Study Guide

Interactive Textbook
- Complete student edition
- Section and chapter self-assessment
- Assessment reports for teachers

Help Students Read

Building Vocabulary

Words in Context Help students use context clues to learn and remember the meaning of unfamiliar words and phrases. Have students locate the term *terminal velocity* in the text. Ask: **What words in the surrounding text could help you remember the meaning of the term *terminal velocity*?** *(Greatest velocity of a falling object)*

Word/Part Analysis Tell students that the prefix *re-* is a Latin prefix meaning again or against. Have students relate this to the term *reaction force.* Ask students to name other words that contain the prefix *re-*. Have students relate the meaning of the prefix to the meaning of the word. *(Sample answer: resealable-able to be sealed again)*

Connecting Concepts

Concept Maps Help students develop a concept map to show how the information in this chapter is related. Forces such as friction and gravity, can be balanced or unbalanced, act on objects, affect the motion of objects, and are explained by Newton's laws. Have students brainstorm to identify the key concepts, key terms, details, and examples. Then, write each one on a self-sticking note and attach it at random on chart paper or on the board.

Tell students that this concept map will be organized in hierarchical order and to begin at the top with the key concepts. Ask students these questions to guide them to categorize the information on the self-sticking notes: **What is force? How do friction and gravity affect the motion of objects? What are Newton's first and second laws? What is Newton's third law? What forces affect the motion of rockets and satellites?** Prompt students to use connecting words or phrases, such as "can be," "affect," and "are explained by" to indicate the basis for the connections in the map. The phrases should form a sentence between or among a set of concepts.

Answer

Accept logical presentations by students.

Chapter Study Guide

1 The Nature of Force

Key Concepts
- Like velocity and acceleration, a force is described by its strength and by the direction in which it acts.
- Unbalanced forces acting on an object result in a net force and cause a change in the object's motion.
- Balanced forces acting on an object do not change the object's motion.

Key Terms

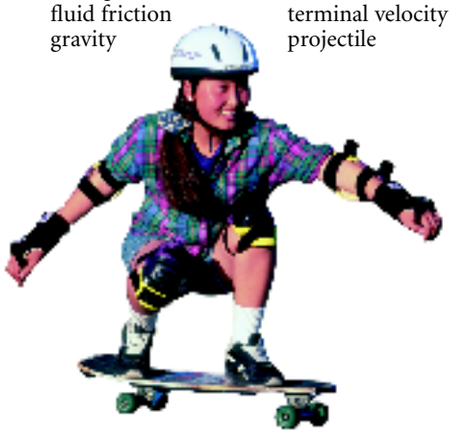
force
newton
net force
unbalanced forces
balanced forces

2 Friction and Gravity

Key Concepts
- The strength of the force of friction depends on two factors: how hard the surfaces push together and the types of surfaces involved.
- Two factors affect the gravitational attraction between objects: mass and distance.
- In free fall, the force of gravity is an unbalanced force, which causes an object to accelerate.

Key Terms

friction
static friction
sliding friction
rolling friction
fluid friction
gravity
mass
weight
free fall
air resistance
terminal velocity
projectile



3 Newton's First and Second Laws

Key Concepts
- An object at rest will remain at rest, and an object moving at a constant velocity will continue moving at a constant velocity, unless it is acted upon by an unbalanced force.
- Acceleration depends on the object's mass and on the net force acting on the object.
- $\text{Acceleration} = \frac{\text{Net force}}{\text{Mass}}$

Key Term

inertia

4 Newton's Third Law

Key Concepts
- If one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object.
- The momentum of a moving object is equal to its mass times its velocity.

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

- The total momentum of any group of objects remains the same, or is conserved, unless outside forces act on the objects.

Key Terms

momentum
law of conservation of momentum

5 Rockets and Satellites

Key Concepts
- A rocket can rise into the air because the gases it expels with a downward action force exert an equal but opposite reaction force on the rocket.
- Satellites in orbit around Earth continuously fall toward Earth, but because Earth is curved they travel around it.

Key Terms

satellite
centripetal force

All in One Teaching Resources
- Key Terms Review: *Forces*
- Connecting Concepts: *Forces*

Review and Assessment

Go Online PHSchool.com
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Organizing Information

Comparing and Contrasting Copy the table about the different types of friction onto a sheet of paper. Then complete it and add a title. (For more on Comparing and Contrasting, see the Skills Handbook.)

Type of Friction	Occurs When	Example
Static	An object is not moving	a. ?
Sliding	b. ?	c. ?
Rolling	d. ?	e. ?
Fluid	f. ?	g. ?

Reviewing Key Terms

Choose the letter of the best answer.

