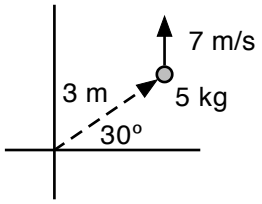
Test: *Rotational Mechanics*

Multiple Choice: *Choose the letter of the best answer. 3 points each.*

1. _____ A 5 kg particle is 3 meters away from the origin, as shown in the diagram. It has a constant velocity of 7 **j** m/s. What is the magnitude of its angular momentum, as measured from the origin?



a. 0 kg·m^2/s. b. 35 kg·m^2/s. c. 52.5 kg·m^2/s.
d. 90.9 kg·m^2/s. e. 105 kg·m^2/s.

2. _____ When a spinning figure skater pulls in their arms, they rotate faster. Which of the following is true in this situation?

I. Angular momentum is conserved.
II. Kinetic energy is conserved.
III. Moment of inertia is conserved.

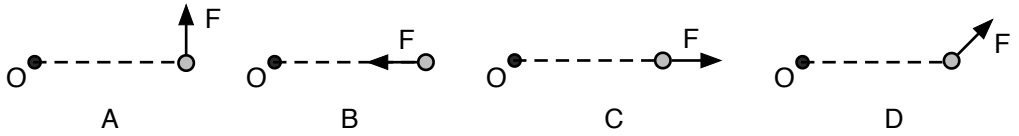
a. I only. b. II only. c. I & III only. d. I & II only. e. I, II & III.

3. _____ How much work would it take to stop a solid sphere of mass 3 kg that was rolling without slipping and had a speed of 7 m/s?
a. 147.0 J. b. 29.4 J. c. 102.9 J. d. 73.5 J.
e. need to know the radius in order to find the actual number.

4. _____ A particle, held by a string whose other end is attached to a fixed point, moves in a circle on a horizontal frictionless surface. If the string is cut, the angular momentum of the particle about the fixed point
a. increases. b. decreases. c. stays the same.
d. changes direction, but not magnitude. e. none of those.

5. _____ A uniform rod is swinging back and forth 30° from the vertical (like a pendulum.) Which of the following statements about the accelerations of the rod is true?
a. The angular speed is a maximum when the angular acceleration is also a maximum.
b. The angular speed is a minimum when the angular acceleration is also a minimum.
c. The angular speed varies, but the angular acceleration is constant.
d. The angular speed is constant, but the angular acceleration varies.
e. The angular speed is a minimum when the angular acceleration is a maximum.

6. _____ A single force F acts on a particle P. Rank each of the orientations of the force shown below according to the magnitude of the time rate of change of the particle's angular momentum about the point O, least to greatest. The particle is the same distance away from the axis in each case.



a. A, B & C, D. b. D, B, C, A.
c. B & C, A, D. d. B &C, D, A. e. all the same.

7. _____ An object has a large angular velocity. Somehow, there is a torque on the object that is constant in magnitude, but always oriented perpendicular to its angular velocity. What will happen to the object?
a. It will speed up at a constant rate.
b. It will slow down at a constant rate.
c. It will speed up at an increasing rate.
d. It will slow down at an increasing rate.
e. It will not speed up or slow down, but will change its axis of rotation.

Test: *Rotational Mechanics*

8. _____ A hoop rolls with constant velocity and without sliding along level ground. Its rotational kinetic energy is
   a. half its translational kinetic energy.
   b. the same as its translational kinetic energy.
   c. twice its translational kinetic energy.
   d. four times its translational kinetic energy.
   e. one-third its translational kinetic energy.

9. _____ A mass m is hanging from a string that is wrapped around a pulley and initially at rest. In order to determine the speed of the mass after it has fallen a distance h, what else would you need to know about the pulley?
   a. its shape (disc, sphere, etc.) and mass.
   b. its moment of inertia and radius.
   c. its mass and radius.
   d. its mass and moment of inertia.
   e. none of those are enough to determine the speed.

10. _____ The moment of inertia of a disc is I. What would be the moment of inertia of a disc made of the same material, but twice the radius?
   a. 16I. b. 8I. c. 4I. d. 2I. e. none of those.

11. _____ When we apply the energy conservation principle to a cylinder rolling down an incline without sliding, we exclude the work done by friction because
   a. there is no friction present.
   b. the angular velocity of the center of mass about the point of contact is zero.
   c. the coefficient of kinetic friction is zero.
   d. the linear velocity of the point of contact (relative to the inclined surface) is zero.
   e. the coefficient of static and kinetic friction are equal.

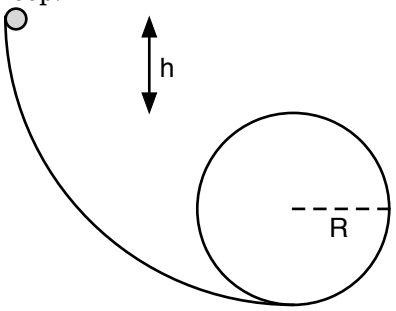
12. _____ The angular momentum vector of Earth about its rotation axis, due to its daily rotation, is directed
   a. tangent to the equator toward the east.
   b. tangent to the equator toward the west.
   c. to the north.
   d. to the south.
   e. to the sun.

13. _____ A playground merry-go-round has a radius R and a rotational inertia I. When the merry-go-round is at rest, a child with mass m runs with speed v along a line tangent to the rim and jumps on. The angular velocity of the merry-go-round is then
   a. mv/I. b. v/R. c. mRv/I. d. $2mRv/I$. e. $mRv/(mR^2 + I)$.

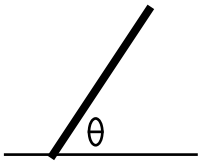
Test: *Rotational Mechanics*

Problem Solving: *Show all work.*

14. A solid sphere rolls without slipping down a ramp and then through a loop-the-loop of radius 25 cm. What is the minimum height above the loop that the sphere must be released from in order to just make the loop? Assume the radius of the sphere is much smaller than the radius of the loop.

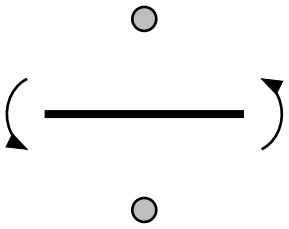


15. A 5 kg rod of length 3 meters is free to rotate about one of its ends, which is fixed to the ground. The rod is held at an initial angle of 50°, as shown in the diagram. How fast (in m/s) is the end of the rod going just as it hits the ground?



Test: *Rotational Mechanics*

16. A 4 kg rod is free to rotate about its center of mass. Starting from rest and from the horizontal position shown, it accelerates at a constant rate of 6 rad/s^2. After it is has rotated 90^o, that acceleration stops and it collides with two small masses, each 1 kg and initially at rest. If the masses stick to the ends of the rod, what is the new angular velocity of the rod and masses immediately after the collision?



17. Show that the moment of inertia for a thin rod of mass M and length L about its center of mass is 1/12 ML^2.