Name: _____ Date: _____

1. Momentum is conserved in which of the following?
   A) elastic collisions
   B) inelastic collisions
   C) explosions
   D) collisions between automobiles
   E) All of these are correct.

2. Glider A, traveling at 10 m/s on an air track, collides elastically with glider B traveling at 8.0 m/s in the same direction. The gliders are of equal mass. The final speed of glider B is
   A) 8.4 m/s B) 10 m/s C) 8.0 m/s D) 4.0 m/s E) 12 m/s

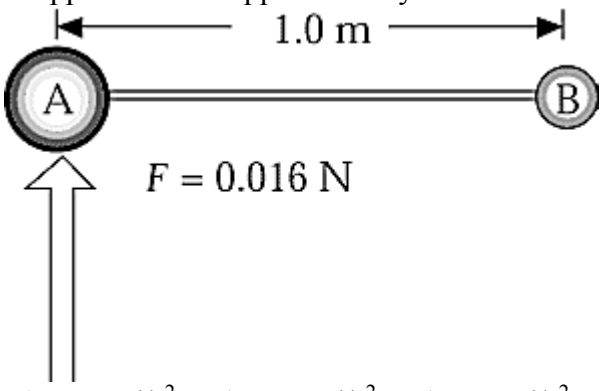
3. Two balls of equal mass are thrown against a massive wall with equal velocities. The first rebounds with a speed equal to its striking speed, and the second sticks to the wall. The impulse that the first ball transmits to the wall, relative to the second, is
   A) twice as great.
   B) half as great.
   C) the same.
   D) four times as great.
   E) one-fourth as great.

4. You are pedaling a bicycle with no slipping at 9.8 m/s. The radius of the wheels of the bicycle is 51.9cm. The angular velocity of rotation of the wheels is
   A) 19 rad/s B) 2.5 rad/s C) 4.5 rad/s D) 3.0 rad/s E) 6.3 rad/s

5. A wheel is rotating at 30 rev/min. The angular velocity of the wheel is
   A) $2\pi^2$ rad/s B) 2π rad/s C) 2 rad/s D) $\pi/2$ rad/s E) π rad/s

6. A disk with a radius of 1.5 m whose moment of inertia is 34 kg · m^2 is caused to rotate by a force of 160 N tangent to the circumference. The angular acceleration of the disk is approximately
   A) 0.14 rad/s^2 B) 0.23 rad/s^2 C) 4.4 rad/s^2 D) 7.1 rad/s^2 E) 23 rad/s^2

7. Two small masses, $m_A = 4.0 \times 10^{-3}$ kg and $m_B = 2.0 \times 10^{-3}$ kg, are connected by a 1.0-m rod of negligible mass. The angular acceleration about B produced by a force of 0.016 N applied at A is approximately



A) 4.0 rad/s^2 B) 2.7 rad/s^2 C) 11 rad/s^2 D) 12 rad/s^2 E) 4.0×10^2 rad/s^2

8. A constant torque of 15 N · m acts for 3.0 s on a system of mass 2.0 kg. The change in angular momentum of the system during this period of time is
   A) 5.0 kg · m^2/s
   B) 7.5 kg · m^2/s
   C) 10 kg · m^2/s
   D) 23 kg · m^2/s
   E) 45 kg · m^2/s

9. 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 kg · m^2/s
   B) 400 kg · m^2/s
   C) 200 kg · m^2/s
   D) 20 kg · m^2/s
   E) 5 kg · m^2/s

10. A woman sits on a spinning piano stool with her arms folded. When she extends her arms, which of the following occurs?
    A) She increases her moment of inertia, thereby increasing her angular speed.
    B) She increases her moment of inertia, thereby decreasing her angular speed.
    C) She decreases her moment of inertia, thereby increasing her angular speed.
    D) She decreases her moment of inertia, thereby decreasing her angular speed.
    E) Both her moment of inertia and her angular speed remain constant.

