1. Two masses, M and $5M$, rest on a horizontal frictionless table with a compressed spring of negligible mass between them. When the spring is released, the energy of the spring is shared between the two masses in such a way that
   A) M gets 3/5 of the energy.
   B) M gets 1/6 of the energy.
   C) M gets 1/5 of the energy.
   D) M gets 4/5 of the energy.
   E) None of these will occur.

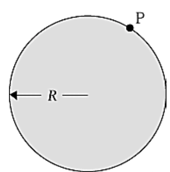
2. A golf ball and a (less massive) Ping-Pong ball are dropped in a vacuum chamber. When they have fallen halfway to the floor, they have the same
   A) speed.
   B) potential energy.
   C) kinetic energy.
   D) momentum.
   E) speed, potential energy, kinetic energy, and momentum.

3. A bullet of mass m and velocity $\vec{u}$ strikes and becomes imbedded in a wooden block of mass M, which is initially at rest on a frictionless surface. The ratio of the velocity of the system after collision to the initial velocity of the bullet is
   A) $(M + m)/m$
   B) $(M + m)/M$
   C) $M/(m + M)$
   D) $m/(m + M)$
   E) $M/(m - M)$

4. While in horizontal flight at a speed of 20 m/s, a baseball of mass 0.11 kg is struck by a bat. After leaving the bat, the baseball has a speed of 29 m/s in a direction opposite to its original direction. The magnitude of the impulse given the ball is
   A) 0.99 kg · m/s
   B) 5.4 kg · m/s
   C) 2.2 kg · m/s
   D) 3.2 kg · m/s
   E) 0.55 kg · m/s

5. A particle moves uniformly around the circumference of a circle whose radius is 8.0 cm with a period of $\pi/20$ s. The angular speed ω of the particle is
   A) 2.5 rad/s
   B) 3.2×10^2 rad/s
   C) 40 rad/s
   D) 7.9 rad/s
   E) 0.96 rad/s

6. A homogeneous solid cylinder of mass m, length L, and radius R rotates about an axis through point P, which is parallel to the cylinder axis. If the moment of inertia about the cylinder axis is $\frac{1}{2} mR^2$, the moment of inertia about the axis through P is



   A) $0.4mR^2$
   B) $\frac{1}{2} mR^2$
   C) $2/3\ mR^2$
   D) mR^2
   E) $1.5mR^2$

7. What constant torque, in the absence of friction, must be applied to a wheel to give it an angular velocity of 50 rad/s if it starts from rest and is accelerated for 10 s? The moment of inertia of the wheel about its axle is $9.0\ \text{kg} \cdot \text{m}^2$.
   A) 4.5 N · m
   B) 9.0 N · m
   C) 45 N · m
   D) 30 N · m
   E) 60 N · m

8. A hoop rotates about an axis through its center with an angular velocity of 40.0 rad/s. If the rotational kinetic energy of the hoop is 400 J, its angular momentum is
   A) $800\ \text{kg} \cdot \text{m}^2/\text{s}$
   B) $400\ \text{kg} \cdot \text{m}^2/\text{s}$
   C) $200\ \text{kg} \cdot \text{m}^2/\text{s}$
   D) $20\ \text{kg} \cdot \text{m}^2/\text{s}$
   E) $5\ \text{kg} \cdot \text{m}^2/\text{s}$

9. The angular momentum of a rotating object is initially $\vec{L}_i = 2\hat{i} + 4\hat{j}$ and 2s later it is $\vec{L}_f = 3\hat{i} + 8\hat{j}$. The units are in kg·m^2/s. The torque that produces the change in angular momentum is

A) $-0.5\,N \cdot m\,\hat{i} - 2\,N \cdot m\,\hat{j}$

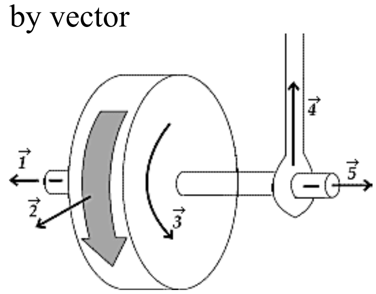
B) $0.5\,N \cdot m\,\hat{i} + 2\,N \cdot m\,\hat{j}$

C) $-1\,N \cdot m\,\hat{i} - 4\,N \cdot m\,\hat{j}$

D) $1\,N \cdot m\,\hat{i} + 4\,N \cdot m\,\hat{j}$

E) none of the above

10. A wheel is set spinning and is then hung by a rope placed at one end of the axle. If the wheel is spinning as shown, the angular momentum of the wheel could be represented by vector



A) $\vec{1}$

B) $\vec{2}$

C) $\vec{3}$

D) $\vec{4}$

E) $\vec{5}$

11. The moment of inertia of a 10.0kg wheel about its axle is $\frac{3}{4}mR^2$. It starts from rest and rolls without slipping down an inclined plane 2.13 m high.

A) Taking the potential energy at the bottom to be zero, the initial potential energy is:

B) The initial kinetic energy is:

C) The final kinetic energy is:

D) The translational speed of its axle at the bottom is:

Answer Key

1. E $p_1=p_5\equiv p$ $K_1=p^2/2M$, $K_2=p^2/2(5M)$, $K=K_1+K_2=6p^2/10M$ $K_1/K=5/6$
2. A *acceleration is same but mass is different*
3. D $mu=(m+M)V$ $V/u=m/(m+M)$
4. B $0.11kg[29-(-20)]m/s=5.39kg\cdot m/s$
5. C $2\pi/(\pi/20)=40rad/sec$
6. E $\frac{1}{2}\cdot mR^2+mR^2=1.5\ mR^2$
7. C $\tau=I\alpha=9.0kg\cdot m^2(50rad/s)/10s=45N\cdot m$
8. D $400J=\frac{1}{2}\cdot I\omega^2=\frac{1}{2}\cdot L\omega$ $L=2(400J)/(40.0rad/s)=20.0kg\cdot m^2/s$
9. B $(\mathbf{L_f}-\mathbf{L_i})/\Delta t=(1\mathbf{i}+4\mathbf{j})/2=(0.5\mathbf{i}+2\mathbf{j})N\cdot m$
10. E *right hand rule*
11. A. $10.0kg(9.81m/s^2)(2.13m)=209J$
    B. *since* $v=0m/s$, $0J$
    C. $K=U\rightarrow K=209J$
    D. $\frac{1}{2}\cdot\frac{3}{4}\cdot mR^2\omega^2+\frac{1}{2}\cdot mv^2=\frac{7}{8}\cdot mv^2=209J$ *since* $R\omega=v$, $v=\sqrt{[(8\cdot 209)/(7\cdot 10)]}=4.89m/s$