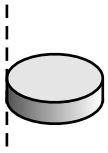
Test: *Rotational Mechanics*

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

1. _____ What is the moment of inertia for a disc of mass M and radius R rotating about an axis touching its edge perpendicular to the disc?



a. $2MR^2$ b. $\frac{3}{2}MR^2$ c. MR^2 d. $\frac{1}{2}MR^2$

2. _____ If a rotating object somehow experiences a torque that is always perpendicular to its angular velocity, what will happen to the object?
   a. What?! That is impossible, so this is a really pointless question.
   b. It will slow down, stop and speed up in the opposite direction.
   c. It will have a constant speed, but keep changing its direction of rotation.
   d. It will it have a chaotic tumbling motion that is diffcult to describe.

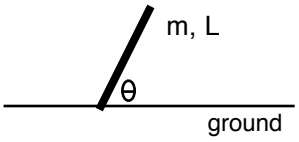
3. _____ Which of the following would represent the angular position of a rotating object slowing down at a constant rate of 4 rad/s^2 and in initial speed of 12 rad/s?

a. $\theta = -2t^2 + 12t - 5$ b. $\theta = -4t^2 + 12t + 5$

c. $\theta = 4t^2 - 12t$ d. $\theta = 8t^2 - 4t - 12$

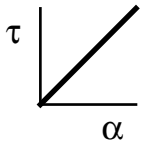
4. _____ As a spinning skater pulls her arms in, she rotates faster. Why does this happen?
   a. Her angular momentum remains constant, so her increasing rotational inertia cause her to speed up.
   b. Her angular momentum remains constant, so her decreasing rotational inertia cause her to speed up.
   c. Her kinetic energy remains constant, so her increasing rotational inertia cause her to speed up.
   d. Her kinetic energy remains constant, so her decreasing rotational inertia cause her to speed up.

5. _____ What is the magnitude of the torque created by the weight of a pole about its contact point with the ground? The pole has a mass "m" and length "L" and leaning with the angle shown.



a. $\frac{1}{2}mgL\sin\theta$ b. $mgL\sin\theta$ c. $\frac{1}{2}mgL\cos\theta$ d. $mgL\cos\theta$

6. _____ Some students do a lab in which they exert a variety of net torques on an object, and measure its resulting angular acceleration. They get a graph that looks like the diagram. What is the physical significance of the slope of the graph?



   a. It is the rotational inertia of the object.
   b. It will be the mass of the object.
   c. It will be the angular momentum of the momentum.
   d. None of the above are correct.

Problems 7 to 9 refer to the following:
A disc (mass 2 kg and radius 40 cm) has an initial speed of 2.5 rad/s. It has a constant acceleration until it has a final speed of 8 rad/s. This process takes 3 second.

7. _____ What was the acceleration of the object?
   a. 16.5 rad/s^2. b. 5.25 rad/s^2. c. 2.67 rad/s^2. d. 1.83 rad/s^2.

8. _____ How much does the disc rotate in this process?
   a. 12 rad. b. 15.75 rad. c. 16.5 rad. d. 24 rad.

9. _____ How much torque would be needed to create an acceleration of 5 rad/s^2?
   a. 0.032 Nm. b. 0.064 Nm. c. 0.80 Nm. d. 1.60 Nm.

Test: *Rotational Mechanics*

10. ____ One revolution per minute is about:
a. 0.0524 rad/s. b. 0.105 rad/s. c. 0.95 rad/s. d. 1.57 rad/s. e. 6.28 rad/s.

11. _____ Four identical point masses, m, are attached to massless rods as shown in the diagram below (left.) What is the total moment of inertia about the axis shown?
a. $2\ ma^2$. b. $4\ ma^2$. c. $6\ ma^2$. d. $8\ ma^2$. e. $10\ ma^2$.

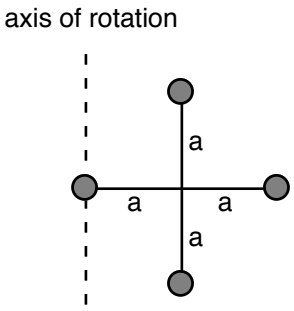


Diagram for Question 4.

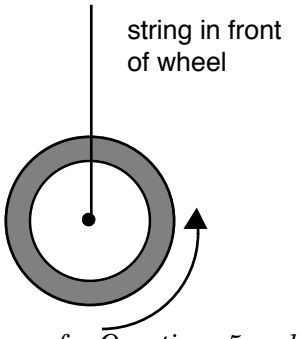


Diagram for Questions 5 and 6.

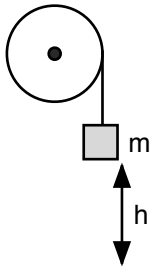
12. _____ A wheel is spinning with a rotational velocity as shown in the diagram above (right.), and is then hung from one side of the axle by a string as shown. What is the direction of the net torque on the wheel?
a. ↑ b. ↓ c. → d. ← e. out of paper.

13. _____ Which of the following are units of angular momentum?
a. $kg \bullet m^2/s$ b. $kg \bullet m/s$ c. $kg \bullet m^2/s^2$ d. $kg \bullet m/s^2$ e. none of these.

Test: *Rotational Mechanics*

Problem Solving: *Show all work.*

14. A 1.3 kg mass is attached to a disc of mass 400 grams and radius 0.5 meters via a string that is wrapped around the outside edge of the disc. If the system started from rest, how fast would the mass be moving after it fell a distance of 0.75 meters?

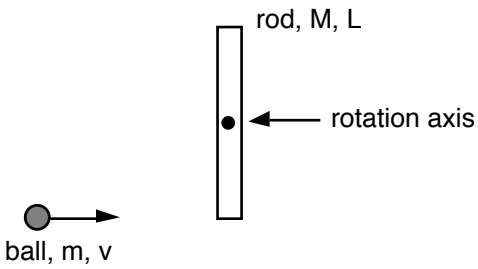


15. A flywheel is initially rotating at 20 rad/s and has a constant angular acceleration. After 9 seconds it has rotated through 450 radians. What is its angular acceleration?

16. A 2.5 meter long stick is held vertically with one end on the floor and is allowed to fall. Find the linear speed of the other end when it hits the floor, assuming that the end on the floor does not slip. (Consider the stick to be a thin rod.)

Test: *Rotational Mechanics*

17. A ball of mass 150 grams collides and sticks to one end of a rod that is free to rotate about its center (but the axis is fixed in place.) The rod has a mass of 250 grams and is 50 cm long. If the ball has an initial velocity of 5 m/s, and strikes the rod at a 90° angle, what is the final angular velocity of the rod and ball? (Treat the ball as a point.)



18. A hollow spherical shell is released from rest at the top of an incline with a height of h. IF the shell rolls without slipping, how fast is it going at the bottom of the incline?

19. A sign of mass m is hung from a pole of mass M and length L as shown. The pole is hung from a wall so that it is horizontal, and there is an additional support wire, also shown. Derive an expression for the tension in the wire.