11. **(Show all work)** A projectile with a mass 6kg is fired at a speed of 400 m/s at an angle of 60º above the horizontal (the x-axis).

a) At the highest point of its trajectory, what is the vertically directed (y-component) momentum?

b) At the highest point of its trajectory, what is the horizontally directed (x-component) momentum?

c) At the highest point of its trajectory, the projectile is broken into two equal pieces by an internal explosion. Just after the explosion, one of the two pieces is known to be traveling vertically downward (minus y-direction) at a speed of 300 m/s. What is the momentum (specify direction) of this piece?

d) What is the horizontal (x) and vertical (y) components of momentum of the other particle?

e) What is the magnitude of the velocity of this "other" particle?

12. **(Show all work)** A solid sphere ($I = 0.4MR^2$) of radius 0.06 m and mass 0.50 kg, starting from rest, rolls without slipping 14m along a plane (all the way to the bottom) inclined at 30º to the horizontal.

a) At the bottom of the plane, the total kinetic energy is

b) At the bottom of the plane, the ratio of rotational kinetic energy to translational kinetic energy (K_r/K_t) is

c) At the bottom of the plane, the rotational kinetic energy is

d) At the bottom of the plane, the translational kinetic energy is

e) At the bottom of the plane, the linear velocity of the center of mass is

Answer Key

1. E All of these are correct.
2. B $v_{Bf} = (2m/2m)v_{Ai} + 0 = v_{Ai} = 10m/s$.
3. A change in velocity of the first is twice that of the second: twice the impulse.
4. A $\omega = v/r = (9.8m/s)/.519m = 18.9$ rad/sec.
5. E $(30 \text{ rev/min})(2\pi \text{ rad/rev})/(60 \text{ sec/min}) = \pi$ rad/sec.
6. D $\alpha = Fr/I = (160N)(1.5m)/(34 \text{ kg} \cdot \text{m}^2) = 7.06 \text{ rad/s}^2$.
7. A $\alpha = Fr/mr^2 = F/mr = 0.016N/(4.0\times10^{-3}\text{kg})(1.0m) = 4.0 \text{ rad/s}^2$.
8. E $\Delta L = \tau \cdot \Delta t = (15N \cdot m)(3.0s) = 45 \text{ kg} \cdot \text{m}^2/\text{s}$.
9. D $400J = (\frac{1}{2}) \cdot I \cdot (40.0\text{rad/s})^2$, $I = (\frac{1}{2})\text{kg} \cdot \text{m}^2$, $L = (\frac{1}{2})\text{kg} \cdot \text{m}^2 \cdot 40.0\text{rad/s} = 20 \text{ kg} \cdot \text{m}^2/\text{s}$.
10. B She increases her moment of inertia, thereby decreasing her angular speed.

11. a) $p_y = 0$ kg·m/s
    b) $p_x = 6\text{kg} \cdot 400 \text{ m/s} \cdot \cos60^\circ = 1200$ kg·m/s
    c) $p_y = 3\text{kg} \cdot (-300\text{m/s}) = -900$ kg·m/s
    d) $p_{xafter} = p_{xbefore} = 1200$ kg·m/s, $p_{yother} = -p_y = 900$ kg·m/s
    e) $v = p/m = \sqrt{(900^2 + 1200^2)} / 3 = 500$ m/s

12. a) $K = Mgh = (.50\text{kg})(9.81\text{m/s}^2)(14\text{m} \cdot \sin30^\circ) = 34.3J$
    b) $K_r/K_t = [(\frac{1}{2}) \cdot 0.4MR^2\omega^2] / (\frac{1}{2}) \cdot Mv^2 = 0.4$ since $R\omega = v$
    c) $34.3J = K_r + K_t = K_r + K_r/.4 = 3.5\ K_r$, $K_r = 9.8J$
    d) $K_t = 34.3J - 9.8J = 24.5J$
    e) $.5(.50\text{kg})v_{cm}^2 = 24.5J$, $v_{cm} = 9.9\text{m/s}$