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Chapter 12 Forces and Motion

Section 12.1 Forces

(pages 356–362)

This section describes what forces are and explains how forces affect the motion of various objects.

Reading Strategy (page 356)

Relating Text and Visuals As you read about forces, look carefully at Figures 2, 3, and 5 in your textbook. Then complete the table by describing the forces and motion shown in each figure. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Forces and Motion		
Figure	**Is Net Force 0?**	**Effect on Motion**
2A	Yes	None
2B	Yes	None
3	Yes	None
5A	Yes	None
5B	No	Potted plant accelerates

What is a Force? (pages 356–357)

1. A force is defined as a(n) ___push___ or a(n) ___pull___ that acts on an object.
2. Is the following sentence true or false? A force can act to cause an object at rest to move or it can accelerate an object that is already moving. ___true___
3. How can a force change the motion of an object that is already moving?
   A force can accelerate a moving object by changing its speed, its direction, or both.
4. Circle the letter of the best answer. What force causes a 1-kg mass to accelerate at a rate of 1 meter per second each second?
   a. 1 $kg/m \cdot s^2$ b. 1 kg/s
   c. 1 kg•m (d.) 1 newton

Combining Forces (pages 357–358)

5. The overall force acting on an object after all the forces are combined is the ___net force___.
6. How do balanced and unbalanced forces affect the motion of an object?
   When balanced forces act on an object, there is no change in the object's motion because the net force is zero. When unbalanced forces act on an object, the net force is not zero, so the object accelerates.

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Chapter 12 Forces and Motion

Friction (pages 359–360)

7. Is the following sentence true or false? Friction is a force that helps objects that are touching move past each other more easily.
false

8. Circle the letters that identify types of friction.
(a) rolling b. gravity
(c) static (d) sliding

9. The friction force that acts on objects that are at rest is static friction.

10. Why is less force needed to keep an object moving than to start the object in motion? Sliding friction, which opposes a moving object, is less than the static friction that acts on an object at rest, so less force is needed to keep an object moving.

11. Complete the table below about friction forces.

Types of Friction Forces	
Friction Force	**Example**
Static	Walking
Sliding	Pushing a book along your desk
Rolling	In-line skates

12. Is the following sentence true or false? Fluid friction is a force that opposes the motion of an object through a fluid such as water.
true

Gravity (page 361)

13. Gravity is a(n) attractive force that pulls objects together.

14. Is the following sentence true or false? Earth's gravity acts downward toward the center of Earth. true

15. Describe how gravity and air resistance affect the motion of a falling object. Gravity causes an object to accelerate downward, whereas air resistance acts opposite the direction of motion to reduce acceleration.

16. Is the following sentence true or false? Terminal velocity is the constant velocity of a falling object when the force of air resistance equals the force of gravity. true

Projectile Motion (page 362)

17. The curved path caused by the combination of an initial forward velocity and the downward force of gravity is known as projectile motion.

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Chapter 12 Forces and Motion

Section 12.2 Newton's First and Second Laws of Motion

(pages 363–369)

This section discusses how force and mass affect acceleration. The acceleration due to gravity is defined, and mass and weight are compared.

Reading Strategy (page 363)

Building Vocabulary As you read this section, write a definition in the table for each vocabulary word you encounter. Use your own words in the definitions. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Matter and Motion	
Vocabulary	**Definition**
Inertia	Inertia is the tendency of an object to resist a change in its motion.
Mass	Mass is the amount of matter an object contains as measured by its inertia.
Weight	Weight is the force of gravity acting on an object.

Aristotle, Galileo, and Newton (pages 363–364)

Match each scientist with his accomplishment.

Accomplishment

b 1. Italian scientist who did experiments that helped correct misconceptions about force and motion

c 2. Scientist who studied in England and introduced several laws describing force and motion

a 3. An ancient Greek philosopher who made many scientific discoveries through observation and logical reasoning

Scientist

a. Aristotle
b. Galileo
c. Newton

Newton's First Law of Motion (pages 364–365)

4. Is the following sentence true or false? According to Newton's first law of motion, an object's state of motion does not change as long as the net force acting on it is zero. true

5. What is inertia? Inertia is the tendency of an object to resist changes in its motion.

6. Is the following sentence true or false? The law of inertia states that an object in motion will eventually slow down and come to a complete stop if it travels far enough in the same direction. false

Newton's Second Law of Motion (pages 365–368)

7. According to Newton's second law of motion, acceleration of an object depends upon the mass of the object and the net force acting on it.

