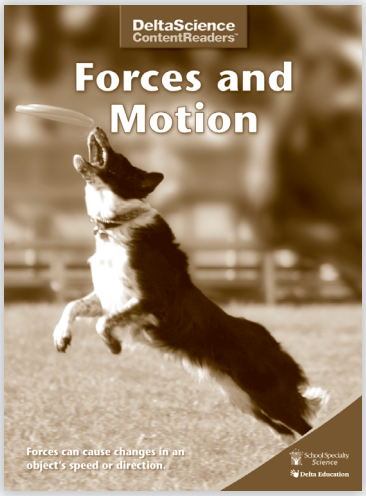


Red Edition
Grade 3–4
reading level

Purple Edition
Grade 4–5
reading level

Objectives

- Describe how forces can change the motion of objects.
- Explain what happens when many forces act on one object at the same time.
- Examine friction, gravity, and magnetic force.
- Compare ways we tell about the position and motion of objects, such as speed, velocity, and acceleration.
- Understand the scientific study of motion.
- Explore three important principles—Newton's laws of motion—that help us explain and predict the motion of objects.

Reading Comprehension Skills

Preview the Book ◆ How to Read Charts

Cause and Effect

Skillbuilders are available for this title.

Supporting English Learners

Teach Academic English Make school language comprehensible to English Learners. Carefully select words related to academic tasks, such as *preview*, *summarize*, and *chart*, and teach them in meaningful contexts. Provide daily, explicit instruction to teach both science vocabulary and school language.

Summary

What are forces? How are forces related to motion? In the Delta Science Content Reader *Forces and Motion*, students learn about forces such as pushes and pulls, friction, gravity, and magnetic force. Students also learn about ways to describe and measure motion, including speed, velocity, and acceleration. They learn that all motion and every change in motion is caused by a force. The book concludes with a discussion of the scientific study of motion and Newton's three laws of motion.

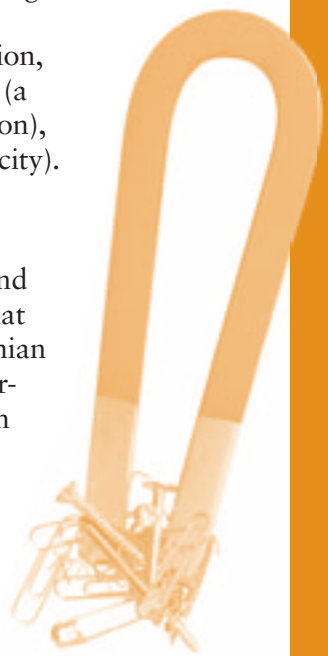
Science Background

Most of the activities we perform each day involve moving things. For an object to move, a force—a push or a pull—must act upon it. The stronger the net force, the farther and faster an object will move. Likewise, the more massive the object, the more force it will take to move it.

Forces are acting on objects all the time. Regardless of how it may feel, no surface is perfectly smooth. Friction is a force that opposes motion when two surfaces come in contact with each other. Gravity is another force. Every particle of matter attracts every other particle of matter. The greater the particles' masses and the closer they are, the stronger the attraction. The attraction of gravity affects everything. Magnetic force is another force in our everyday lives.

Motion occurs when an object changes position. Forces cause motion. We can measure many aspects of motion, including distance, speed, velocity (a measure of both speed and direction), and acceleration (a change in velocity).

Sir Isaac Newton (1642–1727) answered many questions about the relationship between forces and motion. The physics of motion that Newton developed, called Newtonian mechanics, transformed the understanding of objects in motion from the smallest grains of sand on Earth to the largest planets in the solar system.



What Are Forces?

(pages 2–9)

Before Reading

Discuss the Cover

Cover Image Discuss the photograph on the cover of *Forces and Motion*. Use the information on the inside front cover to support the discussion.

Science Statement Discuss the science statement. Ask: *Do you think forces cause changes to objects in sports? What kind of forces do you think these might be? How might forces affect a ball in a soccer match?*

Build Reading Skills (page 2)

Preview the Book Use Build Reading Skills on page 2 to review how to preview the book. Discuss the steps. Then model previewing the red headings.

