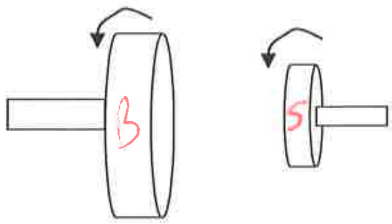
Angular Momentum L=Iw

1. Suppose the large disk of mass 2 kg, radius 0.2m and initial angular velocity of 50rad/s and a small disk with mass 4 kg, radius 0.1m and initial angular velocity of 200rad/s are pushed into one another. Find the common final angular velocity after the disks collide. Is kinetic energy conserved? Disk I = ½ Mr^2

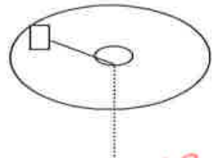


100 rad/s KE not conserved

2. A girl stands at the center of a turntable, holding her arms out horizontally with a 5kg mass in each hand. She is set rotation about a vertical axis with an initial angular velocity of 1 revolution every 2 seconds.
   (A) Find her new angular velocity if she drops her hands to her sides. The girl's inertia may be assumed constant at 6 kgm^2. The original distance of the weights from the axis is 1 meter and their final distance is 0.2 m (look at the weights as particles about an axis). 7.85 rad/s
   (B) Find her original rotational kinetic energy 79 J
   (C) Find her final rotational kinetic energy 197 J
   (D) Explain the results of answers B and C energy put in to system by pulling masses in,

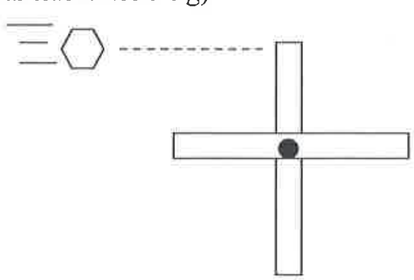
3. A door that is 1 meter wide, has a mass of 15 kg, and is hinged at one side so it can rotate without friction about a vertical axis. A bullet having mass 10 grams and speed 400 m/s is fired into the door, in a direction perpendicular to the plane of the door, and embeds itself at the exact center of the door. Find the angular velocity of the door just after the bullet embeds itself. (Idoor = 1/3 (ML^2)) 0.4 rad/s

4. A puck on a frictionless air hockey table has a mass of 0.05 kg and is attached to a cord passing through a hole in the table surface. The puck is originally revolving at a distance of 0.2 m from the hole, with an angular velocity of 3 rad/s. The cord is then pulled from below, shortening the radius of the circle in which the puck revolves to 0.1m. The puck may be considered a point mass.



   (A) What is the new angular velocity 12 rad/s
   (B) How much work was done by the person who pulled the cord? 0.027 J

(C) 5. A system of 2 bars is connected at their centers to make a "lower case t" as shown below. Each bar is 2 meters long and initially at rest. A wad of gum, mass 450 grams, is thrown at the system with an initial velocity of 15 m/s and sticks to the system causing it to rotate about an axis through the center of the 't' and into the paper. What is the final angular velocity of the system? (each bar has mass 3 kg)



2.75 rad/s

Angular momentum WS

1)
$I_B = \frac{1}{2} 2kg (0.2m)^2$ $\qquad I_s = \frac{1}{2} 4kg (0.1m)^2$

$\omega_B = 50 \frac{rad}{s}$ $\qquad \omega_s = 200 \frac{rad}{s}$

$I_B \omega_B + I_s \omega_s = I_{tot} \omega_{final}$

$\frac{2 + 4}{0.06} = 100 \frac{rad}{s}$

KE NOT conserved

2) a) $\omega_i = \frac{0.5 rev}{s} \cdot \frac{2\pi rad}{1 rev} = \frac{\pi rad}{s}$

$I_{masses\,i} = M_{tot} r^2 = 10kg\, 1m^2 = 10 kg\, m^2$

$I_{girl} = 6 kg\, m^2$ $\qquad I_{mass\,f} = 10kg (0.2m)^2$

$L_i = L_f \Rightarrow L_i = \omega_i (I_{masses\,i} + I_{girl})$

$L_f = \omega_f (I_{masses\,f} + I_{girl})$

$\omega_f = \frac{\omega_i (I_{masses\,i} + I_{girl})}{I_{masses\,f} + I_{girl}} = 7.85 \frac{rad}{s}$

b) $KE = \frac{1}{2}(I_{masses\,i} + I_{girl}) \omega_i^2 = 79J$

c) $KE_f = \frac{1}{2} (I_{masses\,f} + I_{girl}) \omega_f^2 = 197J$

d) Many lessons

3) $L = 1m$ $m_d = 15kg$ $m_b = 0.01g$ $V = 400\frac{m}{s}$

$r_b = 0.5m$ $I_{door} = \frac{1}{3}mL^2$

$L_i = L_f$ $L_i = m_b V r$ $L_f = I_{tot}\,\omega$

$$m_b V r = \left(\frac{1}{3}m_d L^2 + m_b r^2\right)\omega$$

$$\omega = \frac{m_b V r}{\frac{1}{3}m_d L^2 + m_b r^2} = \frac{2}{5+0.0025} \approx \boxed{0.4\frac{rad}{s}}$$

4) a) $m = 0.05kg$ $r_i = 0.2m$ $\omega_i = 3\frac{rad}{s}$

$L_i = L_f$ $r_f = 0.1m$ $I = mr^2$

$$m(r_i)^2\omega_i = m(r_f)^2\omega_f$$

$$\omega_f = \frac{r_i^2\omega_i}{r_f^2} = \boxed{12\frac{rad}{s}}$$

$KE_i = \frac{1}{2}I_i\,\omega_i^2 = 0.009J$

$KE_f = \frac{1}{2}I_f\,\omega_f^2 = 0.036J$

$\Delta KE = work = \boxed{0.027J}$

5) $I_{bars} = \frac{1}{12} m_{tot} L^2$ $\quad I_{tot} = \frac{1}{12} m_{tot} L^2 + m_g \left(\frac{L}{2}\right)^2$

$m_{tot} = 6\,kg$ $\quad L = 2\,m$ $\quad m_g = 0.45\,kg$ $\quad V = 15\,\frac{m}{s}$

$L_i = L_f$ $\quad r = 1\,m$

$$m_g V r = \left(\frac{1}{12} m_{tot} L^2 + m_g \left(\frac{L}{2}\right)^2\right) \omega_f$$

$$\omega_f = \frac{m_g V}{\frac{1}{12} m_{tot} L^2 + m_g} = \frac{0.45\,kg \cdot 15\,\frac{m}{s}}{\frac{1}{12} 6\,kg \cdot 4\,m^2 + 0.45\,kg}$$

$$= \frac{6.75}{2.45} = 2.75\,\frac{rad}{s}$$