Conceptual Questions: Rotational Motion; Torque, Moment of Inertia, & Angular Momentum

1. The name of the quantity which is greater for a long 100 pound barbell than for a short 100 pound barbell, and makes the long barbell harder to twist is rotational
   a. momentum b. energy c. inertia d. weight

2. Why can't you open a door by pushing on its hinged side?
   a. The lever arm is zero
   b. the torque is zero
   c. a is the only correct answer
   d. b is the only correct answer
   e. both a and b are correct

3. Some dragsters are built so that the front wheels are far ahead of the rear wheels. The main reason for this is
   a. to streamline the dragster
   b. to provide better traction.
   c. to keep the front of the car down.

4. Moment of inertia describes
   a. The average position of the mass in an extended object.
   b. How the mass of an extended object is distributed about a rotation axis.
   c. How a force can rotate an object.
   d. The tendency of an object to move in a straight line.

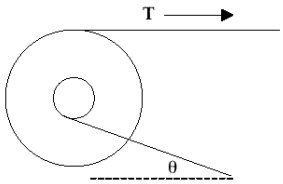
5. The angular displacement of an object is described by $\theta=3+4t^3-5/t$. Write the expression for ω as a function of time.
   a. $3+12t^3-5\ln t$
   b. $12t^2-5\ln t$
   c. $12t^2+5/t^2$
   d. $3+4t^3-5\ln t$

6. The angular displacement of an object is described by $\theta=3+4t^3-5/t$. Write the expression for α as a function of time.
   a. $24t^3-5t\ln t$
   b. $12t^2-5t\ln t$
   c. $12t^2+5/t^2$
   d. $24t-10/t^3$

7. A student sits in a spinning stool with her arms folded. When she extends her arms away from her body, her *kinetic energy*
   a. increases
   b. decreases
   c. remains the same

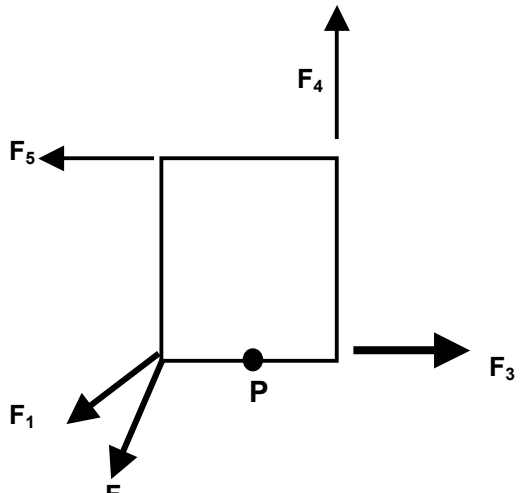
8. A wheel of outer radius *R* has an axle of radius R/6. Strings are wrapped as shown around the rim of the wheel and around the axle. If the string around the rim of the wheel has tension T, then in order to keep the wheel from turning the tension in the string around the axle must be:

   a. 6T
   b. 6Tsinθ
   c. T/6
   d. (T/6)sinθ



9. Five forces of the same magnitude act on a square that can rotate about point P at the midpoint of one of the edges. Rank the forces (in *ascending* order) acting on it according to the magnitude of the torque they create about point P

   a. F_2, F_3, F_4,&F_5 (tie), F_1
   b. F_3, F_4, F_1, F_2, F_5
   c. F_5, F_4, F_3, F_1, F_2
   d. F_3, F_1, F_2, F_4, F_5
   e. F_4, F_3, F_2, F_5, F_1



10. If a net force acting on a body produces purely linear motion
    a. it must pass through body's center of mass
    b. it must be zero
    c. it must be less than the weight of the body
    d. none of the above

11. A hoop of mass M and radius R is cut along a diameter and assembled as shown below. Calculate the moment of inertia of the arrangement if, it is rotated about an axis that is perpendicular to this page and passes through point ***A***.

    a. MR^2
    b. $2MR^2$
    c. $3MR^2$
    d. $6MR^2$
    e. $9MR^2$

12. An object is rolling without slipping on a horizontal surface. The speed of it center of mass is constant. If the speed of the object's center of mass is 1.0m/s, then its instantaneous speed at the point of contact (between the object and the horizontal surface) is
    a. 0m/s
    b. 1.0m/s
    c. 2.0m/s
    d. 3.0m/s

13. A solid sphere and a hoop roll down an incline. The hoop is slower than the sphere if
    a. mass of the hoop equals the mass of the solid sphere
    b. radius of the hoop equals the radius of the solid sphere
    c. both masses and radii are equal
    d. the hoop is always slower regardless of their masses and radii.

14. Assume both objects in the above problem are released from rest, and are of the same mass and radius. Which object has more kinetic energy when it reaches the bottom of the incline?
    a. The solid sphere
    b. The hoop
    c. They both have the same kinetic energy
    d. More information is needed.

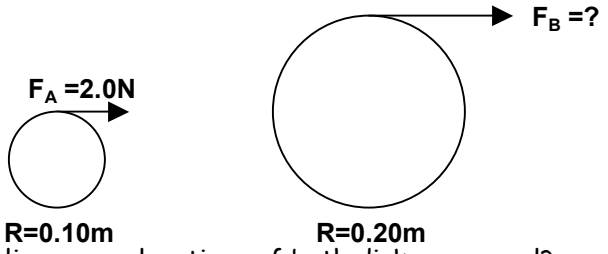
15. Suppose a solid sphere and a hoop are rolled up an incline plane with the same initial velocity. Which object will travel furthest up the plane?
    a. The solid sphere
    b. The hoop
    c. The maximum heights up the incline plane will be the same since their initial velocities are the same!