> **Think Aloud** *Maybe the red headings break each main section into smaller parts. Do they? On page 3, I see that the main section is about the question "What Are Forces?" On page 4, I see the red heading "Pushes and Pulls." Below this, I read that a force is needed to make an object move. So this part tells what a force is. On page 6, I see another red heading, "Friction." This part tells about a kind of force. So I was right.*

Guide students as they finish previewing *Forces and Motion*. Focus on nonfiction text features.

- Prompt them to look at the headings, photographs, captions, and diagrams. Ask questions such as *Why do you think that feature is there? How will it help you understand what you read?*
- Prompt them to look at the bold Vocabulary words. Guide the class in looking up a Vocabulary word in the Glossary.

Students can apply the skill in the Reflect on Reading activity on page 9.

K-W-L Chart Have students begin a K-W-L chart. They should add to it after each section.

What I Know	What I Want to Learn	What I Learned
Forces move objects.	What makes objects stop?	

Make a Connection (page 3)

Make a Connection Discuss the Make a Connection questions. Use this discussion to build background and activate prior knowledge about forces. (Possible answers: Gravity makes objects fall to Earth. Maybe the parachute catches the air.)

Find Out About Read each statement to help students set a reading purpose. Explain that these are the important topics that they will learn about in this section.

Vocabulary Read the Vocabulary words aloud. Explain to students that they will see these words in bold in this section. Start a word web on the board with *Forces* in the center. As they read, have students add kinds of forces to the web.

During Reading

Pushes and Pulls (page 4)

- Ask: *What are the ways in which a force can change motion?* (can make an object start moving; can make a moving object speed up, slow down, or stop; can change the direction in which an object moves)
- Ask: *How is the size of a force related to motion?* (When you apply more force to an object, the object's motion changes more.)
- Help students understand that mass is not weight. Mass is the amount of material, or matter, in an object. Ask: *When is more force needed?* (to move objects with more mass)
- Have students look at the photograph of the tug-of-war game on page 5. Ask: *What two forces are acting on the rope to move the flag?* (two teams pulling in opposite directions)
- Ask: *Where would the flag be if these forces were balanced? Are the forces balanced? How do you know?* (on the white line; No, because the red flag is moving past the white line.)
- Provide additional support for the word *net* in the term *net force*. Say: *If you earned twenty dollars and spent twenty dollars, you would have zero dollars left. Zero dollars would be your net amount of money. If you earned twenty dollars and spent fifteen, you would have five dollars left. Five dollars would be your net amount of money.*

Checkpoint (Possible answer: I lifted my backpack and took out the trash. The backpack took more force to move because it had more mass.)

Friction (page 6)

- Ask: *When does friction happen?* (when two objects touch, roll, rub, or slide against each other)
- Ask: *When do we want less friction?* (when it causes machine parts to slow down or wear out)
- Ask: *When does friction help us?* (when it lets us grip things more tightly)
- Explain that friction can work for us as well as against us. Point out the photograph of the bike tire with the rough treads on page 6 as an example of helpful friction.
- Explain that air resistance is a kind of friction. An airplane experiences air resistance as it flies through the air. Cars also experience air resistance. Cars are designed with special shapes in order to reduce the effects of air resistance.

Checkpoint (Friction acts against an object's motion. It can stop an object from moving or slow down a moving object.)

Gravity (page 7)

- Ask: *What is gravity?* (It is a force that acts between all objects that have mass. It pulls objects toward each other.)
- Students may think of weight, and sometimes gravity, as a property of objects rather than as a force. Make sure students understand that weight is a measurement of the force of gravity pulling on an object.
- Ask: *Have you ever seen pictures of astronauts jumping on the surface of the Moon? Why do they seem to bounce when they walk?* (The Moon's mass is less than Earth's, so the force of gravity pulling on the astronauts is not as strong on the Moon.)
- Ask: *Would you have less mass on the Moon than on Earth?* (no)

Checkpoint (The force of gravity is stronger between objects that have more mass.)

Magnetic Force (page 9)

- Ask: *Where on a magnet is the magnetic field strongest?* (at the poles)
- Ask: *If the distance between the object and the magnet increases, what happens to the magnetic attraction?* (It gets weaker.)
- Explain that Earth is like a giant bar magnet. Earth has a magnetic north pole and a magnetic south pole. Earth also has a magnetic field.
- Earth's magnetic poles are not in the same places as Earth's geographic North and South poles. The location of the magnetic poles moves a little every year. In fact, every 200,000 years or so, the magnetic north and south poles switch places.
- Some rocks found in nature are magnetic. These rocks are called lodestone or magnetite. They once were called magic stones.

