Q1W6-Ph.-H.W.- Momentum and Collisions

Problem

1. A 56.0 kg diver jumps off a diving platform, rises about 1.0 m above the platform, then falls to the pool. What is the diver's momentum at her highest point in the dive?

    A. 10 kg•m/s
    B. 0 kg•m/s
    C. 20 kg•m/s
    D. 30 kg•m/s

2. A bowling ball with a mass of 6.8 kg strikes a stationary pin that has a mass of 1.6 kg. The pin flies forward with a velocity of 6.8 m/s, and the ball continues forward at 4.5 m/s. What was the original velocity of the ball?

    A. 6.2 m/s forward
    B. 7.2 m/s forward
    C. 8.2 m/s forward
    D. 9.2 m/s forward

3. A diver with a mass of 79.0 kg jumps from a dock into a 111.0 kg boat at rest on the west side of the dock. If the velocity of the diver in the air is 4.70 m/s to the west, what is the final velocity of the diver after landing in the boat?

    A. 4.95 m/s to the west
    B. 3.95 m/s to the west
    C. 2.95 m/s to the west
    D. 1.95 m/s to the west

4. A swimmer with a mass of 59 kg dives off a raft with a mass of 400 kg. If the swimmer's speed is 3 m/s immediately after leaving the raft, what is the speed of the raft?

    A. 0.4 m/s
    B. 0.5 m/s
    C. 0.6 m/s
    D. 0.7 m/s

5. A cricket ball with a mass of 0.158 kg moves at a speed of 17 m/s. Then the ball is hit by a bat and rebounds in the opposite direction at a speed of 18 m/s. What is the change in momentum of the ball?

    A. -4.5 kg.m/s
    B. -5.5 kg.m/s
    C. -6.5 kg.m/s
    D. -7.5 kg.m/s

6. A baseball bat strikes a baseball with a force of 37 N. The bat is in contact with the ball for 0.19 s. What is the magnitude of the change in momentum of the ball?

   A. 6.0 kg.m/s
   B. 7.0 kg.m/s
   C. 8.0 kg.m/s
   D. 9.0 kg.m/s

7. A train with a mass of 2.1×10^5 kg is moving at 12 m/s when the engineer applies the brakes. If the braking force is constant at 3.7×10^4 N, how long does it take the train to stop? How far does the train travel during this time?

   A. 48 s; 4.1 x 10^2 m
   B. 58 s; 4.1 x 10^2 m
   C. 68 s; 4.1 x 10^2 m
   D. 78 s; 4.1 x 10^2 m

8. What velocity must a 1120 kg car have in order to have the same momentum as a 3360 kg truck traveling at a velocity of 16 m/s to the west?

   A. 18 m/s to the west
   B. 28 m/s to the west
   C. 38 m/s to the west
   D. 48 m/s to the west

9. A bullet with a mass of 6.58 g is fired through a 1.95 kg block of wood on a frictionless surface. The initial speed of the bullet is 822 m/s, and the speed of the bullet after it exits the block is 439 m/s. At what speed does the block move after the bullet passes through it?

   A. 4.29 m/s
   B. 3.29 m/s
   C. 2.29 m/s
   D. 1.29 m/s

10. A 5.68×10^{-2} kg tennis ball moves at a speed of 13 m/s. The ball is struck by a racket, causing it to rebound in the opposite direction at a speed of 18 m/s. What is the change in the ball's momentum?

   A. -108 kg.m/s
   B. -208 kg.m/s
   C. -308 kg.m/s
   D. -408 kg.m/s

11. A player at first base catches a throw traveling 38 m/s. The baseball, which has a mass of 0.145 kg, comes to a complete stop in the glove after 0.14 s. Assuming the force of the glove was uniform, what force did the glove exert on the ball?

    A. 39 N in the direction opposite the throw
    B. 49 N in the direction opposite the throw
    C. 59 N in the direction opposite the throw
    D. 69 N in the direction opposite the throw

12. An infant throws 7 g of applesauce at a velocity of 0.5 m/s. All of the applesauce collides with a nearby wall and sticks to it. What is the decrease in kinetic energy of the applesauce?

    A. 6×10^{-4} J
    B. 7×10^{-4} J
    C. 8×10^{-4} J
    D. 9×10^{-4} J

13. The diver strikes the water at a speed of 13.9 m/s, then slows to a stop underwater in 0.65 s. What force does the water exert on the diver?

    A. 3.2×10^{3} N upward
    B. 2.2×10^{3} N upward
    C. 1.2×10^{3} N upward
    D. 0.2×10^{3} N upward

14. A bullet with a mass of 4.87×10^{-3} kg is loaded into a gun. The loaded gun has a mass of 0.74 kg. The bullet is fired, causing the empty gun to recoil at a speed of 4.3 m/s. What is the speed of the bullet?

