Name:

AP Physics 1
M. Lam

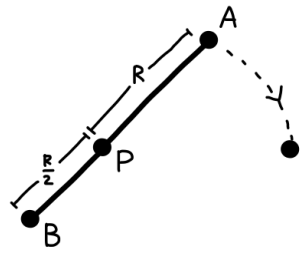
Angular Momentum and Rotational Kinetic Energy

Block:

1. A 1500 kg satellite orbits a planet in a circular orbit of radius 6.2 x 10^6 m. What is the angular momentum of the satellite in its orbit around the planet if the satellite completes one orbit every 1.5 x 10^4 s?

2. A 60.0 kg skater begins a spin with an angular speed of 6.0 rad/s. By changing the position of her arms, the skater decreases her rotational inertia by 50%. What is the skater's final angular speed?

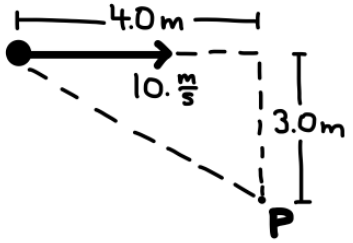
3. Two equal spheres, labelled A and B in the figure, are attached to a massless rod with a frictionless pivot at the point P. The system is made to rotate clockwise with angular speed ω on a horizontal, frictionless tabletop. Sphere A collides with and sticks to an equal sphere that is at rest on the tabletop. What is the angular speed of the system immediately after the collision?



4. Planets A and B are uniform solid spheres that rotate at a constant speed about axes through their centres. Although B has twice the mass and three times the radius of A, each planet has the same rotational kinetic energy. What is the ratio ω_B:ω_A? (I_{sphere} = 2/5 MR^2)

5. A solid sphere of radius R rotates about a diameter with an angular speed ω, The sphere then collapses under the action of internal forces to a final radius R/2. What is the final angular speed of the sphere? (I_{sphere} = 2/5 MR^2)

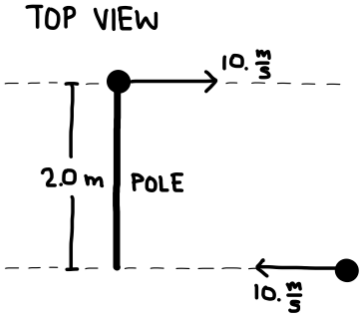
6. A 3.0 kg ball moves in a straight line at 10 m/s as shown in the figure. At the instant shown, what is the angular momentum about the point P?



7. A hollow sphere of radius 0.25 m is rotation at 13 rad/s about an axis that passes through its centre. The mass of the sphere is 3.8 kg. Assuming a constant net torque is applied to the sphere, how much work is required to bring the sphere to a stop? ($I_{\text{hollow sphere}} = 2/3\ MR^2$)

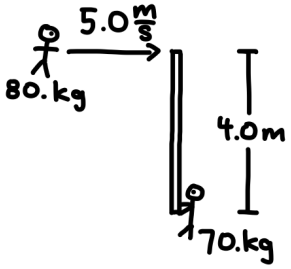
8. A ceiling fan has five blades, each with a mass of 0.34 kg and a length of 0.66 m. The fan is operating in its "low" setting at which the angular speed is 9.4 rad/s. If the blades can be approximated as uniform thin rods that rotate about one end, what is the total rotational kinetic energy of the five blades? ($I_{\text{rod, rotating about one end}} = 1/3\ ML^2$)

9. Two skaters, each of mass 40.0 kg approach each other along parallel paths that are separated by a distance of 2.0 m. Both skaters have a speed of 10 m/s. The first skater carries a 2.0 m massless pole. As the second skater passes the pole, he catches hold of the end. The two skaters then go around in a circle around the centre of the pole.



   a) What is the forward speed of the centre of mass of the stick after the collision?
   b) What is the angular velocity of the stick about its centre of mass after the collision?
   c) Find the initial kinetic energy and the final kinetic energy of the system.

10. A 70 kg astronaut is in deep space. Approaching him at 5.0 m/s is a 80 kg astronaut. The 70 kg astronaut holds a 4.0 m massless rod vertically upwards such that the other astronaut can grab on to the end.



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   b) What is the angular velocity of the stick about its centre of mass after the collision?
   c) Find the initial kinetic energy and the final kinetic energy of the system.

11. A 2.0 kg hoop rolls without slipping on a horizontal surface so that its centre proceeds to the right with a constant linear speed of 6.0 m/s. What is the total kinetic energy of the hoop? ($I_{\text{hoop}} = MR^2$)

12. A 2.7 g ping pong ball rolls down a 1.0 m high ramp. What is the speed of the ping pong ball as it reaches the bottom of the ramp? ($I_{\text{hollow sphere}} = 2/3\ MR^2$)

