Review Problems

From

Chapter 10&11

1) At t=0, a disk has an angular velocity of 360 rev/min, and constant angular acceleration of -0.50 rad/s2. How many rotations does the disk make before coming to rest?**

A1 226
A2 180
A3 360
A4 90
A5 113

$$\omega_0 = \frac{360 \times 2\pi}{60} = 120\pi \ rad/s, \ \ \alpha = -0.50 \ rad/s_2, \ \omega = 0$$

$$\omega = \omega_0 + \alpha t \Rightarrow t = \frac{-\omega_0}{\alpha} \Rightarrow \ find \ t$$

$$\theta = \omega t - \tfrac{1}{2}\alpha t^2 = -\tfrac{1}{2}\alpha t^2 \Rightarrow \ find \ \theta \ in \ rad/s$$

$$divide \ by \ 2\pi \ to \ get \ \theta \ in \ revolutions.$$

2) Two wheels A and B are identical. Wheel B is rotating with twice the angular velocity of wheel A. The ratio of the radial acceleration of a point on the rim of B (a2) to the radial acceleration of a point on the rim of A (a1) is (a2/a1):

A1 4
A2 2
A3 1/2
A4 1/4
A5 1

$$\omega_B = 2\omega_A \Rightarrow \frac{\omega_B}{\omega_A} = 2$$

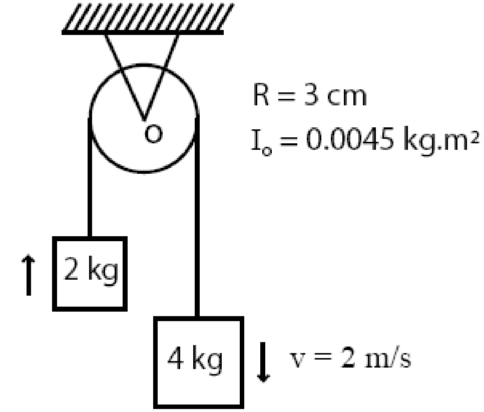
$$a_1 = \omega^2{}_A R$$

$$a_2 = \omega^2{}_B R$$

$$\frac{a_2}{a_1} = \frac{\omega^2{}_B R}{\omega^2{}_A R} = \left(\frac{\omega_B}{\omega_A}\right)^2 = 4$$

3) Fig shows a pulley (R=3.0 cm and Io= 0.0045 kg*m**2) suspended from the ceiling. A rope passes over it with a 2.0 kg block attached to one end and a 4.0 kg block attached to the other. When the speed of the heavier block is 2.0 m/s the total kinetic energy of the pulley and blocks is :

A1 22 J
A2 10 J
A3 2 J
A4 16 J
A5 38 J



Let's call the 2kg body 1, the 4 kg body 2 and the pulley p;

$v_p = v_1 = v_2 = 2\ m/s$, v_p is the velocity of any point at the rim of the pulley.

$$\omega_p = \frac{v_p}{R} = \frac{2}{0.03} = 66.7\ rad/s$$

$$K_1 = \frac{1}{2} m_1 v_1^2 = \frac{1}{2} \times 2 \times 2^2 = 4\ J$$

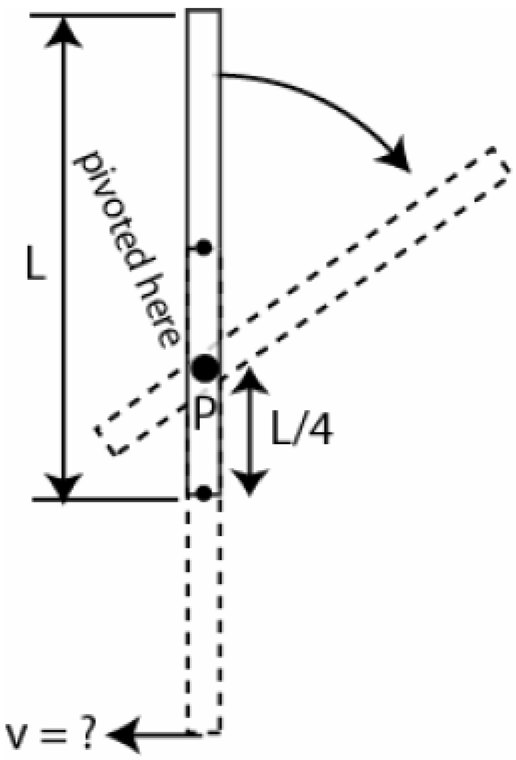
$$K_2 = \frac{1}{2} m_2 v_2^2 = \frac{1}{2} \times 4 \times 2^2 = 8\ J$$