    A. 4.5×10^{2} m/s
    B. 5.5×10^{2} m/s
    C. 6.5×10^{2} m/s
    D. 7.5×10^{2} m/s

15. A 0.12 kg object makes an elastic head-on collision with a 0.18 kg stationary object. The final velocity of the 0.12 kg object after the collision is 0.048 m/s in the direction opposite its initial movement. The final velocity of the 0.18 kg object after the collision is 0.19 m/s in the same direction as the object which strikes it. What was the initial velocity of the 0.12 kg object?

    A. 0.13 m/s forward
    B. 0.23 m/s forward
    C. 0.33 m/s forward
    D. 0.423 m/s forward

16. A 19 g marble moves to the right at 3.4 m/s and makes an elastic head-on collision with a 27 g marble. The final velocity of the 19 g marble is 5.1 m/s to the left, and the final velocity of the 27 g marble is 2.8 m/s to the right. What was the initial velocity of the 27 g marble?

    A. 0.2 m/s to the left

    B. 1.2 m/s to the left
    C. 2.2 m/s to the left
    D. 3.2 m/s to the left

17. Two ice-skaters, each with a mass of 50.0 kg, are stationary on a frictionless ice pond. One skater throws a 0.90 kg ball with a speed of 2.0 m/s to the other skater, who catches it. What are the velocities of the skaters when the ball is caught?

    A. Skater 1 has a velocity of 3.6×10^{-2} m/s away from skater 2. Skater 2 has a velocity of 3.6×10^{-2} m/s away from skater 1.

    B. Skater 1 has a velocity of 2.6×10^{-2} m/s away from skater 2. Skater 2 has a velocity of 2.6×10^{-2} m/s away from skater 1.
    C. Skater 1 has a velocity of 1.6×10^{-2} m/s away from skater 2. Skater 2 has a velocity of 1.6×10^{-2} m/s away from skater 1.
    D. Skater 1 has a velocity of 0.6×10^{-2} m/s away from skater 2. Skater 2 has a velocity of 0.6×10^{-2} m/s away from skater 1.

18. Use the impulse-momentum theorem to find the diver's momentum after falling for 1.29 s.

    A. 408 kg. m/s downward
    B. 508 kg. m/s downward
    C. 608 kg. m/s downward
    D. 708 kg. m/s downward

19. Compare the momentum of a 5450 kg truck moving at 8.00 m/s to the momentum of a 2725 kg car moving at 16.0 m/s.

    A. They have the same momentum (2.36×10^4 kg.m/s)

    B. They have the same momentum (3.36×10^4 kg.m/s)
    C. They have the same momentum (4.36×10^4 kg.m/s)
    D. They have the same momentum (5.36×10^4 kg.m/s)

20. A clay ball with a mass of 0.25 kg strikes another 0.25 kg clay ball at rest, and the two balls stick together. The final velocity of the balls is 4.4 m/s north. What was the first ball's initial velocity?

    A. 8.8 m/s to the north
    B. 7.8 m/s to the north
    C. 6.8 m/s to the north
    D. 5.8 m/s to the north

21. A 83 kg halfback runs north and is tackled by a 123 kg opponent running south at 7.8 m/s. The collision is perfectly inelastic. Just after the tackle, both players move at a velocity of 2.2 m/s north. Calculate the velocity of the 83 kg player just before the tackle.

    A. 11 m/s to the north
    B. 13 m/s to the north
    C. 15 m/s to the north
    D. 17 m/s to the north

22. A 5.3×10^3 kg truck moving at 16 m/s strikes a 1.7×10^3 kg automobile stopped at a traffic light. The vehicles hook bumpers and skid together at 10.4 m/s. What is the decrease in kinetic energy?

    A. 2.0×10^4 J
    B. 3.0×10^4 J
    C. 4.0×10^4 J
    D. 5.0×10^4 J

23. A clay ball with a mass of 0.48 kg has an initial speed of 4.08 m/s. It strikes a 3.04 kg clay ball at rest, and the two balls stick together and remain stationary. What is the decrease in kinetic energy of the 0.48 kg ball?

    A. 2.0 J
    B. 3.0 J
    C. 4.0 J
    D. 5.0 J

24. A pool cue strikes a 0.16 kg billiard ball with a force of 11 N. The cue remains in contact with the ball for 0.065 s. The ball was initially at rest. What is the final speed of the ball?