1. When an unbalanced force acts on an object, the force
   a. changes the motion of the object.
   b. is canceled by another force.
   c. does not change the motion of the object.
   d. is equal to the weight of the object.
2. Air resistance is a type of
   a. rolling friction.
   b. sliding friction.
   c. centripetal force.
   d. fluid friction.
3. Which of the following is not a projectile?
   a. a satellite
   b. a thrown ball
   c. a ball on the ground
   d. a soaring arrow
4. The resistance of an object to any change in its motion is called
   a. inertia.
   b. friction.
   c. gravity.
   d. weight.
5. The product of an object's mass and its velocity is called the object's
   a. net force.
   b. weight.
   c. momentum.
   d. gravitation.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. Balanced forces are equal forces acting on an object in opposite directions.
7. Rolling friction occurs when two solid surfaces slide over each other.
8. The greatest velocity a falling object reaches is called its momentum.
9. The law of universal gravitation states that the total momentum of objects that interact does not change.
10. The force that causes a satellite to orbit Earth is a centripetal force.

Writing in Science

Descriptive Paragraph Suppose you have been asked to design a new amusement park ride. Write a description of how you will design it. Explain the role that friction and gravity will play in the ride's design.

Discovery Channel SCHOOL
Forces
Video Preview
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Video Assessment

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Students can take a practice test online that is automatically scored.

All in One Teaching Resources

- Transparency M22
- Chapter Test
- Performance Assessment Teacher Notes
- Performance Assessment Student Worksheet
- Performance Assessment Scoring Rubric

ExamView® Computer Test Bank CD-ROM

Review and Assessment

Organizing Information

Sample answers:

a. Friction between an unmoving book and the desk on which it is sitting
b. Two solid surfaces slide over each other
c. Rubber pads on a bicycle's brakes rubbing against the tire
d. An object rolls across a surface
e. Ball bearings in skateboard wheels
f. A solid object moves through a fluid
g. Air resistance

Reviewing Key Terms

1. a **2.** d **3.** c **4.** a **5.** c
6. true
7. Sliding friction
8. terminal velocity
9. law of conservation of momentum
10. true

Discovery Channel SCHOOL Video Assessment

Forces

Show the Video Assessment to review chapter content and as a prompt for the writing assignment. Discussion questions: **What force accelerates a roller coaster train that is going downhill?** *(Gravity)* **What force helps a roller coaster to stop?** *(Friction)*

Writing in Science

Writing Mode Description

Scoring Rubric

4 Exceeds criteria; includes a detailed description of an amusement park ride with a thorough and correct explanation of the role of gravity and friction
3 Meets criteria
2 The paragraph lacks detail and/or includes information about only gravity or only friction
1 The paragraph does not relate gravity and friction to the amusement park ride and/or contains numerous errors

Checking Concepts

11. The forces the four children are exerting on the object balanced one another.

12. The fluids keep the surfaces from making direct contact and thus reduce friction.

13. No, a flat sheet of paper will accelerate more slowly due to increased air resistance.

14. Newton's second law states that force is equal to mass multiplied by acceleration.

15. You can throw your empty jet pack away from the space station. As a result, the reaction force exerted on you by the jet pack will accelerate you toward the space station.

16. Students' drawings should resemble the art in Figure 21, with Earth's gravitational force directed toward the center of Earth and perpendicular to the satellite's motion. Yes, the satellite is accelerating because it is changing direction.

Thinking Critically

17. Static friction allows you to walk without slipping.

18. The skateboard stops, but your inertia causes you to keep moving forward.

19. The net force is 90 N to the right. The acceleration is 6 m/s^2.

20. Yes, the pavement exerts a force on the ball.

Math Practice

21. $7.3\ kg \times 37\ m/s^2 = 27.01\ N$

22. $(240 + 75)kg \times 16\ m/s = 5{,}040\ kg \cdot m/s$

Review and Assessment

Checking Concepts

11. Four children pull on the same toy at the same time, yet there is no net force on the toy. How is that possible?

12. Why do slippery fluids such as oil reduce sliding friction?

13. Will a flat sheet of paper dropped from a height of 2 m accelerate at the same rate as a piece of paper crumpled into a ball? Why or why not?

14. Explain how force, mass, and acceleration are related by Newton's second law of motion.

15. Suppose you are an astronaut making a space walk outside your space station when your jet pack runs out of fuel. How can you use your empty jet pack to get you back to the station?

16. Draw a diagram showing the motion of a satellite around Earth. Label the forces acting on the satellite. Is the satellite accelerating?

Thinking Critically

17. **Classifying** What kind of friction allows you to walk without slipping?

18. **Applying Concepts** You are moving fast on a skateboard when your wheel gets stuck in a crack on the sidewalk. Using the term *inertia*, explain what happens.

19. **Problem Solving** Look at the diagram below of two students pulling a bag of volleyball equipment. The friction force between the bag and the floor is 15 N. What is the net force acting on the bag? What is the acceleration of the bag?

20. **Relating Cause and Effect** When you drop a golf ball to the pavement, it bounces up. Is a force needed to make it bounce up? If so, what exerts the force?

