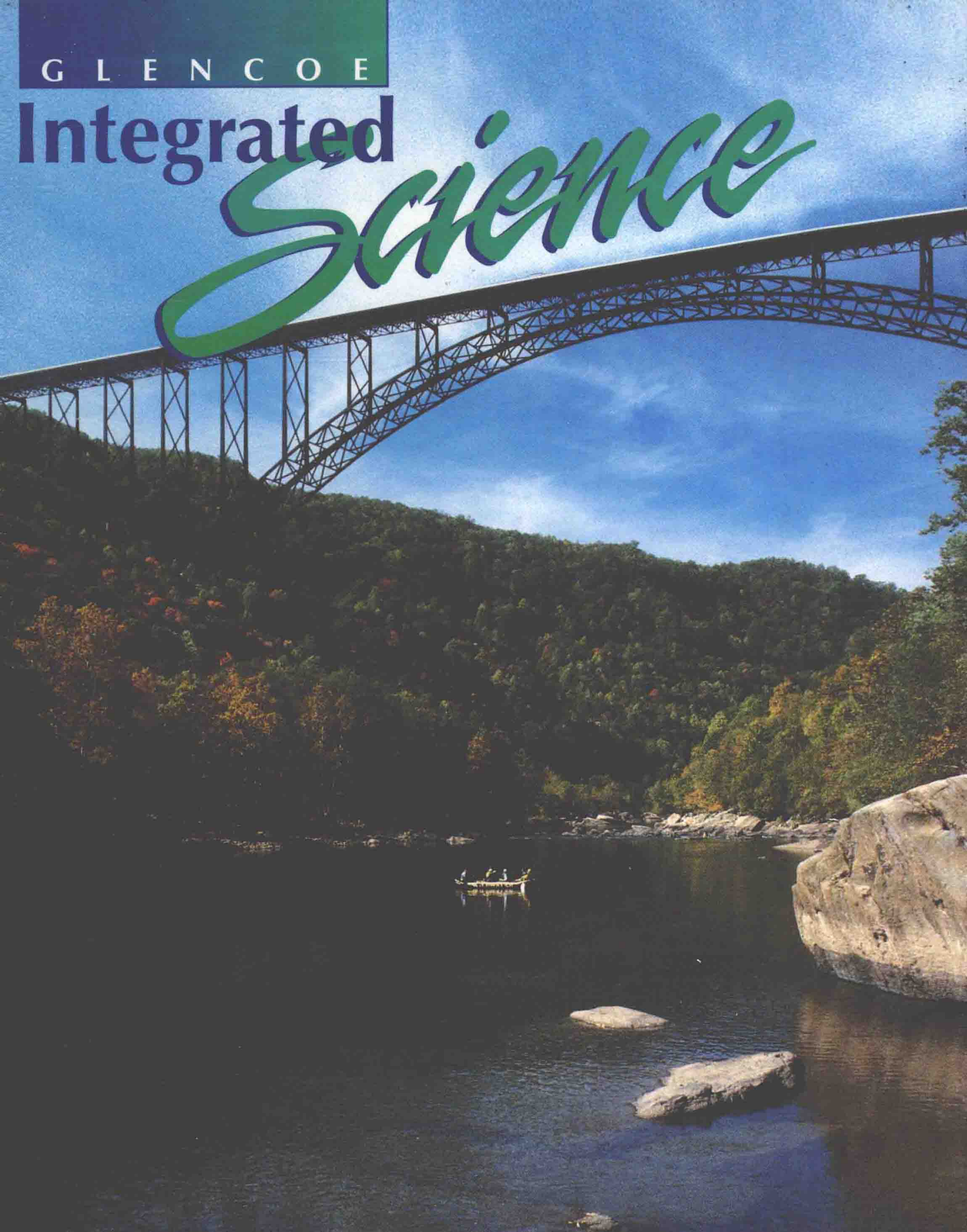
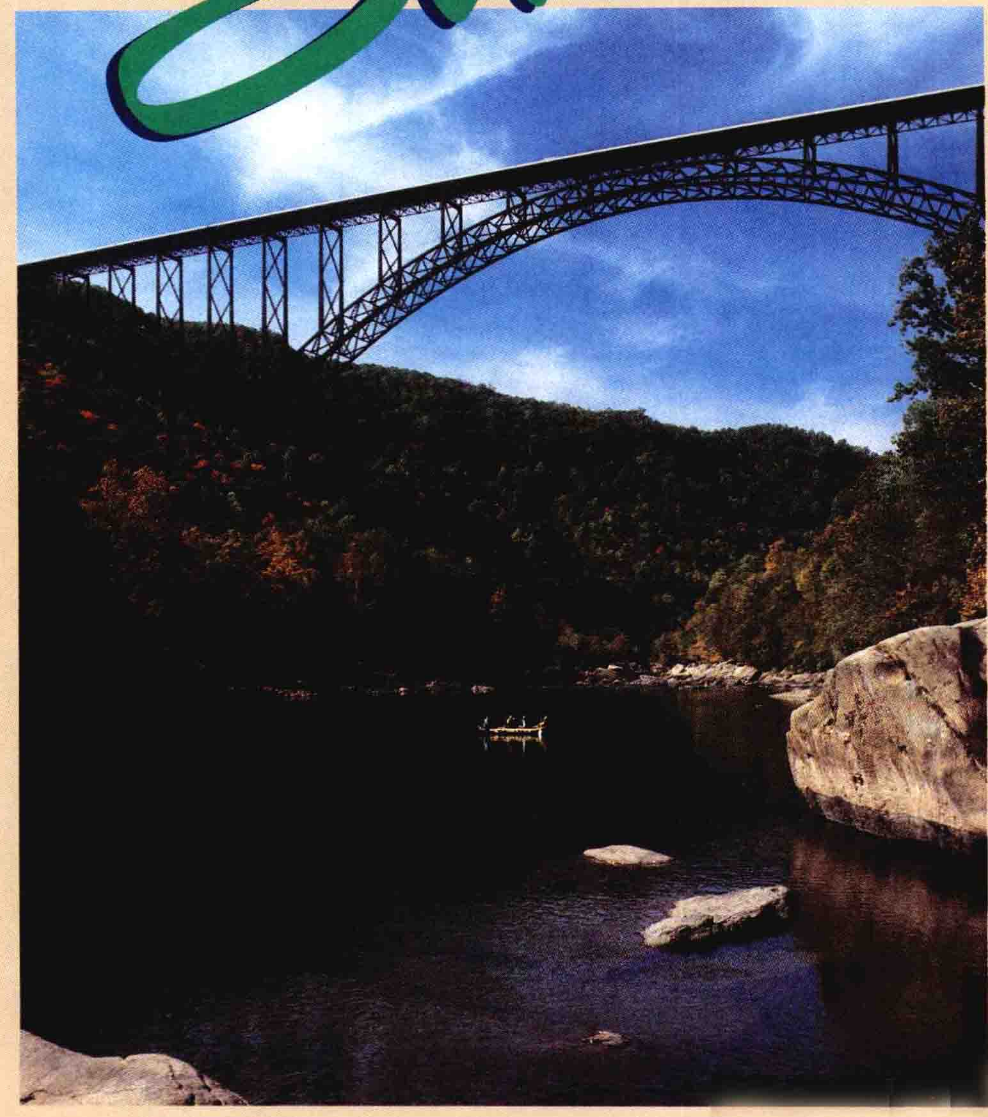
GLENCOE