$$K_p = \frac{1}{2} I_o \omega_p^2 = \frac{1}{2} \times 0.0045 \times 66.7^2 = 10\ J$$

$$K = K_1 + K_2 + K_p = 4 + 8 + 10 = 22\ J$$

4) A uniform rod (M = 2.0 kg, L = 2.0 m) is held vertical about a pivot at point P, a distance L/4 from one end (as in the Figure). The rotational inertia of the rod about P is 1.17 kg*m2. If it starts rotating from rest, what is the linear speed of the lowest point of the rod as it passes again through the vertical position (v)?**

A1 8.7 m/s
A2 4.8 m/s
A3 17 m/s
A4 2.4 m/s
A5 zero



$$K_i = 0.0, \quad U_i = Mg(\frac{L}{4}) \quad (taking\ our\ U = 0.0\ at\ the\ point\ P)$$

$$\Rightarrow E_i = K_i + U_i = Mg(\frac{L}{4})$$

$$K_f = \tfrac{1}{2} I\omega^2, U_f = -Mg(\frac{L}{4}) \quad \Rightarrow \quad E_f = K_f + U_f = \tfrac{1}{2} I\omega^2 - Mg(\frac{L}{4})$$

$$but\ E_i = E_f \quad \Rightarrow \quad Mg(\frac{L}{4}) = \tfrac{1}{2} I\omega^2 - Mg(\frac{L}{4})$$

$$\frac{1}{2} Mg\left(L\right) = \frac{1}{2} I\omega^2 \quad \Rightarrow \omega = \sqrt{\frac{MgL}{I}} = \frac{v}{\left(3L/4\right)} \Rightarrow find\ v$$

5) A uniform solid sphere of radius 0.10 m rolls smoothly across a horizontal table at a speed 0.50 m/s with total kinetic energy 0.70 J. Find the mass of the sphere.

A1 4.0 kg
A2 8.0 kg
A3 2.0 kg
A4 1.0 kg
A5 5.0 kg

$$R = 0.10\ m,\ K = 0.70\ J$$

$$K = \frac{1}{2}Mv_{com}^2 + \frac{1}{2}I\omega^2 \qquad (1)$$

$$sub.\ in\ (1)\ \ for\ \ I = \frac{2}{5}MR^2 \quad (sphere)\ and\ \ for\ \omega = \frac{v_{com}}{R}\ (rolling)$$

$$to\ get\ M.$$

6) A 3.0 kg wheel, rolling smoothly on a horizontal surface, has a rotational inertia about its axis= M*R**2/2, where M is its mass and R is its radius. A horizontal force is applied to the axle so that the center of mass has an acceleration of 2.0 m/s**2. The magnitude of the frictional force of the surface is :

