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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		
2B		
3		
5A		
5B		

What is a Force? (pages 356–357)

1. A force is defined as a(n) _____ or a(n) _____ 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. _____
3. How can a force change the motion of an object that is already moving?

_____

_____

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 _____.
6. How do balanced and unbalanced forces affect the motion of an object?

_____

_____

_____

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.
_____

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 _____.

10. Why is less force needed to keep an object moving than to start the object in motion? _____
_____
_____

11. Complete the table below about friction forces.

Types of Friction Forces	
Friction Force	**Example**
Static	
	Pushing a book along your desk
Rolling	

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.
_____

Gravity (page 361)

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

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

15. Describe how gravity and air resistance affect the motion of a falling object. _____
_____

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. _____

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 _____ motion.

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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	

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

Match each scientist with his accomplishment.

Accomplishment

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

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

_____ 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. _____

5. What is inertia? _____

_____

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. _____

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 _____ of the object and the _____ acting on it.

Match each term with its description.

Description	Term
_____ 8. A measure of the inertia of an object	a. mass
_____ 9. Net force/Mass	b. net force
_____ 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. _____

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. _____

Weight and Mass (pages 368–369)

13. What is weight? _____

_____

14. Write the formula used to calculate the weight of an object.

_____

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. _____

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

Mass and Weight	
Mass	**Weight**

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

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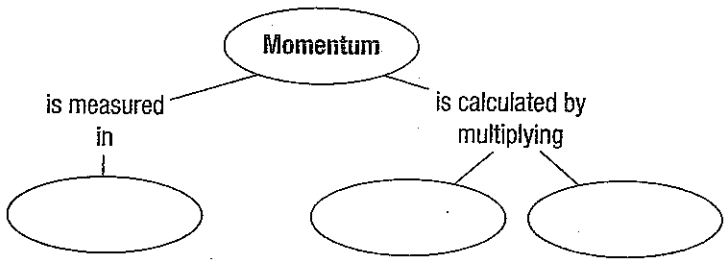
Section 12.3 Newton's Third Law of Motion and Momentum

(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? _____

_____

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

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 _____ momentum.

7. Your in-line skates are sitting in a box on a shelf in the closet. What is their momentum? _____
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. _____
9. Write the momentum formula, including the correct units.

_____

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? _____

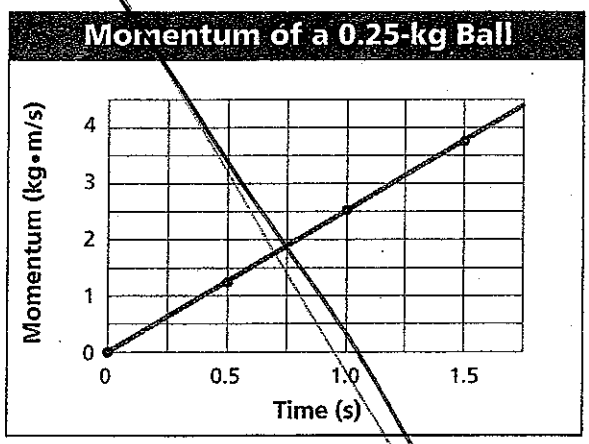
_____

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. _____
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?

_____

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. _____

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



15. The momentum of the ball at one second is _____.
16. What is the speed of the ball at 0.5 seconds? Show your calculation. *Hint:* Solve the momentum formula for velocity.

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WordWise

Complete the sentences using one of the scrambled words below.

nicofirt	vtiyagr	aecmleorntcgeti corfe
ssma	raeeaclnocit	hwgeti
ten eofrc	lirnetcptae refco	swonten
lfudi tnfcriio	kewa cnuarel	teianri
mtnmoemu		

A measure of an object's inertia is its _____.

The _____ force affects all particles in a nucleus and acts only over a short range.

A sky diver experiences _____, which opposes the force of gravity.

A change in an object's speed or direction of motion is called _____.

The product of an object's mass and its velocity is _____.

A measure of the force of gravity acting on an object is its _____.

A center-directed _____ continuously changes the direction of an object to make it move in a circle.

A force associated with charged particles is _____.

Mass is the measure of the _____ of an object.

A force that opposes the motion of objects that touch as they move past each other is called _____.

The universal force that causes every object to attract every other object is _____.

A person's weight on Mars, measured in _____, is 0.38 times the weight on Earth.

Acceleration equals _____ divided by mass.

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Calculating Acceleration

A car with a mass of 1300 kg accelerates as it leaves a parking lot. If the net force on the car is 3900 newtons, what is the car's *acceleration*?

Math Skill: Formulas and Equations

You may want to read more about this **Math Skill** in the **Skills and Reference Handbook** at the end of your textbook.

1. Read and Understand

What information are you given?

Mass , $m = 1300$ kg

Force, $F = 3900$ N (in the forward direction)

2. Plan and Solve

What unknown are you trying to calculate?

Acceleration, $a = ?$

What formula contains the given quantities and the unknown?

$$a = \frac{F}{m}$$

Replace each variable with its known value and solve.

$$a = \frac{3900\ \text{N}}{1300\ \text{kg}} = 3\ \frac{\text{N}}{\text{kg}} = 3\ \frac{\text{kg} \cdot \text{m/s}^2}{\text{kg}} = 3\ \text{m/s}^2$$

$a = 3$ m/s^2 in the forward direction

3. Look Back and Check

Is your answer reasonable?

Powerful sports cars can accelerate at 6 m/s^2, so a smaller acceleration of 3 m/s^2 seems reasonable.

Math Practice

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

1. A construction worker pushes a wheelbarrow with a total mass of 50.0 kg. What is the acceleration of the wheelbarrow if the net force on it is 75 N?

2. A van with a mass of 1500 kg accelerates at a rate of 3.5 m/s^2 in the forward direction. What is the net force acting on the van? (*Hint:* Solve the acceleration formula for force.)

3. A 6.0×10^3 N force accelerates a truck entering a highway at 2.5 m/s^2. What is the mass of the truck? (*Hint:* Solve the acceleration formula for mass.)