Chapter 8 Drill

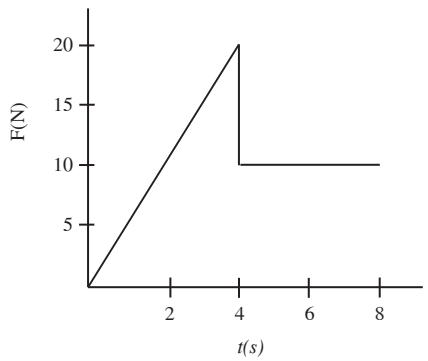
The answers and explanations can be found in Chapter 17.

Section I: Multiple Choice

1. An object of mass 2 kg has a linear momentum of magnitude 6 kg·m/s. What is this object's kinetic energy?

   (A) 3 J
   (B) 6 J
   (C) 9 J
   (D) 12 J
   (E) 18 J

2. The graph below shows the force on an object over time.



   If the object has a mass of 8 kg and is moving in a straight line, what is its change in speed?

   (A) 16 m/s
   (B) 14 m/s
   (C) 12 m/s
   (D) 10 m/s
   (E) 8 m/s

3. A box with a mass of 2 kg accelerates in a straight line from 4 m/s to 8 m/s due to the application of a force whose duration is 0.5 s. Find the average strength of this force.

   (A) 2 N
   (B) 4 N
   (C) 8 N
   (D) 12 N
   (E) 16 N

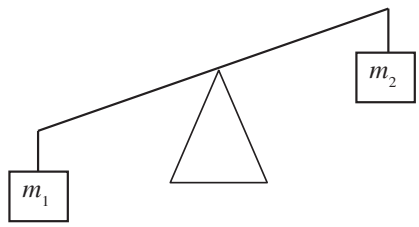
4. A ball of mass m traveling horizontally with velocity $\mathbf{v}$ strikes a massive vertical wall and rebounds back along its original direction with no change in speed. What is the magnitude of the impulse delivered by the wall to the ball?

   (A) 0
   (B) $\frac{1}{2}m\mathbf{v}$
   (C) $m\mathbf{v}$
   (D) $2m\mathbf{v}$
   (E) $4m\mathbf{v}$

5. Two objects, one of mass 3 kg and moving with a speed of 2 m/s and the other of mass 5 kg and speed 2 m/s, move toward each other and collide head-on. If the collision is perfectly inelastic, find the speed of the objects after the collision.

   (A) 0.25 m/s
   (B) 0.5 m/s
   (C) 0.75 m/s
   (D) 1 m/s
   (E) 2 m/s

6. A student is trying to balance a meter stick on its midpoint. Given that $m_1 = 6$ kg and $m_2 = 2$ kg, how far from the left edge should the student hang a third mass, $m_3 = 10$ kg, to balance the meter stick?

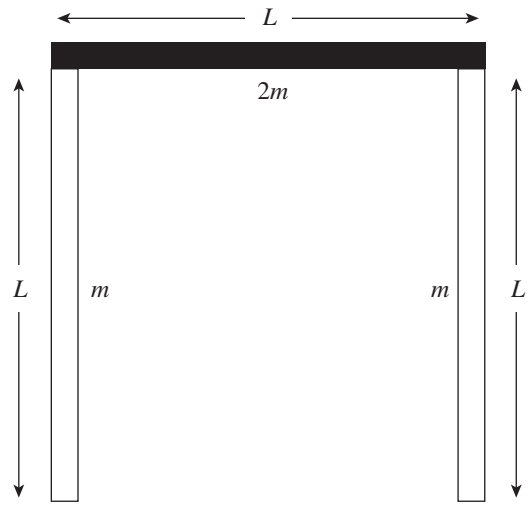


   (A) 40 cm
   (B) 50 cm
   (C) 60 cm
   (D) 70 cm
   (E) 80 cm

7. Two objects move toward each other, collide, and separate. If there was no net external force acting on the objects, but some kinetic energy was lost, then

   (A) the collision was elastic and total linear momentum was conserved
   (B) the collision was elastic and total linear momentum was not conserved
   (C) the collision was not elastic and total linear momentum was conserved
   (D) the collision was not elastic and total linear momentum was not conserved
   (E) None of the above

8. Three thin, uniform rods each of length L are arranged in the shape of an inverted U:



   The two rods on the arms of the U each have mass m; the third rod has mass $2m$. How far below the midpoint of the horizontal rod is the center of mass of this assembly?