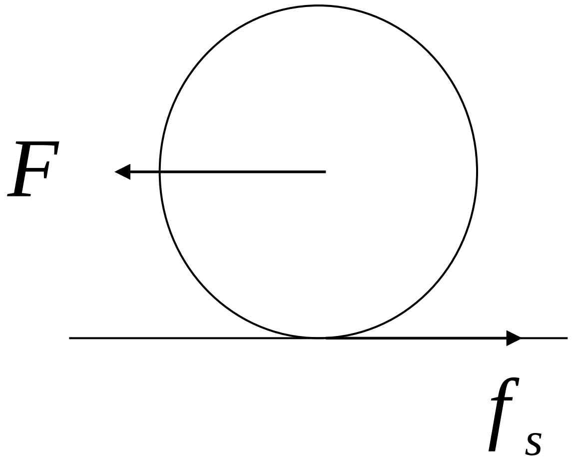
A1 3.0 N
A2 6.0 N
A3 9.0 N
A4 12 N
A5 0 N

$$\alpha = \frac{a_{com}}{R}$$

$$\tau = I\alpha$$

$$f_s R = \left(\frac{1}{2}MR^2\right) \times \left(\frac{a_{com}}{R}\right)$$

$$f_s = \frac{1}{2}Ma_{com} = \frac{1}{2} \times 3.0 \times 2.0 = 3.0\ N$$



7) A 2.0 kg particle is moving such that its position vector (r) relative to the origin is r =(-2.0*t2 i + 3.0 j) m. What is the torque (about the origin) acting on the particle at t=2.0 s?**

A1 24 k N.m

A2 -36 k N.m

A3 -24 k N.m

A4 -48 k N.m

A5 0

$$v = \frac{dr}{dt} = -4t\ i$$

$$a = \frac{dv}{dt} = -4.0\ i$$

$$F = ma = 2.0(-4.0)i = -8.0\ i$$

$$r(2.0) = -8.0\ i + 3.0\ j$$

$$\tau(2.0) = r \times F$$

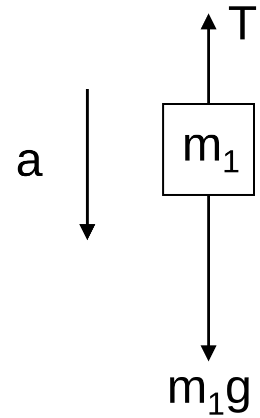
$$= (-8.0\ i + 3.0\ j) \times \left(-8.0\ i\right)$$

$$= (3.0\ j) \times \left(-8.0\ i\right)$$

$$= 24\ k$$

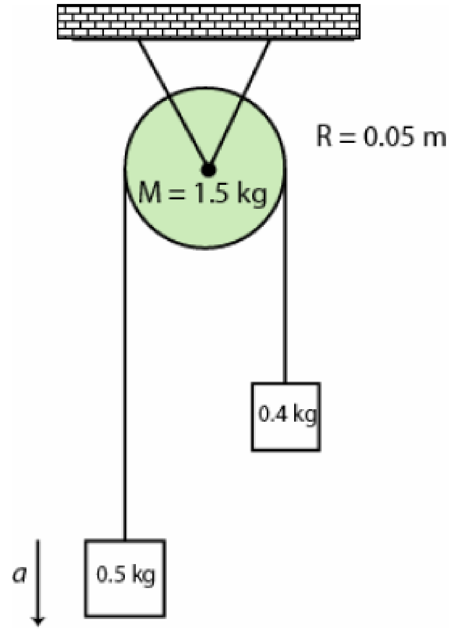
8) In the figure, m1 = 0.50 kg, m2 = 0.40 kg and the pulley has a disk shape of radius 0.05 m and mass M = 1.5 kg. What is the linear acceleration of the block of mass m2?

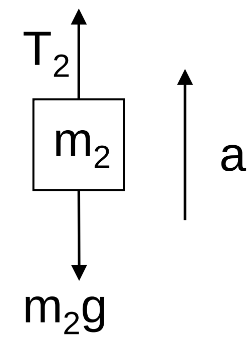
A1 0.59 m/s2**
A2 0.42 m/s2**
A3 1.46 m/s2**
A4 0.21 m/s2**
A5 0.0



