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Chapter 8 Momentum

Exercises

8.1 Momentum (page 125)

1. Define momentum. the mass of an object multiplied by its velocity
2. What is the equation for momentum? momentum = mass × velocity = mv
3. A moving object can have a large momentum if it has a(n) large mass, a(n) high speed, or both.

8.2 Impulse Changes Momentum (pages 125–129)

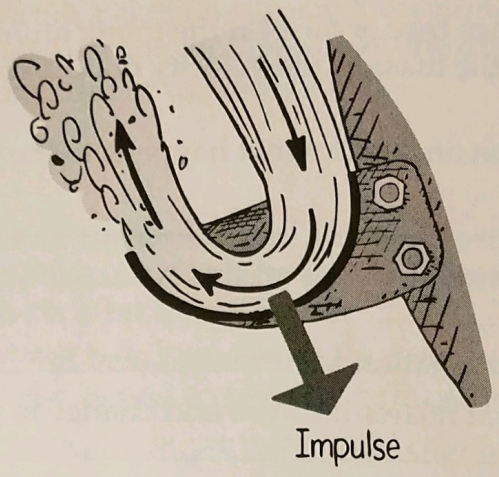
4. Is the following sentence true or false? If the momentum of an object changes, either the mass or the velocity or both change.
   true
5. If a force is increased on an object, what happens to the velocity and the momentum?
   There is a greater change in velocity and momentum.
6. The change in momentum depends on the force that acts and the length of time it acts.
7. What is the short-hand notation for impulse? impulse = $F\Delta t$
8. What is the formula that relates impulse and change in momentum?
   $F\Delta t = \Delta(mv)$
9. Explain why a baseball player follows through with his or her swing.
   The baseball player wants to apply the greatest force possible for as long as possible so that the ball goes as far as possible.
10. Is the following sentence true or false? By hitting a soft object, such as a haystack, instead of a hard object, such as a concrete wall, you extend the contact time in which the momentum is brought to zero.
    true
11. Circle the letter of each sentence that is true about impulse and momentum.
    a. When jumping from an elevated position down to the ground, you should keep your legs stiff to decrease the momentum.
    b. A wrestler thrown to the floor should extend his time hitting the mat by relaxing his muscles and spreading the impulse to his foot, knee, hip, ribs, and shoulder.
    c. When a boxer gets punched, she should move her head away from the punch to increase the contact time and reduce the force.
    d. A dropped dish is more likely to survive a fall on carpet rather than concrete, because the softness of the carpet leads to increased contact time.

8.3 Bouncing (pages 129–130)

12. Is the following sentence true or false? The impulse required to bring an object to a stop and then to "throw it back again" is less than the impulse merely to bring the object to a stop. false

13. Explain how a person practicing karate can break bricks with his or her bare hand.

The karate expert strikes the bricks in such a way that his or her hand bounces back, yielding as much as twice the impulse to the bricks.



14. Use the diagram of the Pelton Wheel above to explain how the blades work.

The curved blades of the Pelton Wheel cause water to bounce and make a U-turn, producing a large impulse that turns the wheel.

8.4 Conservation of Momentum (pages 130–131)

Match each phrase with another phrase that makes the statement true.

b 15. If you wish to change the momentum of an object,

d 16. The force or impulse must be exerted on the object

a 17. If no outside force is present,

c 18. The force on the cannonball inside the cannon barrel is equal

a. no change in momentum is possible.

b. exert an impulse on it.

c. and opposite to the force causing the cannon to recoil.

d. by something outside the object.

19. Explain why the total momentum of a cannon–cannonball system is zero after firing.

After firing, the net momentum, or total momentum, is zero because the momentum of the cannon is equal and opposite to the momentum of the cannonball.

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20. Is momentum a vector or a scalar quantity? vector

21. Is the following sentence true or false? The law of conservation of momentum states that, in the absence of an external force, the momentum of a system remains unchanged. true

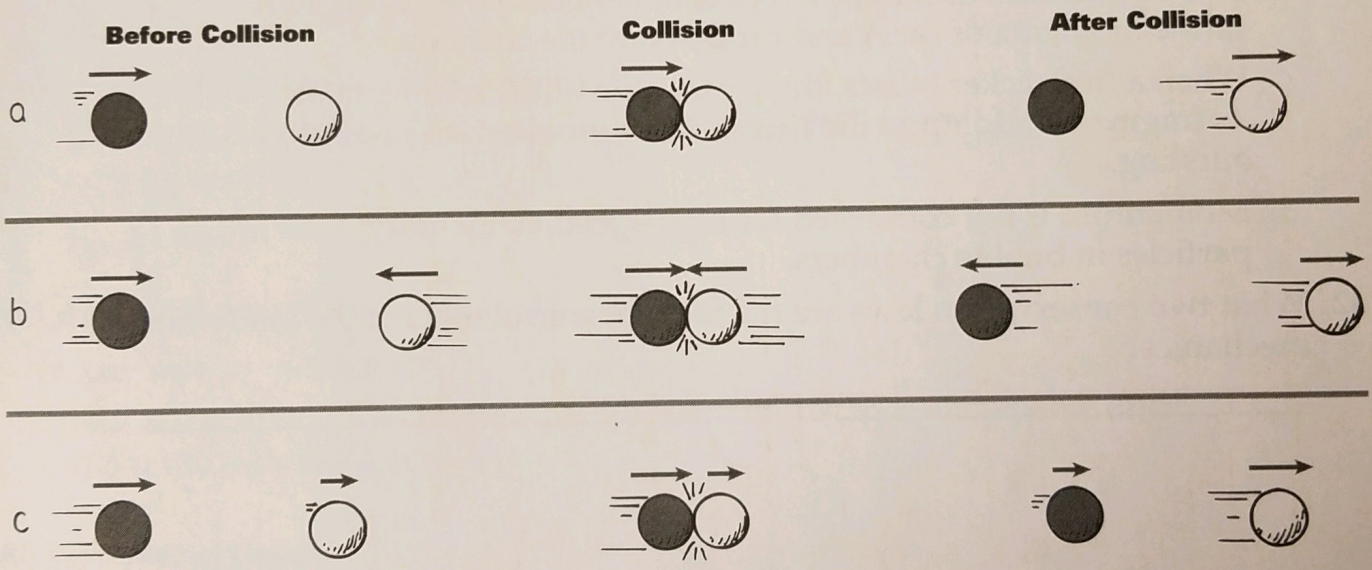
22. Is the following sentence true or false? If a system undergoes changes wherein all the forces are internal, such as an atomic nuclei undergoing nuclear decay, the net momentum of the system before and after the event is the same. true