Checkpoint (The paper clip might not be made of iron, nickel, or cobalt.)

After Reading

Reflect on Reading (page 9) Ask: *What different kinds of forces did you learn about?* (pushes and pulls; friction; gravity; magnetic force) *Which book features helped you understand about different kinds of forces?* (Answers will vary.)

Apply Science Concepts (page 9) This activity applies a concept from Find Out About on page 3. (Possible answer: You apply force to make it move. The ball rises through the air and then is pulled down through the net and to the floor by the force of gravity. Some friction from the net probably slows down the ball.)

How Do We Describe Motion? (pages 10–17)

Before Reading

Build Reading Skills (page 10)

How to Read Charts Use Build Reading Skills on page 10 to review how to read charts. Discuss the tips. Then model how to read the chart on page 15.

Think Aloud *When I read the column headings across the top, I learn that the chart lists speeds of animals and objects. I also learn that the chart tells speeds in two units, metric and customary. The row headings down the side name each animal or object. The first row heading is "Snail." If I*

follow the row, I learn that a snail's speed is 0.045 km/hr, which is 0.028 mi/hr.

Guide students to find the fastest speed of an animal in the chart on page 15. (a diving peregrine falcon) Students can apply the skill in the Reflect on Reading activity on page 17.

Make a Connection (page 11)

Make a Connection Discuss the Make a Connection question. Use this discussion to build background and activate prior knowledge about motion. (Possible answer: The cars are moving fast. They are moving along a curve, not in a straight line. Their position is always changing. They come back to the same position every time they finish a lap.)

Find Out About Read the statement to help students set a reading purpose. Explain that this is the important topic that they will learn about in this section.

Vocabulary Read the Vocabulary words aloud. Explain to students that they will see these words in bold in this section. Start a T-chart on the board with the headings *Position* and *Motion*. Have students add examples to each column as they read.

During Reading

Position and Motion (page 12)

- Ask: *What is position?* (the location of an object)
- Ask: *How could you describe your position right now?* (Possible answer: in my classroom; sitting at my desk; between two other students)
- Ask: *When does motion happen?* (when an object changes position) *What causes motion?* (forces)
- Ask: *Can you give an example you saw today of a force, or forces, causing motion?* (Possible answer: I pulled my chair away from my desk so I could sit down. The force I used made the chair move.)
- Ask: *What is distance?* (how far it is from one point to another)

Checkpoint (It changes position compared to an object that is not moving.)

Speed (page 14)

- Ask: *What is speed?* (the measure of how quickly an object's position changes)
- Ask: *What is the formula for speed?* (*speed = distance ÷ time*)

Checkpoint (the distance the object moved and the amount of time it took to move that distance)

Velocity (page 16)

- Ask: *What does velocity measure?* (speed and direction)
- Ask: *If you walk west to get to school, and your speed is five kilometers per hour, what is your velocity?* (5 km/hr, west)

Checkpoint (They can be going in different directions.)

Acceleration (page 17)

- Ask: *What is acceleration?* (any change in an object's velocity) *What causes acceleration?* (a net force acting on the object)
- Ask: *How does mass affect acceleration?* (It takes more force to accelerate objects with more mass.)

Checkpoint (by slowing down, speeding up, or changing direction)

After Reading

Reflect on Reading (page 17) Once students have shared their ideas, challenge them to research the actual average speed of their favorite animal.

Apply Science Concepts (page 17) This activity applies a concept from Find Out About on page 11. Before students write, help them think about the relationship between position and motion. Review the definitions of speed, velocity, and acceleration.

What Are Newton's Laws of Motion?

(pages 18–23)

Before Reading

Build Reading Skills (page 18)

Cause and Effect Use Build Reading Skills on page 18 to review cause and effect. Discuss the tips. Then read aloud the first paragraph of regular text on page 21, and model identifying cause and effect.

Think Aloud *What do I learn first? No acceleration happens without a net force. When I read on, I learn a net force is needed to make an object*

start moving, speed up, slow down, change direction, or stop. What causes these changes? The net force. What is the effect? Acceleration.