    A. 1.5 m/s
    B. 2.5 m/s
    C. 3.5 m/s
    D. 4.5 m/s

25. A 74.0 kg ice-skater standing on frictionless ice throws a 0.12 kg snowball horizontally at a speed of 27.0 m/s. At what speed does the skater move backward?

    A. 2.4×10^{-2} m/s
    B. 3.4×10^{-2} m/s
    C. 4.4×10^{-2} m/s
    D. 5.4×10^{-2} m/s

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. A rubber ball moving at a speed of 5 m/s hit a flat wall and returned to the thrower at 5 m/s. The magnitude of the momentum of the rubber ball
a. increased.
b. remained the same.
c. was not conserved.
d. decreased.

____ 2. The impulse experienced by a body is equivalent to the body's change in
a. force.
b. kinetic energy.
c. momentum.
d. velocity.

____ 3. After colliding, objects are deformed and lose some kinetic energy. Identify the type of collision.
a. nearly elastic
b. perfectly inelastic
c. inelastic
d. elastic

____ 4. Two swimmers relax close together on air mattresses in a pool. One swimmer's mass is 48 kg, and the other's mass is 55 kg. If the swimmers push away from each other,
a. their total momentum decreases.
b. their total momentum triples.
c. their momenta are equal but opposite.
d. their total momentum doubles.

____ 5. Two objects stick together and move with a common velocity after colliding. Identify the type of collision.
a. nearly elastic
b. inelastic
c. perfectly inelastic
d. elastic

____ 6. The change in an object's momentum is equal to
a. the product of the mass of the object and the time interval.
b. the net external force divided by the time interval.
c. the product of the force applied to the object and the time interval.
d. the time interval divided by the net external force.

____ 7. A billiard ball collides with a stationary identical billiard ball in an elastic head-on collision. After the collision, which of the following is true of the first ball?
a. It comes to rest.
b. It has one-half its initial velocity.
c. It maintains its initial velocity.
d. It moves in the opposite direction.

____ 8. A soccer ball collides with another soccer ball at rest. The total momentum of the balls
a. is zero.
b. increases.
c. remains constant.
d. decreases.

____ 9. Which of the following has the greatest momentum?
a. a turtle with a mass of 91 kg moving at a velocity of 1.4 m/s
b. a hare with a mass of 2.7 kg moving at a velocity of 7.5 m/s
c. a roadrunner with a mass of 1.8 kg moving at a velocity of 6.7 m/s
d. a tortoise with a mass of 275 kg moving at a velocity of 0.55 m/s

____ 10. A person sitting in a chair with wheels stands up, causing the chair to roll backward across the floor. The momentum of the chair
a. remained the same.
b. was greatest while the person sat in the chair.
c. was zero when the person got out of the chair and increased while the person sat.
d. was zero while stationary and increased when the person stood.

____ 11. A 0.2 kg baseball is pitched with a velocity of 40 m/s and is then batted to the pitcher with a velocity of 60 m/s. What is the magnitude of change in the ball's momentum?
a. 20 kg•m/s
b. 2 kg•m/s
c. 4 kg•m/s
d. 8 kg•m/s

____ 12. Two balls of dough collide and stick together. Identify the type of collision.
a. inelastic
b. perfectly inelastic
c. nearly elastic
d. elastic

____ 13. Which of the following situations is an example of a significant change in momentum?
a. A helium-filled balloon rises upward into the sky.
b. An airplane flies into some scattered white clouds.
c. A bicyclist rides over a leaf on the pavement.
d. A tennis ball is hit into a net.

____ 14. In a two-body collision,
a. momentum is always conserved.
b. kinetic energy is always conserved.
c. both momentum and kinetic energy are always conserved.
d. neither momentum nor kinetic energy is conserved.

____ 15. Which of the following situations is an example of a visible change in momentum?
a. A car drives over a pebble.
b. A volleyball hits a mosquito in the air.
c. A hiker walks through a spider's web.
d. A baseball is hit by a bat.

____ 16. Which of the following best describes the momentum of two bodies after a two-body collision if the kinetic energy of the system is conserved?
a. must also be conserved
b. might also be conserved
c. must be less
d. is doubled in value

____ 17. Which of the following equations can be used to directly calculate the change in an object's momentum?
a. $\Delta p = F\Delta t$
b. $\mathbf{p} = \frac{m}{\mathbf{v}}$
c. $p = F\Delta t$
d. $p = mv$

____ 18. Two objects with different masses collide and bounce back after an elastic collision. Before the collision, the two objects were moving at velocities equal in magnitude but opposite in direction. After the collision,
a. the more massive object had gained momentum.
b. both objects had the same momentum.
c. both objects lost momentum.
d. the less massive object had gained momentum.