Integrated Science



GLENCOE

Integrated Science



GLENCOE

Macmillan/McGraw-Hill

New York, New York   Columbus, Ohio   Mission Hills, California   Peoria, Illinois

A GLENCOE PROGRAM

GLENCOE INTEGRATED SCIENCE

Student Edition
Teacher Guide and Classroom Resources

Send all inquiries to:
Glencoe/McGraw-Hill
936 Eastwind Drive
Westerville, OH 43081

ISBN 0–02–827198–X

Printed in the United States of America.

2 3 4 5 6 7 8 9 VH/VH 01 00 99 98 97 96 95 94

AUTHORS

Ralph M. Feather, Jr. is a teacher of geology, astronomy, and earth science, and serves as Science Department Chair in the Derry Area School District, PA. He holds a B.S. in Geology and an M.Ed in Geoscience from the Indiana University of Pennsylvania, and is currently working on his Ph.D. at the University of Pittsburgh. Mr. Feather has more than 20 years of teaching experience in secondary science and has supervised student teachers for over 15 years. He is a past recipient of the Outstanding Earth Science Teacher Award from the National Association of Geology Teachers and the Keivin Burns Citation from the Spectroscopy Society of Pittsburgh. In 1989, Mr. Feather was nominated for Excellence in Science Teaching. He is also a member of the Geological Society of America, the National Science Teachers Association, the American Association for the Advancement of Science, and the Association for Supervision and Curriculum Development. Mr. Feather is an author for several lab manuals and textbooks related to the earth sciences.

Susan Leach Snyder is a teacher of earth science at Jones Middle School, Upper Arlington School District, Columbus, Ohio. She serves on the Board of Trustees of North American Astrophysical Observatory and has served on the Boards of Directors for state and national science organizations. Ms. Snyder received a B.S. in Comprehensive Science from Miami University, Oxford, Ohio, and an M.S. in Entomology from the University of Hawaii. She has 18 years of teaching experience and is author of various educational materials. Ms. Snyder, in addition to receiving Exemplary Earth Science and Career Awareness in Science Teaching Team awards from NSTA, was the 1987 Ohio Teacher of the Year, and one of four finalists for the 1987 National Teacher of the Year.

Dale T. Hesser currently serves as the Assistant Superintendent of Schools in North Syracuse, New York. A past recipient of the Outstanding Earth Science Teacher award from the National Association of Geology Teachers, Mr. Hesser received his B.S. in earth science from Buffalo State college, New York, and holds an M.S. and Certificate of Advanced Studies in Science Education from Syracuse University. He has over 20 years of classroom teaching experience in the earth sciences ranging from junior/senior high school through college astronomy, and numerous pre-service and in-service teacher training institutes. Mr. Hesser currently serves as an adjunct instructor for Syracuse University in Earth Science Teaching, and is co-author of a number of textbooks and publications related to the earth sciences.