Guide students to look for effects as they read. Students can apply the skill in the Reflect on Reading activity on page 23.

Make a Connection (page 19)

Make a Connection Discuss the Make a Connection question. Use this discussion to build background and activate prior knowledge about how forces affect motion. (Possible answer: When you apply force to the water in one direction, it can cause motion in the other direction.)

Find Out About Read each statement to help students set a reading purpose. Explain that these are the important topics that they will learn about in this section.

Vocabulary Read the Vocabulary word aloud. Explain to students that they will see this word in bold in this section. Start a word web on the board with *Inertia* in the center. Have students add examples of inertia as they read.

During Reading

The Science of Motion (page 20)

- Show students a Newton's Cradle toy or a picture of one. Newton's Cradle is a set of identical pendulums that transfer their momentum to each other as they collide. Newton used a similar device to study forces, motion, and momentum. Doing experiments with these pendulums led Newton to develop his third law of motion.

Checkpoint (Galileo rolled balls down ramps, tossed objects into the air, and swung weights on ropes. Newton read about Galileo's work, watched how things in nature move, and worked with ramps and other machines.)

Newton's First Law of Motion (page 21)

- Emphasize that changes in speed or direction of motion are caused by forces.
- Ask: *What is inertia?* (a property of objects that tells how objects keep moving or stay still until a net force acts on them)

Checkpoint (Inertia keeps the book on the desk until a force acts on it. A force could act on the book by lifting it, pushing it, opening it, and so on.)

Newton's Second Law of Motion (page 22)

- Ask: *How is acceleration related to force?* (When more force acts on an object, the object accelerates more.)
- Ask: *How does mass change the amount of force needed to make an object accelerate?* (Objects with more mass need more force to accelerate.)
- Emphasize that the greater the net force is, the greater the change in motion.

Checkpoint (The more force is acting on an object, the more the object will accelerate. The more mass an object has, the more force is needed to make it accelerate.)

Newton's Third Law of Motion (page 23)

Checkpoint (The action force is the force an object applies to another object. The reaction force is the force the second object applies back to the first object. The reaction force is equal to the action force in strength and opposite in direction.)

After Reading

Reflect on Reading (page 23) (Possible answer: An object keeps moving or stays still until a net force acts on it.) Once students have completed their charts, have them work in pairs or small groups to test some of their ideas in the classroom.

Apply Science Concepts (page 23) This activity applies a concept from Find Out About on page 19. (When you push off the ground, the ground pushes back against you and you accelerate into the air. Newton's first and third laws tell us about this. How much acceleration you have when you jump depends on the force you used when jumping and on how much mass you have. Newton's second law tells us about this. You keep moving up until gravity has slowed you down enough to cause you to stop, change direction, and come back down. Newton's first law tells us about this.)

Continued on last page

Name: Date:

Test: **Forces and Motion**

Part A: Vocabulary

distance	force	friction	gravity
inertia	magnetic force	motion	position

Choose the correct vocabulary word for each definition. Write the word on the line.

1. It takes more _____ to move objects with more mass.

2. When two objects touch, rub, roll, or slide against each other, _____ acts against their motion.

3. The force of _____ pulls objects toward each other.

4. Objects containing iron can be attracted by _____.

5. If you tell someone where you are, you tell them your _____.

6. Your frame of reference helps you know you are in _____.

7. You need to know _____ as well as time to find an object's speed.

8. Because of _____, bowling pins don't move until a ball hits them or another net force acts on them.

Part B: Science Concepts

Mark the best answer to each question.

9. Measured in newtons, the force of gravity on an object is called _____.

Ⓐ friction
Ⓒ motion
Ⓑ weight
Ⓓ inertia

10. In order to accelerate, objects with more mass need more _____.

Ⓐ speed
Ⓒ inertia
Ⓑ gravity
Ⓓ force

Test: **Forces and Motion** *(continued)*

11. Which best describes how people in history studied the motion of objects?

Ⓐ They read what others wrote and did their own experiments.

Ⓑ They only did experiments and did not write things down.

Ⓒ They tied weights to ropes and rolled balls down ramps.

Ⓓ They read about what Greek philosophers thought.