____ 19. What are the SI units for momentum?
a. N•m
b. kg•m/s
c. $kg•m/s^2$
d. J

____ 20. In an inelastic collision between two objects with unequal masses,
a. the kinetic energy of one object will increase by the amount that the kinetic energy of the other object decreases.
b. the total momentum of the system will decrease.
c. the total momentum of the system will increase.
d. the momentum of one object will increase by the amount that the momentum of the other object decreases.

____ 21. When comparing the momentum of two moving objects, which of the following is correct?
a. The object with the higher velocity will have less momentum if the masses are equal.
b. The less massive object will have less momentum if the velocities are the same.
c. The more massive object will have less momentum if the velocities are the same.
d. The more massive object will have less momentum if its velocity is greater.

____ 22. Which of the following statements about the conservation of momentum is *not* correct?
a. Momentum is conserved when two or more interacting objects push away from each other.
b. Momentum is conserved for a system of objects pushing away from each other.
c. Momentum is not conserved for a system of objects in a head-on collision.
d. The total momentum of a system of interacting objects remains constant regardless of forces between the objects.

____ 23. Two skaters stand facing each other. One skater's mass is 60 kg, and the other's mass is 72 kg. If the skaters push away from each other without spinning,
a. the lighter skater has less momentum.
b. their total momentum decreases.
c. their momenta are equal but opposite.
d. their total momentum doubles.

____ 24. If a force is exerted on an object, which statement is true?
a. A small force always produces a large change in the object's momentum.
b. A large force always produces a large change in the object's momentum.
c. A large force produces a large change in the object's momentum only if the force is applied over a very short time interval.
d. A small force applied over a long time interval can produce a large change in the object's momentum.

____ 25. A 20 kg shopping cart moving at a velocity of 0.5 m/s collides with a store wall and stops. The momentum of the shopping cart
a. increases.
b. is conserved.
c. remains the same.
d. decreases.

____ 26. A billiard ball collides with a second identical ball in an elastic head-on collision. What is the kinetic energy of the system after the collision compared with the kinetic energy before the collision?
a. unchanged
b. four times as great
c. two times as great
d. one-fourth as great

____ 27. Two objects move separately after colliding, and both the total momentum and total kinetic energy remain constant. Identify the type of collision.
a. nearly elastic
b. perfectly inelastic
c. elastic
d. inelastic

____ 28. Two billiard balls collide. Identify the type of collision.
a. perfectly inelastic
b. inelastic
c. nearly elastic
d. elastic

____ 29. A roller coaster climbs up a hill at 4 m/s and then zips down the hill at 30 m/s. The momentum of the roller coaster
a. is greater down the hill than up the hill.
b. is zero throughout the ride.
c. remains the same throughout the ride.
d. is greater up the hill than down the hill.

____ 30. A ball with a momentum of 4.0 kg•m/s hits a wall and bounces straight back without losing any kinetic energy. What is the change in the ball's momentum?
a. 8.0 kg•m/s
b. 0.0 kg•m/s
c. –8.0 kg•m/s
d. –4.0 kg•m/s

____ 31. Which of the following equations can be used to directly calculate an object's momentum, p?

a. $\mathbf{p = \frac{m}{v}}$

b. $\Delta p = F\Delta t$

c. $p = mv$

d. $p = F\Delta t$

____ 32. A 75 kg person walking around a corner bumped into an 80 kg person who was running around the same corner. The momentum of the 80 kg person

a. decreased.
b. was conserved.
c. increased.
d. remained the same.

____ 33. Which of the following statements properly relates the variables in the equation $F\Delta t = \Delta p$?

a. A large constant force does not necessarily cause a change in an object's momentum.
b. A large constant force acting over a long time interval causes a large change in momentum.
c. A large constant force changes an object's momentum at various time intervals.
d. A large constant force changes an object's momentum over a long time interval.

____ 34. The law of conservation of momentum states that

a. the total initial momentum of all objects interacting with one another does not equal the total final momentum.
b. the total initial momentum of all objects interacting with one another usually equals the total final momentum.
c. the total momentum of all objects interacting with one another is zero.
d. the total momentum of all objects interacting with one another remains constant regardless of the nature of the forces between the objects.

____ 35. A child with a mass of 23 kg rides a bike with a mass of 5.5 kg at a velocity of 4.5 m/s to the south. Compare the momentum of the child with the momentum of the bike.

a. The bike has a greater momentum than the child.
b. The child has a greater momentum than the bike.
c. Neither the child nor the bike has momentum.
d. Both the child and the bike have the same momentum.

==========