16. A very massive object traveling at 10 m/s strikes a very light object, initially at rest. The very light object takes off in the direction of travel of the heavy object. If the collision is elastic, the speed of the lighter object is
    a. 0.0 m/s
    b. 5.0m/s
    c. 10.0m/s
    d. 15.0m/s
    e. 20.0m/s

17. The work done by friction when an object is rolling on a horizontal surface is equal to
    a. $\mu_s Nd$, where d is the distance traveled.
    b. $\mu_s Nd$, where d is the distance traveled.
    c. 0
18. An object is rolling down an incline plane. Which of the following best describes frictional force acting on the object.
    a. $f_s = \mu_s N$
    b. $f_s > \mu_s N$
    c. $f_s < \mu_s N$
    d. 0

19. The moment of inertia of a rectangle of sides equal to *a* and *b* is rotated about an axis that passes through (and is perpendicular to) one of its corners. The moment of inertia of the rectangle is
    a. $(M/12)(a^2+b^2)$
    b. $(M/2^{1/2})(a^2+b^2)$
    c. $(M/3)(a^2+b^2)$
    d. $(13M/12)(a^2+b^2)$

20. Two disks each having a mass of 2kg start from rest with forces applied as shown. What is F_B if the angular accelerations are equal?
    a. 0.5N
    b. 1.0N
    c. 2.0N
    d. 4.0N
    e. more information is needed



21. What is F_B in the above problem if the linear accelerations of both disks are equal?
    a. 0.5N
    b. 1.0N
    c. 2.0N
    d. 4.0N
    e. more information is needed

22. Angular velocity and linear velocity have the same dimensions. This statement is
    a. true
    b. false

23. A ball is hit very near the top so that it starts to move with topspin. As is slides friction will
    a. decrease the velocity of the center of mass and increase the angular velocity of the ball.
    b. increase the velocity of the center of mass and increase the angular velocity of the ball.
    c. decrease the velocity of the center of mass and decrease the angular velocity of the ball.
    d. increase the velocity of the center of mass and decrease the angular velocity of the ball.

24. A particle with linear momentum $\mathbf{p}=(-4\mathbf{j}+2\mathbf{k})$N is at the position $\mathbf{r}=(3\mathbf{j}-5\mathbf{k})$m. What is its angular momentum with respect to the origin?
    a. $-14\mathbf{i}$ kgm^2/s
    b. $26\mathbf{i}$ kgm^2/s
    c. $6\mathbf{j}$ kgm^2/s
    d. $-20\mathbf{j}$ kgm^2/s
    e. $26\mathbf{k}$ kgm^2/s

25. A horizontal disk with moment of inertia I_1 rotates with angular velocity ω_1 about a vertical frictionless axle. A second horizontal disk (initially not rotating), with moment of inertia I_2 is dropped onto the first disk. Both disks spin together about the vertical axis with a final angular speed ω_2. The ratio ω_2/ω_1 is
    a. I_1/I_2
    b. I_2/I_1

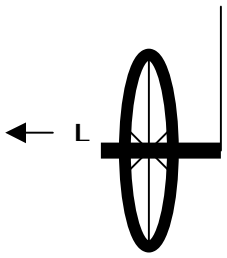
c. $I_2/(I_1+I_2)$
d. $I_1/(I_1+I_2)$
e. $I_2 I_1$

26. The torque vector
    a. is perpendicular to the position vector
    b. is perpendicular to the force vector
    c. along with the position and force vector define a right-handed coordinate system
    d. only a and b are correct.
    e. a, b, and c are correct.

27. A particle is acted upon by a force **F**=(**i**-2**j**)N is at the position **r**=(4**j**-3**k**)m. What is the torque with respect to the origin?
    a. -6**i**-3**j**-4**k** kgm^2/s^2
    b. 10**i**+3**j**+8**k** kgm^2/s^2
    c. 6**j** kgm^2/s^2
    d. 6**i**-8**j**-3**k** kgm^2/s^2
    e. 6**i**-3**j** kgm^2/s^2

28. What is the torque with respect to the point (0,3,-2) in the above problem?
    a. -10**i**-5**j**-7**k** kgm^2/s^2
    b. 10**i**+3**j**+8**k** kgm^2/s^2
    c. -2**i**-**j**-**k** kgm^2/s^2
    d. 8**k** kgm^2/s^2

29. A physics 4A student mounts a bicycle wheel on an axle is spinning with its angular momentum as indicated. One end of the axle (point **A**) is attached to a vertical string, which supports the weight of the wheel system. As a result the vector **L** will rotate
    a. clockwise within the plane of this paper
    b. out of the plane of this paper
    c. counterclockwise within the plane of this paper
    d. into the plane of this paper



30. An ice skater spins with her arms folded. When she extends her arms outward her angular momentum
    a. increases
    b. decreases
    c. remains the same

31. An ice skater spins with her arms folded. When she extends her arms outward her angular velocity
    a. increases
    b. decreases
    a. remains the same