Match each term with its description.

	Description	Term
a	8. A measure of the inertia of an object	a. mass
c	9. Net force/Mass	b. net force
b	10. Causes an object's velocity to change	c. acceleration

11. Is the following sentence true or false? The acceleration of an object is always in the same direction as the net force acting on the object. true

12. Is the following sentence true or false? If the same force acts upon two objects with different masses, the acceleration will be greater for the object with greater mass. false

Weight and Mass (pages 368–369)

13. What is weight? Weight is the force of gravity acting on an object.

14. Write the formula used to calculate the weight of an object.
Weight = Mass × Acceleration due to gravity

15. Is the following sentence true or false? Because the weight formula shows that mass and weight are proportional, doubling the mass of an object will not affect its weight. false

16. Complete the table below by describing the difference between mass and weight.

Mass and Weight	
Mass	**Weight**
Measure of the inertia of an object	Measure of the force of gravity acting on an object

17. On the moon, the acceleration due to gravity is only about one sixth that on Earth. Thus, an object will weigh less on the moon than it weighs on Earth.

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Chapter 12 Forces and Motion

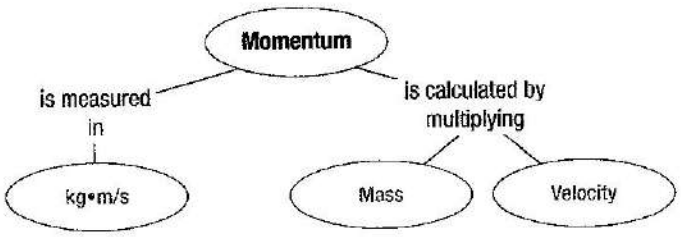
Section 12.3 Newton's Third Law of Motion and Momentum

(pages 372–377)

This section describes action-reaction forces and how the momentum of objects is determined.

Reading Strategy (page 372)

Summarizing As you read about momentum in this section, complete the concept map to organize what you learn. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.



Newton's Third Law (page 373)

1. According to Newton's third law of motion, what happens whenever one object exerts a force on a second object? The second object exerts an equal and opposite force on the first object.

2. The equal and opposite forces described by Newton's third law are called action and reaction forces.

3. Circle the letters that identify each sentence that is true about action-reaction forces.
   a. Newton's second law describes action-reaction forces.
   (b.) Forces always exist in pairs.
   (c.) Action-reaction forces never cancel.
   d. All action-reaction forces produce motion.

4. Is the following statement true or false? Action-reaction forces do not cancel each other because the action force is always greater than the reaction force. false

Momentum (pages 374–375)

5. Circle the letter of each factor that affects the momentum of a moving object.
   (a.) mass b. volume c. shape (d.) velocity

6. If two identical objects are moving at different velocities, the object that is moving faster will have greater momentum.

7. Your in-line skates are sitting in a box on a shelf in the closet. What is their momentum? zero

8. Is the following sentence true or false? An object with a small mass can have a large momentum if the object is traveling at a high speed. true

9. Write the momentum formula, including the correct units.
Momentum (kg•m/s) = Mass (kg) × Velocity (m/s)

10. Circle the letter of the object that has the greatest momentum.
   a. a 700-gram bird flying at a velocity of 2.5 m/s
   b. a 1000-kilogram car traveling at 5 m/s
   c. a 40-kilogram shopping cart rolling along at 0.5 m/s
   (d.) a 300-kilogram roller coaster car traveling at 25 m/s

Conservation of Momentum (pages 376–377)

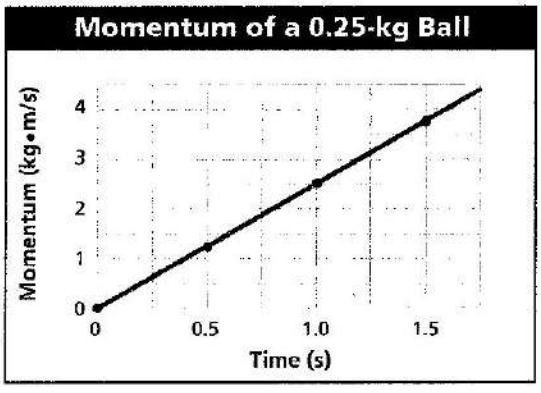
11. What does conservation of momentum mean? Momentum does not increase or decrease.

