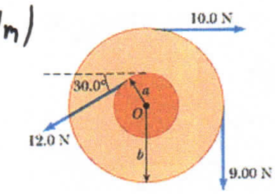
Name Key

Unit 5: Homework Questions #2

Torque and Angular Accelerations

1. Find the net torque on the wheel shown below about the axle through *O*, taking *a* = 6.00 cm and *b* = 21.0 cm. (Assume that the positive direction is counterclockwise.)



-3.27 N·m

$(12N)(.06m)-(10N)(.21m)-(9)(.21m)$

$= -3.27\ Nm$

2. A grinding wheel is in the form of a uniform solid disk of radius 6.99 cm and mass 2.02 kg. It starts from rest and accelerates uniformly under the action of the constant torque of 0.594 N·m that the motor exerts on the wheel.

$I = \frac{1}{2}(2.02)(.0699)^2 = .00493$

(a) How long does the wheel take to reach its final operating speed of 1290 rev/min?

1.12 s

$.594\ Nm = (.00493\ kgm^2)(\alpha)$ → $135.1\ \frac{rad}{s}$

$\alpha = 120.37\ \frac{rad}{s^2}$

$\frac{135.1}{120.37} = 1.12s$

(b) Through how many revolutions does it turn while accelerating?

12.1 rev

$\Delta\theta = \frac{1}{2}(120.37\ \frac{rad}{s^2})(1.12)^2 = \frac{75.8\ rad}{2\pi} = 12.06\ rev$

3. The combination of an applied force and a constant frictional force produces a constant total torque of 35.6 N·m on a wheel rotating about a fixed axis. The applied force acts for 6.06 s. During this time the angular speed of the wheel increases from 0 to 9.7 rad/s. The applied force is then removed, and the wheel comes to rest in 59.2 s.

$\frac{9.7\ rad/s}{6.06} = 1.6\ \frac{rad}{s^2}$

(a) Find the moment of inertia of the wheel.

22.2 kg·m^2

$35.6\ Nm = I(1.6\ \frac{rad}{s^2})$

$I = 22.2$

(b) Find the magnitude of the frictional torque.

3.64 N·m

$\frac{9.7}{59.2} = -.164\ \frac{rad}{s^2}$

$I = (22.2\ kgm^2)(.164\ \frac{rad}{s^2}) = 3.64\ Nm$

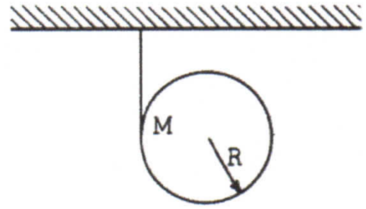
(c) Find the total number of revolutions of the wheel.

50.4 rev

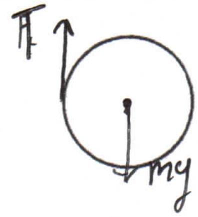
$\frac{1}{2}(1.6\ \frac{rad}{s^2})(6.06)^2 = 29.39$

$\frac{1}{2}(-.164)(59.2)^2 + (9.7)(59.2) = 286.12$

$\frac{29.39 + 286.12}{2\pi} = 50.4\ rev$



4. (No Answers) A cloth tape is wound around the outside of a uniform solid cylinder (mass M, radius R) and fastened to the ceiling as shown in the diagram above. The cylinder is held with the tape vertical and then released from rest. As the cylinder descends, it unwinds from the tape without slipping. The moment of inertia of a uniform solid cylinder about its center is ½MR².



a. On the circle below draw vectors showing all the forces acting on the cylinder after it is released. Label each force clearly.

b. In terms of g, find the downward acceleration of the center of the cylinder as it unrolls from the tape.

c. While descending, does the center of the cylinder move toward the left, toward the right, or straight down? Explain.

Straight down, no force in x-direction.

$Ma = mg - T$

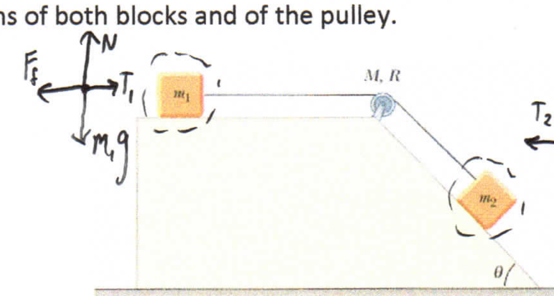
$TR = \frac{1}{2}MR^2\frac{a}{R}$

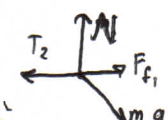
$T = \frac{1}{2}Ma$

$Ma = Mg - \frac{1}{2}Ma$

$a = \frac{2}{3}g$

5. A block of mass m_1 = 2.15 kg and a block of mass m_2 = 6.10 kg are connected by a massless string over a pulley in the shape of a solid disk having radius R = 0.250 m and mass M = 10.0 kg. These blocks are allowed to move on a fixed block-wedge of angle ϑ = 30.0°. The coefficient of kinetic friction is 0.360 for both blocks. Draw free-body diagrams of both blocks and of the pulley.





$N = m_2 g\cos\theta$

(a) Determine the acceleration of the two blocks.

0.277 m/s²

$m_1a = T_1 - m_1g\mu$

$m_2a = m_2g\cos\theta + m_2g\sin\theta\mu - T_2$

solve this system →

$R(T_2 - T_1) = \frac{1}{2}MR^2\frac{a}{R}$

(b) Determine the tensions in the string on both sides of the pulley.

left of the pulley 8.18 N

right of the pulley 9.56 N

$(2.15)(.277) = T_1 - (2.15)(9.8)(.36)$

$T_1 = 8.18N$

$(6.1)(.277) = (6.1)(9.8)(\cos 30) + (6.1)(9.8)(\sin 30)(.36) - T_1$

$T_1 = 9.56N$