm{kg})(1.5\ \mathrm{m})^2 = 3.60\ \mathrm{kg\cdot m^2}$$

b) What is the angular acceleration of the object while the torque is acting?

Use $\tau_{\rm net} = I_{\rm obj}\alpha$, then:

$$\alpha = \frac{\tau_{\rm net}}{I_{\rm obj}} = \frac{(20.0\ \mathrm{N\cdot m})}{(3.60\ \mathrm{kg\cdot m^2})} = 5.55\,\tfrac{\mathrm{rad}}{\mathrm{s^2}}$$

c) What is the angular velocity of the object at the end of the 5.0 s?

$$\omega = \omega_0 + \alpha t = 0 + (5.55\tfrac{\mathrm{rad}}{\mathrm{s^2}})(5.0\ \mathrm{s}) = 27.8\tfrac{\mathrm{rad}}{\mathrm{s}}$$

d) What is the kinetic energy of the object at that time?

The kinetic energy is

$$\mathrm{KE_{rot}} = \tfrac{1}{2}I\omega^2 = \tfrac{1}{2}(3.60\ \mathrm{kg\cdot m^2})(27.8\tfrac{\mathrm{rad}}{\mathrm{s}})^2 = 1.39\times 10^3\ \mathrm{J}$$

You must show all your work and include the right units with your answers!

$$\omega = \omega_0 + \alpha t \qquad \theta = \omega_0 t + \tfrac{1}{2}\alpha t^2 \qquad \omega^2 = \omega_0^2 + 2\alpha\theta \qquad s = r\theta \qquad v_T = r\omega$$

$$a_T = r\alpha \qquad a_c = r\omega^2 \qquad \tau = Fr\sin\phi \qquad \tau = I\alpha$$

$$I_{\rm disk} = \tfrac{1}{2}MR^2 \qquad I_{\rm sph} = \tfrac{2}{5}MR^2 \qquad I_{\rm rod,\ end} = \tfrac{1}{3}ML^2 \qquad I_{\rm rod,\ mid} = \tfrac{1}{12}ML^2$$

$$\mathrm{KE_{rot}} = \tfrac{1}{2}I\omega^2$$