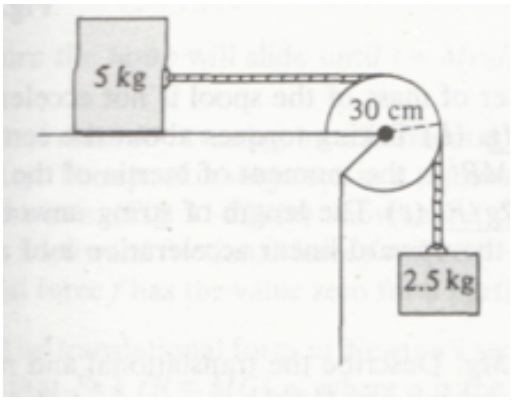
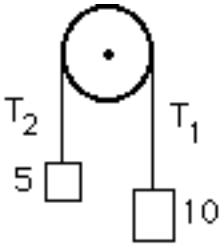
ROTATIONAL DYNAMICS

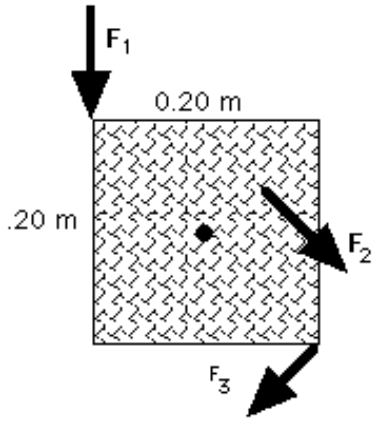


1. The frictional force between the block and table is 20 N. If the moment of inertia of the wheel is 4.0 kgm^2,
a. What is the tension pulling up and the tension pulling across?
[$T_1 = 24.3$ N, $T_2 = 20.4$ N]
b. What is the acceleration of the blocks? [0.0866 m/s^2]
c. What is the angular acceleration of the pulley? [0.289 radians/s^2]
d. how long will it take the block to drop 60 cm after the system is released? [3.72 s] Assume no slippage between rope & wheel.

2. Two masses of 5 and 10 kg are attached together by a string that goes over a flywheel as indicated in the diagram. The flywheel is a uniform disc of radius 20 cm and mass 6 kg. If there is no slippage between the string and the flywheel rim, and if there is a friction torque of 3 Nm exerted on the wheel by its axle, what are T_1, T_2, and angular acceleration of the wheel?
Hin: $T_1 \neq T_2$
[$T_2 = 58.4$ N, $T_1 = 79.1$ N, $\alpha = 9.44$ radians/s^2]



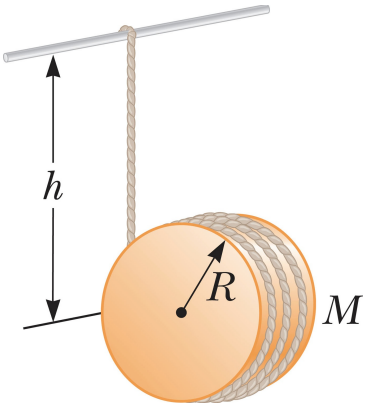
3. A 5.5 kg flywheel at radius 20 cm is made to rotate at 600 rpm in 20 seconds starting from rest.
a. What is the torque produced by the motor? [$\tau = 0.314$ Nm]
b. How much work does it do? [W = 197.2 J]
c. How much power does it produce? [P = 9.86W]
d. What if you turned off the motor and and a friction torque of 0.6 Nm started, how much time would elapse before the flywheel came to rest? [t = 11.51s]



4. A square metal plate 0.20 m on each side, mass = 24 kg is pivoted about an axis through its center and perpendicular to the plate, as shown in the figure. Calculate the net torque about the axis [answer: 1.96 Nm], and the angular acceleration [answer: 12.3 rad/s^2] due to the

$$I_{\text{rectangle}} = \frac{M}{12}\left(\ell^2 + w^2\right)$$

three forces shown in the figure if the magnitudes of the forces are $F_1 = 80.0$ N, $F_2 = 20$ N, and $F_3 = 15$ N, and a friction torque of 2.5 Nm. (F_2 is in the midpoint between the center and the corner)



5. A string is wrapped around a uniform cylinder of mass M and radius R. the cylinder is released from rest with the string vertical and its top end tied to a fixed bar.
a. show that the tension in the string is one-third the weight of the cylinder.
b. the magnitude of the acceleration of the center of gravity is 2g/3, and
(c) the speed of the center of gravity is $(4gh/3)^{1/2}$ after the cylinder has descended through distance h. Verify your answer to part (c) with the energy approach.

a.

Torque Analysis

$$\sum \tau_i = I\alpha$$

$$TR\sin 90° = \frac{1}{2}mR^2\alpha$$

$$T = \frac{1}{2}mR\alpha \rightarrow\rightarrow T = \frac{1}{2}mR\frac{a}{R}$$

$$T = \frac{1}{2}ma$$

$$a = \frac{2T}{m}$$

Force Analysis

$$T = W - ma$$

$$T = W - m\left(\frac{2T}{m}\right)$$

$$T = W - 2T$$

$$3T = W$$

$$T = \frac{W}{3}$$

b & c do yourselves