8.5 Collisions (pages 132–134)

23. Is the following sentence true or false? Whenever objects collide in the absence of external forces, the net momentum of both objects before the collision does not equal the net momentum of both objects after the collision. false

24. When objects collide without being permanently deformed and without generating heat, the collision is said to be a(n) elastic collision.

25. Describe how the velocities of each of the billiard balls changes in the elastic collisions below.



a. The balls exchange velocities.

b. The balls exchange velocities.

c. The balls exchange velocities.

26. A collision in which the colliding objects become distorted and generate heat during the collision is a(n) inelastic collision.

27. What is the equation for the conservation of momentum?
$(\text{net } mv)_{\text{before}} = (\text{net } mv)_{\text{after}}$

28. Since there is no air resistance in space, what is the only opposing force that affects two docking space stations? gravity

29. What is an example of a perfectly elastic collision at the microscopic level?
the collision of electrically charged particles

8.6 Momentum Vectors (pages 135–136)

30. Is this sentence true or false? Momentum is conserved only when interacting objects move along the same straight path.
false

31. Circle the letter of each sentence that is true.

(a.) The vector sum of the momenta is the same before and after a collision.

b. The momentum of the car wreck is not equal to the vector sum of the momenta of car A and car B before the collision.

(c.) When a firecracker bursts, the vector sum of the momenta of its fragments add up to the firecracker's momentum just before bursting.

d. Momentum is not conserved for high-speed elementary particles in bubble chambers.

32. What two conservation laws are the most powerful tools in the study of mechanics?
conservation of momentum and conservation of energy

Momentum

A 0.5-kg toy truck moving at a velocity of 0.5 m/s collides head-on with a 0.75-kg toy truck that is at rest. The trucks become entangled and lock together. What is the velocity of the two toy trucks after the collision?

1. Read and Understand

What information are you given?

$m_{\text{toy 1}} = 0.5 \text{ kg}$

$v_{\text{toy 1}} = 0.5 \text{ m/s}$

$m_{\text{toy 2}} = 0.75 \text{ kg}$

$v_{\text{toy 2}} = 0 \text{ m/s}$

2. Plan and Solve

What unknown are you trying to calculate?

$v_{\text{after}} = ?$

What formula contains the given quantities and the unknown?

$(\text{net } mv)_{\text{before}} = (\text{net } mv)_{\text{after}}$

Replace each variable with its known value.

$(0.5 \text{ kg})(0.5 \text{ m/s}) + (0.75 \text{ kg})(0 \text{ m/s}) = (0.5 \text{ kg} + 0.75 \text{ kg})(v_{\text{after}})$

$0.25 \text{ kg} \cdot \text{m/s} = (1.25 \text{ kg})(v_{\text{after}})$

$v_{\text{after}} = 0.2 \text{ m/s}$

3. Look back and check

Is your answer reasonable?

Yes, the number calculated is the quotient of distance and speed, and the units indicate a velocity.

Math Practice

On a separate sheet of paper, solve the following problems.

1. A 0.25-kg ball rolling at 1.0 m/s rolls and overtakes a 0.3-kg ball rolling in the same direction at 0.5 m/s. The balls stick together on impact. What is the velocity of the two balls after the collision?

   $(0.25 \text{ kg})(1.0 \text{ m/s}) + (0.3 \text{ kg})(0.5 \text{ m/s}) = (0.25 \text{ kg} + 0.3 \text{ kg})(v_{\text{after}})$

   $0.4 \text{ kg} \cdot \text{m/s} = (0.55 \text{ kg})(v_{\text{after}})$

   $v_{\text{after}} = 0.7 \text{ m/s}$

2. A 5.0-kg puppy running at 2.0 m/s picks up a 1.0-kg stick that is sitting on the ground. What is the momentum of the puppy and the stick after the puppy picks up the stick?

   $(5.0 \text{ kg})(2.0 \text{ m/s}) + (1.0 \text{ kg})(0 \text{ m/s}) = (5.0 \text{ kg} + 1.0 \text{ kg})(v_{\text{after}})$

   $10.0 \text{ kg} \cdot \text{m/s} = (6.0 \text{ kg})(v_{\text{after}})$

   $v_{\text{after}} = 1.7 \text{ m/s}$