12. A rolling ball will keep rolling until a net force acts on it. This is an example of _____.

Ⓐ velocity

Ⓑ speed

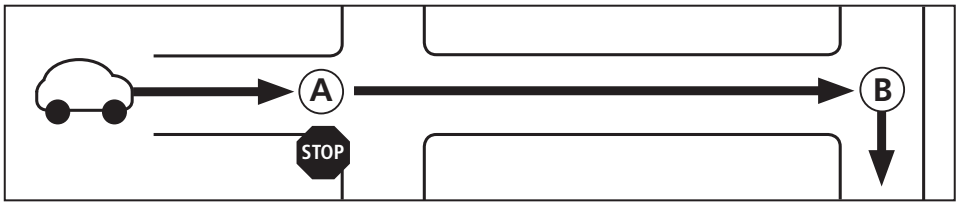
Ⓒ position

Ⓓ inertia

Write the answer.

13. What happens to an object when the net force acting on it is zero? What happens to that object when the net force is greater than zero? Explain.

14. Look at the diagram below. Does the car's velocity change at Point A or Point B? Explain your answer. Be sure to use the word *acceleration*.



15. What are three ways a force can change an object's motion?

Let's Review

(inside back cover)

Have students complete their K-W-L charts before answering these questions. Possible answers are shown.

1. **Cover Connection** (Students may mention the fact that a net force is needed to make an object accelerate. They may also point out that acceleration is any change in velocity, which is a measure of both speed and direction.)
2. (The forces of the kick, friction from the grass, and gravity act on the ball. These affect the distance the ball travels, its speed and velocity, and its acceleration.)
3. (18 kilometers per hour, north)
4. (Because the robot dog is running in a circle, it is constantly changing direction. An object accelerates if it slows down, stops, speeds up, or changes direction. The robot dog is accelerating even though it isn't speeding up, slowing down, or stopping.)
5. **Compare and Contrast** (Less force is needed to start the empty wheelbarrow moving and to keep it moving than to do the same things to the full wheelbarrow. This is because the empty wheelbarrow has less mass than the full wheelbarrow.)
6. **Write** (Newton's third law explains why a ball bounces. When the ball hits the floor, it pushes against the floor. This is the action force. The floor pushes back with an equal amount of force that is opposite in direction. This is the reaction force. The reaction force acts on the ball, pushing it back up off the ground.)

Try It! If students have difficulty, ask: *What force pushes the toy car forward?* (force from the movement of someone's hand) *What other force acts against this force?* (friction) *Which surface creates more friction?* (carpet or rug)

Science at Home Have students do this activity with a family member. They may be surprised at the number of velocity changes. Suggest that they think about where such changes almost always occur (near traffic lights, for example).

Answers to Test

(Teacher's Guide pages 6–7)

1. force **2.** friction **3.** gravity **4.** magnetic force **5.** position **6.** motion **7.** distance **8.** inertia **9.** B **10.** D **11.** A **12.** D **13.** If the net force is zero, the forces acting on it are equal and balanced so the object does not move. If the net force is greater than zero, then the force in one direction is greater than the force in the other direction, so the object moves in the direction of the greater force. **14.** The car's velocity changes at both points. Point A: The car slows and stops. Point B: The car changes direction and may also slow down again. These are both examples of changes in velocity, or acceleration. **15.** A force can make an object start moving, slow down, stop moving, speed up, or change direction.

ADDITIONAL ASSESSMENT OPPORTUNITIES Use the Checkpoints, Reflect on Reading, and Apply Science Concepts features and Let's Review questions as additional assessment opportunities.

Delta Science Content Readers are 24-page nonfiction student books with informative, engaging text and full-color photos and illustrations. The readers present key science content and vocabulary found on state tests, present key reading skills and strategies useful for reading informational text, support and extend the experiences and content of hands-on activities, promote scientific inquiry, and serve as a home-school link. **They are available in two editions: Red Edition for Grades 3–4 and Purple Edition for Grades 4–5.**

This teacher's guide is available online at
www.deltaeducation.com
1-800-442-5444

School Specialty Science

Delta Education

Forces and Motion
Teacher's Guide
1278145
2 3 4 5 6 7 8 QUE 13 12 11 10 09

ISBN: 978-1-60395-446-4
90000>
9 781603 954464