

1. If a body moves in such a way that its linear momentum is constant, then
  - A) its kinetic energy is zero.
  - B) the sum of all the forces acting on it must be zero.
  - C) its acceleration is greater than zero and is constant.
  - D) its center of mass remains at rest.
  - E) the sum of all the forces acting on the body is constant and nonzero.
  
2. A 5.0-kg ball and a 10.0-kg ball approach each other with equal speeds of 20 m/s. If they collide perfectly inelastically, the speed of the balls just after the collision is approximately
  - A) 1.0 m/s
  - B) 20 m/s
  - C) 6.7 m/s
  - D) 1.5 m/s
  - E) zero
  
3. A pitcher throws a baseball with a speed of 27 m/s. After being struck by a bat the ball travels in the opposite direction with a speed of 40 m/s. If the ball has a mass of 0.11 kg and is in contact with the bat for 3.0 ms, the average force exerted by the bat on the ball is
  - A) 0.99 kN
  - B) 4.8 kN
  - C) 1.5 kN
  - D) 7.4 kN
  - E) 2.5 kN
  
4. The SI units of momentum are
  - A)  $\text{kg} \cdot \text{m} \cdot \text{s}$
  - B)  $\text{m}^2/\text{s}$
  - C)  $\text{kg} \cdot \text{s}/\text{m}$
  - D)  $\text{kg}/\text{J}$
  - E)  $\text{kg} \cdot \text{m}/\text{s}$
  
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  $\omega$  of the particle is
  - A) 2.5 rad/s
  - B)  $3.2 \times 10^2$  rad/s
  - C) 40 rad/s
  - D) 7.9 rad/s
  - E) 0.96 rad/s

6. A point P is at a distance  $R$  from the axis of rotation of a rigid body. The linear speed, centripetal acceleration, and tangential acceleration of the point can be expressed as

	Linear speed	Centripetal acceleration	Tangential acceleration
A)	$R\omega$	$R\omega^2$	$R\alpha$
B)	$R\omega$	$R\alpha$	$R\omega^2$
C)	$R\omega^2$	$R\alpha$	$R\omega$
D)	$R\omega$	$R\omega^2$	$R\omega$
E)	$R\omega^2$	$R\alpha$	$R\omega^2$

- A) A  
B) B  
C) C  
D) D  
E) E

7. The moment of inertia of a slim rod about a transverse axis through one end is  $mL^2/3$ , where  $m$  is the mass of the rod and  $L$  is its length. The moment of inertia of a 0.24-kg meterstick about a transverse axis through its center is

- A)  $0.14 \text{ kg} \cdot \text{m}^2$   
B)  $20 \text{ kg} \cdot \text{m}^2$   
C)  $0.020 \text{ kg} \cdot \text{m}^2$   
D)  $80 \text{ kg} \cdot \text{m}^2$   
E)  $4.5 \text{ kg} \cdot \text{m}^2$

8. The angular momentum of a flywheel about its axis is  $925 \text{ kg} \cdot \text{m}^2/\text{s}$ . If its moment of inertia about the same axis is  $2.50 \text{ kg} \cdot \text{m}^2$ , its angular speed is

- A) 370 rev/min  
B) 62 rev/min  
C) 36 rev/min  
D) 2210 rad/s  
E) 370 rad/s

9. If the sum of the external torques on a system is zero, there is

- A) a change in the system's moment of inertia.  
B) no change in the system's moment of inertia.  
C) a change in the system's angular momentum.  
D) no change in the system's angular momentum.  
E) a precessional angular velocity.

10. A constant torque of  $15 \text{ N} \cdot \text{m}$  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)  $5.0 \text{ kg} \cdot \text{m}^2/\text{s}$   
B)  $7.5 \text{ kg} \cdot \text{m}^2/\text{s}$   
C)  $10 \text{ kg} \cdot \text{m}^2/\text{s}$   
D)  $23 \text{ kg} \cdot \text{m}^2/\text{s}$   
E)  $45 \text{ kg} \cdot \text{m}^2/\text{s}$

11. **Show all work:** A superball of mass 1 kg is dropped vertically from a height of 5.1 m. (Assume that the superball bounces back to the same height.) If the impact time with the floor is .002 s,

a) what is the speed with which it hits the floor?

b) what is the momentum change of the ball due to impact with the floor?

c) what is the average force on the ball due to the floor?

## Answer Key

1. B the sum of all the forces acting on it must be zero
2. C  $v_{cm} = [10\text{kg}(20\text{m/s}) + 5\text{kg}(-20\text{m/s})] / (10+5)\text{kg} = 6.67\text{m/s}$
3. E  $.11\text{kg}[40 - (-27)]\text{m/s} / .003\text{s} = 2457\text{N}$
4. E  $\text{kg} \cdot \text{m/s}$
5. C  $2\pi\text{rad} / (\pi/20)\text{s} = 40\text{rad/s}$
6. A  $R\omega$   $R\omega^2$   $R\alpha$
7. C  $I_{cm} = mL^2/3 - m(L/2)^2 = mL^2/12 = .24\text{kg}(1\text{m})^2/12 = .020\text{kg} \cdot \text{m}^2$
8. E  $\omega = 925 \text{ kg} \cdot \text{m}^2/\text{s} / 2.50 \text{ kg} \cdot \text{m}^2 = 370 \text{ rad/s}$
9. D no change in the system's angular momentum
10. E  $\Delta L = 15\text{N} \cdot \text{m} (3.0\text{s}) = 45 \text{ kg} \cdot \text{m}^2/\text{s}$
11. a)  $\frac{1}{2} \cdot mv^2 = mgh$   $v = \sqrt{2gh} = \sqrt{[2(9.81\text{m/s}^2)(5.1\text{m})]} = 10.0\text{m/s}$   
b)  $\Delta p = 2mv = 2(1\text{kg})(10.0\text{m/s}) = 20.0\text{kg} \cdot \text{m/s}$   
c)  $F = \Delta p / \Delta t = 20.0\text{kg} \cdot \text{m/s} / .002\text{s} = 1.00 \times 10^4 \text{ N}$