12. Is the following sentence true or false? Objects within a closed system can exert forces on one another, but other objects and forces cannot leave or enter the system. true

13. According to the law of conservation of momentum, what happens to the total momentum of a system if no net force acts on the system?
The total momentum does not change.

14. Is the following sentence true or false? In a closed system with two objects, the loss of momentum of one object equals the gain in momentum of the other object. true

For questions 15 and 16, refer to the graph below.



15. The momentum of the ball at one second is 2.5 kg•m/s.

16. What is the speed of the ball at 0.5 seconds? Show your calculation. *Hint:* Solve the momentum formula for velocity.
Momentum = Mass × Velocity; 1.25 kg•m/s = 0.25 kg × Velocity; Velocity = $\frac{1.25\ \text{kg•m/s}}{0.25\ \text{kg}} = 5\ \text{m/s}$

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Chapter 12 Forces and Motion

Section 12.4 Universal Forces

(pages 378–382)

This section defines four forces that exist throughout the universe. Each force is described and its significance is discussed.

Reading Strategy (page 378)

Comparing and Contrasting As you read this section, compare two universal forces by completing the table. For more information on this Reading Strategy, see the **Reading and Study Skills** in the **Skills and Reference Handbook** at the end of your textbook.

Universal Nuclear Forces			
Force	**Acts on Which Particles?**	**Acts Over What Distance?**	**Relative Strength**
Strong nuclear	Neutrons and protons	Very short	Very strong (100 times stronger than electrical force)
Weak nuclear	All particles	Short	Weaker than the strong force

1. What are the four universal forces?
   a. Electromagnetic b. Strong nuclear
   c. Weak nuclear d. Gravitational

Electromagnetic Forces (pages 378–379)

2. Is the following sentence true or false? Electromagnetic force is associated with charged particles. true
3. Name the only two forces that can both attract and repel. Electric and magnetic forces can both attract and repel.
4. Objects with like charges repel one another, and objects with opposite charges attract one another.
5. Circle the letters of the sentences that correctly describe magnets or magnetic forces.
   (a.) Magnetic forces act on certain metals.
   (b.) Magnets have two poles, north and south.
   c. Two poles that are alike attract each other.
   (d.) Magnetic forces can both attract and repel.

Nuclear Forces (pages 379–380)

6. The force that holds particles in the nucleus together is the strong nuclear force.
7. What evidence suggests that nuclear forces have a powerful force of attraction? These forces are strong enough to overcome the electric force of repulsion that acts among the positively charged protons in the nucleus.

8. Circle the letter of the best answer. Over extremely short distances, approximately how many times stronger is the strong nuclear force than the electric force of repulsion?

   a. 10 (b.) 100 c. 1000 d. 10,000

9. Compare and contrast the strong and weak nuclear forces. Both forces act within the nucleus of an atom to hold it together. The strong nuclear force affects only the neutrons and protons in the nucleus and acts over extremely short distances. The weak nuclear force acts over an even shorter distance but affects all particles, not just protons and neutrons.

Gravitational Force (pages 380–382)

10. State Newton's law of universal gravitation. Every object in the universe attracts every other object.

11. Circle the letter of each sentence that is true about gravitational force.

    a. The closer two objects are to one another, the weaker the gravitational force.

    (b.) The farther apart two objects are, the weaker the gravitational force.

    (c.) The greater the mass of an object, the stronger its gravitational force.

    d. Earth's gravitational force is stronger than the gravitational force of the sun.

12. The gravitational force of attraction between two objects depends on mass and distance.

13. Is the following sentence true or false? Gravity is the weakest universal force, but it is the most effective force over long distances. true

14. The sun's mass is much greater than the mass of Earth, so the sun's gravitational force is much stronger than that of Earth.

15. Why does the moon orbit Earth in a nearly circular path? The moon's inertia and centripetal force from Earth produce the nearly circular path.

16. Is the following sentence true or false? The gravitational pull of the moon is the primary cause of Earth's ocean tides. true

17. Is the following sentence true or false? The pull of Earth's gravity can slow an artificial satellite, causing it to lose altitude and fall from the sky. false

18. List four uses of artificial satellites. Students' answers should include four of the following: Satellites monitor Earth's weather, create detailed radar maps of Earth's surface, use telescopes to gaze into space, study Earth's climate, receive and transmit radio and microwave signals, receive and transmit cell phone and satellite television signals.