   (A) $L/8$
   (B) $L/4$
   (C) $3L/8$
   (D) $L/2$
   (E) $3L/4$

9. A car of mass 1,000 kg collides head-on with a truck of mass 2,000 kg. Both vehicles are moving at a speed of 21 m/s, and the collision is perfectly inelastic. After the crash, the two vehicles skid to a halt. Assuming friction is the only force acting on the vehicles after the collision, how much work is done by friction after the crash?

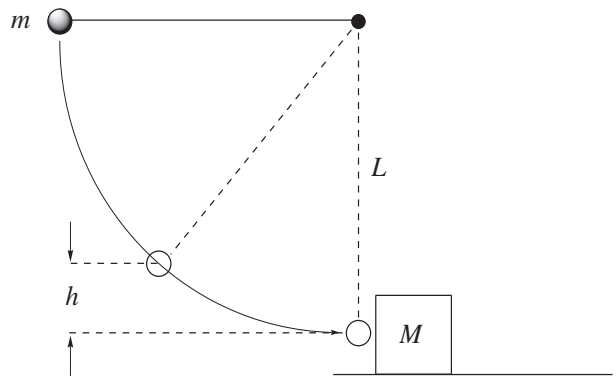
   (A) 73,500 J
   (B) –73,500 J
   (C) 147,000 J
   (D) –147,000 J
   (E) 220,500 J

10. Which of the following best describes a perfectly inelastic collision free of external forces?

    (A) Total linear momentum is never conserved.
    (B) Total linear momentum is sometimes conserved.
    (C) Kinetic energy is never conserved.
    (D) Kinetic energy is sometimes conserved.
    (E) Kinetic energy is always conserved.

Section II: Free Response

1. A steel ball of mass m is fastened to a light cord of length L and released when the cord is horizontal. At the bottom of its path, the ball strikes a hard plastic block of mass $M = 4m$, initially at rest on a frictionless surface. The collision is elastic.

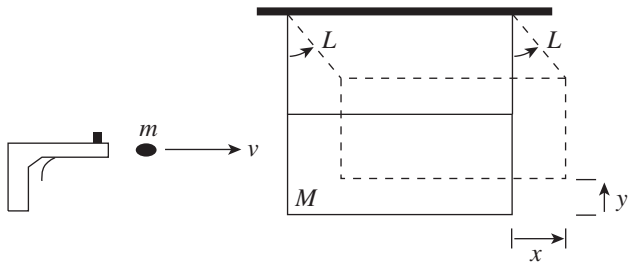


   (a) Find the tension in the cord when the ball's height above its lowest position is $\frac{1}{2}L$. Write your answer in terms of m and g.

   (b) Find the speed of the block immediately after the collision.

   (c) To what height h will the ball rebound after the collision?

2. A *ballistic pendulum* is a device that may be used to measure the muzzle speed of a bullet. It is composed of a wooden block suspended from a horizontal support by cords attached at each end. A bullet is shot into the block, and as a result of the perfectly inelastic impact, the block swings upward. Consider a bullet (mass m) with velocity v as it enters the block (mass M). The length of the cords supporting the block each have length L. The maximum height to which the block swings upward after impact is denoted by y, and the maximum horizontal displacement is denoted by x.



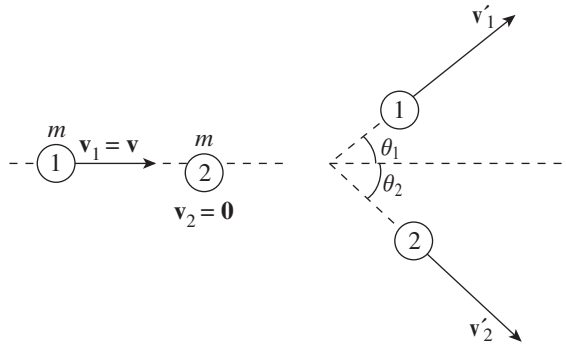
   (a) In terms of m, M, g, and y, determine the speed v of the bullet.

   (b) What fraction of the bullet's original kinetic energy is lost as a result of the collision? What happens to the lost kinetic energy?

   (c) If y is very small (so that y^2 can be neglected), determine the speed of the bullet in terms of m, M, g, x, and L.

   (d) Once the block begins to swing, does the momentum of the block remain constant? Why or why not?

3. An object of mass m moves with velocity $\mathbf{v}$ toward a stationary object of the same mass. After their impact, the objects move off in the directions shown in the following diagram:



Before the collision After the collision

Assume that the collision is elastic.

(a) If K_1 denotes the kinetic energy of Object 1 before the collision, what is the kinetic energy of this object after the collision? Write your answer in terms of K_1 and θ_1.

(b) What is the kinetic energy of Object 2 after the collision? Write your answer in terms of K_1 and θ_1.

(c) What is the relationship between θ_1 and θ_2?