$$m_1 g - T_1 = m_1 a$$

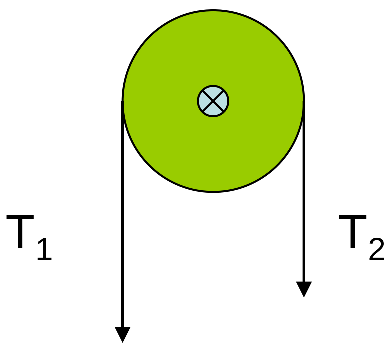
$$T_1 = m_1 g - m_1 a \quad (1)$$





$$T_2 - m_2 g = m_2 a$$

$$T_2 = m_2 a + m_2 g \quad (2)$$



$$\tau_{net} = I\alpha = I\left(\frac{a}{R}\right)$$

$$I = \frac{1}{2}MR^2$$

$$T_1 R - T_2 R = I\left(\frac{a}{R}\right) \quad (3)$$

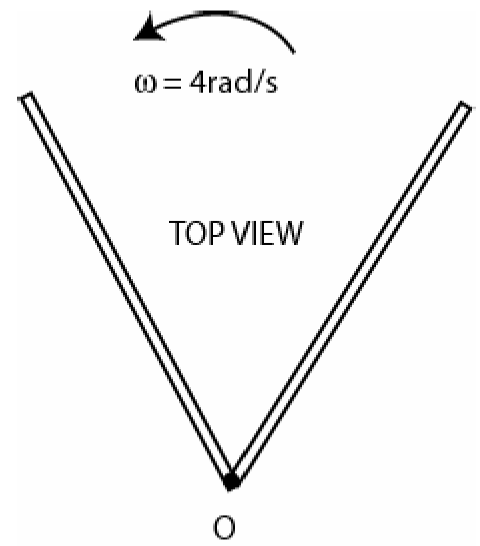
from (1) and (2) we get :

$$T_1 - T_2 = (m_1 - m_2)g - (m_1 + m_2)a$$

put this in (3) to get the value of a

9) Consider two thin rods each of length (L = 1.5 m) and mass 30 g, arranged on a frictionless table as shown in the figure. The system rotates about a vertical axis through point O with constant angular speed of 4.0 rad/s. What is the angular momentum of the system about O?

A1 0.18 kg*m2/s**
A2 0.54 kg*m2/s**
A3 1.5 kg*m2/s**
A4 0.27 kg*m2/s**
A5 0.0

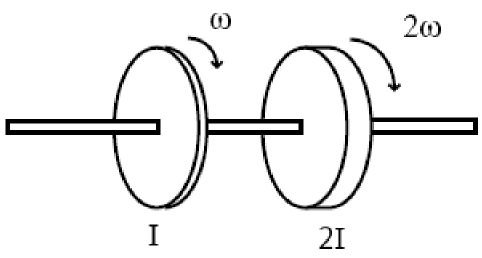


$$I = 2I_{rod} \ \ around \ O$$

$$= 2(\frac{1}{12}ML^2 + M(\frac{L}{2})^2) = 2(\frac{1}{3}ML^2)$$

$$L(\ around \ O\ ) = I\omega$$

10) Fig shows two disks mounted on bearings on a common axis . The first disk has rotational inertia I and is spinning with angular velocity w. The second disk has rotational inertia 2I and is spinning in the same direction as the first disk with angular velocity 2w. The two disks are slowly forced toward each other along the axis until they stick and have a final common angular velocity of:



A1 5*w/3
A2 w*sqrt(3)
A3 w
A4 3*w
A5 2*w

$$\ell_1 = I_1\omega_1 = I\,\omega$$

$$\ell_2 = I_2\omega_2 = 4I\,\omega$$

$$L_i = \ell_1 + \ell_2 = 5I\,\omega$$

$$I_{tot} = I_1 + I_2 = 3I$$

$$L_f = I_{tot}\omega_f = 3I\,\omega_f$$

$$L_i = L_f$$

$$5I\,\omega = 3I\,\omega_f$$

$$\omega_f = \frac{5}{3}\omega$$