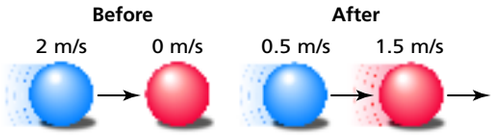
Math Practice

21. **Calculating Force** A 7.3-kg bowling ball accelerates at a rate of 3.7 m/s^2. What force acts on the bowling ball?

22. **Calculating Momentum** A 240-kg snowmobile travels at 16 m/s. The mass of the driver is 75 kg. What is the momentum of the snowmobile and driver?

Applying Skills

Use the illustration showing a collision between two balls to answer Questions 23–25.



23. **Calculating** Use the formula for momentum to find the momentum of each ball before and after the collision. Assume the mass of each ball is 0.4 kg.

24. **Inferring** Find the total momentum before and after collision. Is the law of conservation of momentum satisfied in this collision? Explain.

25. **Designing Experiments** Design an experiment in which you could show that momentum is not conserved between the balls when friction is strong.

Lab zone Chapter Project

Performance Assessment Test your vehicle to make sure it will work on the type of floor in your classroom. Will the vehicle stay within the bounds set by your teacher? Identify all the forces acting on the vehicle. What was the most significant source of friction for your vehicle? List at least three features you included in the design of the vehicle that led to an improvement in its performance. For example, did you give it a smooth shape for low air resistance?

Lab zone Chapter Project

L3

Performance Assessment Provide time for students to test their vehicles. Remind students to include diagrams identifying forces on the vehicles. After all of the presentations are complete, have students discuss the source of friction for the different vehicles. Encourage students to incorporate Newton's laws of motion when they explain the features of their designs that improved performance. Also, encourage them to compare design features with their classmate's vehicles as they evaluate their own vehicles.

Standardized Test Prep

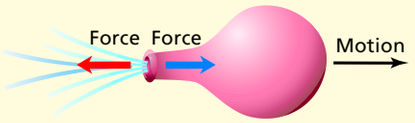
Test-Taking Tip

Interpreting Diagrams

On some tests, you may be asked questions about a diagram. Understanding the information in the diagram is the key to answering the question correctly. When you are shown a diagram, examine it carefully. Look at the objects and symbols in the diagram and read the labels.

Sample Question

What conclusion can you draw by looking at the diagram?



A Air resistance in front of the balloon pushes it backward.
B Gravity forces air out of the balloon's open end.
C The force of the air leaving the balloon propels it forward.
D Friction causes the balloon's acceleration to decrease.

Answer

The diagram shows a pair of action-reaction forces. The action force is caused by the balloon pushing out air. According to Newton's third law of motion, the reaction force of the air pushes on the balloon, propelling it forward. The answer is **C**.

Choose the letter of the best answer.

1. In the balloon diagram above, why don't the two forces cancel each other out?
A They are not equal.
B They both act on the air.
C They both act on the balloon.
D They act on different objects.

2. What force makes it less likely for a person to slip on a dry sidewalk as opposed to an icy sidewalk?
F air resistance
G friction
H inertia
J momentum

3. Which of the following is determined by the force of gravity?
A weight
B momentum
C mass
D distance

4. The table below shows the mass and velocity of four animals. Which animal has the greatest momentum?

Mass and Velocity of Animals

Animal	Mass (kg)	Velocity (m/s)
Cheetah	45	20
Grizzly bear	200	13
Hyena	70	18
Wild turkey	11	7

F cheetah
G grizzly bear
H hyena
J wild turkey

5. A 50-car freight train and an 8-car passenger train are stopped on parallel tracks. It is more difficult to move the freight train than the passenger train. What accounts for this fact?
A terminal velocity
B inertia
C centripetal force
D speed

Constructed Response

6. Write a short paragraph explaining how a parachute works in terms of forces.

Applying Skills

23. Left ball before: 0.4 kg × 2 m/s = 0.8 kg·m/s; right ball before: 0.4 kg × 0 m/s = 0 kg·m/s; left ball after: 0.4 kg × 0.5 m/s = 0.2 kg·m/s; right ball after: 0.4 kg × 1.5 m/s = 0.6 kg·m/s

24. Total momentum before: 0.8 kg·m/s + 0 kg·m/s = 0.8 kg·m/s; total momentum after: 0.2 kg·m/s + 0.6 kg·m/s = 0.8 kg·m/s; Yes, the law of conservation is satisfied. The total momentum before the collision is equal to the total momentum after the collision.

25. Students' designs will vary, but should include a high-friction surface to demonstrate how friction will decrease momentum.

Standardized Test Prep

1. D **2.** G **3.** A **4.** G **5.** B

6. A parachute works by creating air resistance to act opposite the force of gravity. When a person jumps from a plane, gravity pulls that person toward the ground. Once the parachtue opens, the air under the parachute canopy exerts an upward force. So while gravity continues to pull down on the person, air resistance pushes up on the parachute canopy and slows the rate of descent. The forces of gravity and air resistance are not balanced, however.The force of the air resistance is less than the force of gavity. If the forces were equal, the person would float in the air indefinitely and never make it to the ground.