Practice your rotation and rotate your name on this paper: Key

AP Physics C: 7.8 Rotational Momentum

1. What is the formula for angular momentum and what are the units?

$L = I\omega$ I is kgm^2 ω is $\frac{rad}{sec}$

units $\frac{kgm^2}{sec}$

2. In linear momentum there are 3 types of equations (bouncy, perfectly inelastic and explosion). In rotational momentum you mostly just deal with objects that are spinning then attach to each other. Write me a set up for 2 objects rotating separately and then connecting together.

$I_1\omega_{1_0} + I_2\omega_{2_0} = (I_1 + I_2)\omega_f$

3. In linear momentum, change in momentum is equal to Impulse. What is the formula for Impulse?

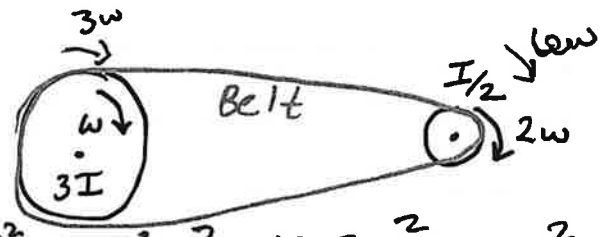
$\Delta p = J = \int F\,dt$

$\Delta L = \int \tau\,dt$

4. If you wanted to calculate change in angular momentum on a graph by taking the integral, what would the y-axis and x-axis need to be?

Y-axis: torque x-axis: _____

5. To the right is a pulley system that moves two wheels. The one on the left has a moment of inertia of $3I$ and a speed ω. The wheel on the right has a moment of inertia of $I/2$ and a speed of 2ω.



   a. Calculate the angular kinetic energy of each wheel.

K_{rot} Left $= \frac{3I(\omega)^2}{2}$ right: $K_{rot} = \frac{(I/2)(2\omega)^2}{2} = \frac{\frac{I}{2}\cdot 4\omega^2}{2} = \frac{2I\omega^2}{2} = I\omega^2$

   b. Calculate the angular momentum of each wheel.

Left: $L = 3I\omega$ right: $L = \left(\frac{I}{2}\right)2\omega = I\omega$

   c. Calculate the angular momentum and angular kinetic energy of the system.

$K_{rot} = \frac{3I\omega^2}{2} + I\omega^2 = \frac{3I\omega^2}{2} + \frac{2I\omega^2}{2} = \boxed{\frac{5I\omega^2}{2}}$ $L_{tot} = 3I\omega + I\omega = \boxed{4I\omega}$

   d. If the angular velocity of the larger wheel was increased to 3ω and the smaller wheel was increased to 6ω, calculate the change in the angular momentum of the system.

Final: $L_{tot} = (3I)(3\omega) + \left(\frac{I}{2}\right)(6\omega) = 9I\omega + 3I\omega = 12I\omega$

Initial: $L_{tot} = 4I\omega$

$\Delta L = L_f - L_0 = 12I\omega - 4I\omega = 6I\omega$

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6. A merry-go-round with an angular momentum of 145 kgm^2/s is spinning at a constant speed. Then some unknown torque speeds the merry-go-round up to an angular momentum of 250 kgm^2/s.
   a. If the torque was applied for 5 seconds, how much torque was applied to the merry-go-round?

$\Delta L = \int F\,dt$

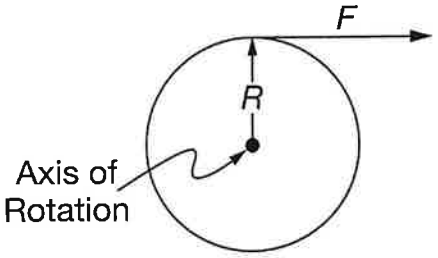
$250 - 145 = \int_0^5 \tau\,dt$ $\qquad \tau = 105\ Nm$

   b. If the moment of inertia of the merry-go-round was 1.2 kgm^2, at what acceleration was the merry-go-round being turned.

$\tau = I\alpha$

$105 = 1.2\alpha$ $\qquad 87.5\ \frac{rad}{sec^2}$

7. A disk of radius R, mass M and moment of inertia I is being spun in a clockwise direction with a force F.



   a. Calculate the angular speed of the disk after a time T seconds. (answer in terms of variables given)

$\omega = ?$ $\quad F = F$ $\quad \tau = I\alpha$ $\quad \omega_f = \omega_0 + \alpha t$

$R = R$ $\quad \tau = FR$ $\quad \alpha = \frac{FR}{I}$ $\quad = \left(\frac{FR}{I}\right)T = \boxed{\frac{FRT}{I}}$

$M = M$ $\quad t = T$

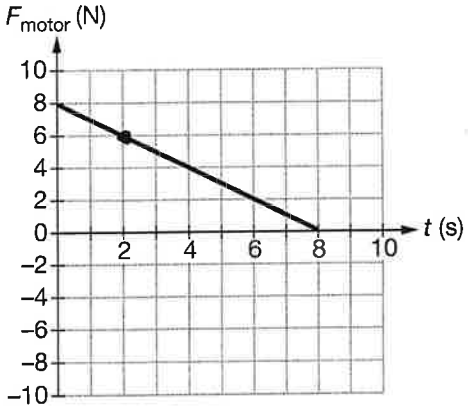
$I = I$

   b. Calculate the angular momentum at time T.

$L = I\omega$

$= I\left(\frac{FRT}{I}\right) = \boxed{\frac{IFRT}{I}} = FRT$

1. The graph to the right shows the force a motor applies to a wheel of radius 0.3 meters.



   a. Calculate the torque applied to the wheel at t=2 seconds.

$\tau = F \cdot R$

$= 6(.3) = 1.8\ Nm$

   b. Calculate the change in angular momentum of the wheel for the 8 second time interval. *(hint: use angular impulse)*

$\Delta L = \int F\,dt$

$32\ \frac{kgm^2}{s}$