Angular Momentum Practice

$\omega = \frac{\Delta\theta}{t}$ $\alpha = \frac{\Delta\omega}{t}$ $\Delta\theta = \frac{\Delta x}{r}$ $\omega = \frac{v}{r}$ $\omega = \frac{2\pi}{T}$ $\alpha = \frac{a_T}{r}$ $a_c = \frac{v^2}{r} = \omega^2 r$

$v = \frac{2\pi r}{T}$ $\omega_f = \omega_0 + \alpha t$ $\Delta\theta = \frac{1}{2}(\omega_0 + \omega_f)t$ $\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ $\omega_f^2 = \omega_0^2 + 2\alpha\Delta\theta$ $T = \frac{1}{f}$

$\tau = F_\perp r_\perp$ $I_{hoop} = mr^2$ $I_{mass} = mr^2$ $I_{disk} = \frac{1}{2}mr^2$ $I_{rod(center)} = \frac{1}{12}ml^2$ $I_{rod(end)} = \frac{1}{3}ml^2$ $\tau = I\alpha$

$K_{trans} = \frac{1}{2}mv^2$ $K_{rot} = \frac{1}{2}I\omega^2$ $L = I\omega$

1. A rock with a mass of 0.05 kg is swung overhead in a horizontal circle of radius 0.3 m at a constant rate of 5 revolutions per second. What is the angular momentum of the rock? ***0.141 kg m²/s***

2. A 0.015 kg record with a radius of 15 cm rotates with an angular speed of 33 rpm. Find the angular momentum of the record. ***5.8 x 10⁻⁴ kg m²/s***

3. A uniform rod rotates in a horizontal plane about a vertical axis through one end. The rod is 6.00 m long, has a mass of 1.0 kg, and rotates at 40 rad/s clockwise when seen from above. Calculate the rotational inertia of the rod about the axis of rotation and the angular momentum of the rod about the axis. ***12 kg m²; 480 kg m²/s***

4. You stand on a frictionless platform that is rotating at 1.5 rad/s. Your arms are outstretched, and you hold a heavy weight in each hand. The moment of inertia of you, the extended weights, and the platform is 6.0 kg m^2. When you pull the weights in toward your body, the moment of inertia decreases to 1.8 kg m^2. What is the resulting angular speed of the platform? ***5 rad/s***

5. A small blob of putty of mass 200 g falls from the ceiling and lands on the outer rim of a turntable of radius 25 cm and mass of 125 g that is rotating freely with angular speed 1.6 rad/s about its vertical fixed-symmetry axis. What is the post-collision angular speed of the turntable-putty system? ***0.38 rad/s***

6. A 65.0 kg woman stands at the rim of a horizontal turntable that has a moment of inertia of 400 kg · m^2 and a radius of 3.00 m. The turntable is initially at rest and is free to rotate about a frictionless, vertical axle through its center. The woman then starts walking around the rim clockwise (as viewed from above the system) at a constant speed of 2.0 m/s relative to the Earth. In what direction and with what angular speed does the turntable rotate? ***Counterclockwise, 0.98 rad/s***

7. A student sits at rest on a piano stool that can rotate without friction. The moment of inertia of the student-stool system is 4.1 kg m^2. A second student tosses a 1.5 kg mass with a speed of 2.7 m/s to the student on the stool, who catches it a distance of 0.4 m from the axis of rotation. What is the resulting angular speed of the student and the stool? ***0.37 rad/s***

8. A torque of 0.12 Nm is applied to an egg beater. If the egg beater starts from rest, what is its angular momentum after 0.5 s? ***0.06 kg m²/s***

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① $L = I\omega$ $\quad I = mr^2$ $\quad \omega = 5\ \frac{rev}{s} \cdot 10\pi\ rad/s$

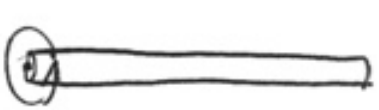
$L = (.0045\ kg\cdot m^2)(10\pi\ rad/s)$ $\quad I = (.05\ kg)(.3m)^2$

$L = 0.141\ kg\cdot m^2/s$ $\quad I = .0045\ kg\cdot m^2$

② $L = I\omega$ $\quad I = \frac{1}{2}mr^2$ $\quad \omega = 33\ \frac{rev}{min} \cdot 3.46\ rad/s$

$L = (.000169\ kg\cdot m^2)(34.6\ rad/s)$ $\quad I = \frac{1}{2}(.015\ kg)(.15m)^2$

$L = .000584\ kg\cdot m^2/s$ $\quad I = .000169\ kg\cdot m^2$

③ 

$I = \frac{1}{3}ml^2$ $\quad L = I\omega$

$I = \frac{1}{3}(1\ kg)(6m)^2$ $\quad L = (12\ kg\cdot m^2)(40\ rad/s)$

$I = 12\ kg\cdot m^2$ $\quad L = 480\ kg\cdot m^2/s$

④ $L_o = L_f$

$I_o\omega_o = I_f\omega_f$

$(6.0\ kg\cdot m^2)(1.5\ rad/s) = (1.8\ kg\cdot m^2)\omega_f$

$\omega_f = 5\ rad/s$

⑤ $L_o = L_f$

$I_o\omega_o = I_f\omega_f$

$(.00391\ kg\cdot m^2)(1.6\ rad/s) = (.0164\ kg\cdot m^2)\omega_f$

$\omega_f = 0.381\ rad/s$

$I_o = \frac{1}{2}mr^2$

$I_o = \frac{1}{2}(.115\ kg)(.25m)^2$

$I_o = .00391\ kg\cdot m^2$

$I_f = I_o + mr^2$

$I_f = I_o + (.200\ kg)(.25m)^2$

$I_f = 0.0164\ kg\cdot m^2$

⑥

$I_0 = I_f$

$0 = I_\omega \omega_{\omega_f} + I_{++} \omega_{++_f}$

$I_\omega = mr^2$

$I_\omega = (65\ kg)(3m)^2$

$I_\omega = 585\ kg \cdot m^2$

$\omega_{\omega_f} = \frac{V}{r}$

$\omega_{\omega_f} = \frac{2\ m/s}{3m}$

$\omega_{\omega_f} = 0.67\ rad/s$

$0 = (585\ kg \cdot m^2)(.67\ rad/s) + (400\ kg \cdot m^2)\omega_{++_f}$

$\omega_f = -0.98\ rad/s$

⑦

$I_0 = I_f$

$I_m \omega_{m_0} = (I_m + I_0)\omega_f$

$I_m = mr^2$

$I_m = (1.5\ kg)(.4m)^2$

$I_m = 0.24\ kg \cdot m^2$

$\omega_{m_0} = \frac{V}{r}$

$\omega_{m_0} = \frac{2.7\ m/s}{0.4m}$

$\omega_{m_0} = 6.75\ rad/s$

$(.24\ kg \cdot m^2)(6.75\ rad/s) = (.24\ kg \cdot m^2 + 4.1\ kg \cdot m^2)\omega_f$

$\omega_f = 0.37\ rad/s$

⑧

$\Delta L = \tau \cdot t$

$\Delta L = (0.12\ N \cdot m)(.5s)$

$\Delta L = 0.06\ kg \cdot m^2/s$