Marilyn Thompson teaches physics, chemistry, and physical science at Center Senior High School in Kansas City, Missouri. Ms. Thompson holds a B.A. degree in chemistry with an emphasis in physics and education from Carleton College, Northfield, Minnesota. She is a member of the American Association of Physics Teachers and the National Science Teachers Association.

CONSULTANTS

Senior Consultant, Physics:
John D. McGervey
Professor of Physics
Case Western Reserve University
Cleveland, Ohio

Physics:
Patrick Hamill, Ph.D.
Professor of Physics
San Jose State University
San Jose, California

Oceanography, Environmental/Resources, Geology:
Dr. James B. Phipps
Professor of Geology and Oceanography
Grays Harbor College
Aberdeen, Washington

Earth History, Geology:
Dr. Allan A. Ekdale
Professor of Geology
University of Utah
Salt Lake City, Utah

Meteorology:
Eric Danielson
Associate Professor of Meteorology
Hartford College for Women
Hartford, Connecticut

Reading:
Barbara Pettegrew, Ph.D.
Director of Reading/Study Center
Assistant Professor of Education
Otterbein College
Westerville, Ohio

Safety:
Robert Tatz, Ph.D.
Instructional Lab Supervisor
Department of Chemistry
The Ohio State University
Columbus, Ohio

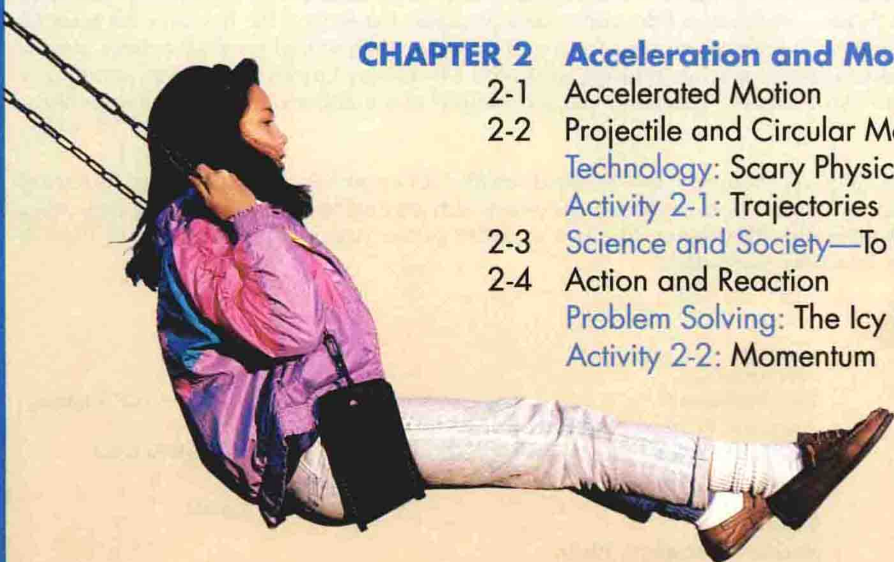
Special Features:
Stephen C. Blume
Presidential Award for Excellence in Science and Mathematics, 1990
St. Tammany Public School System
Slidell, Louisiana

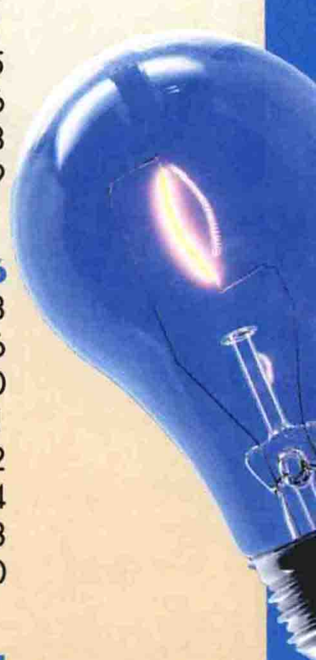
John R,. Grube
High School Science Coordinator (former)
Eastside Union High School District
San Jose, California

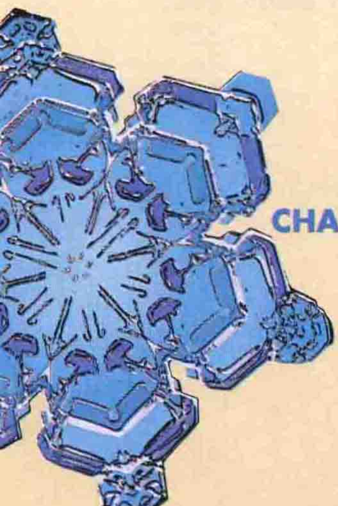
Gifted and Mainstreamed:
Barbara Murdock
Elementary Consultant For Instruction
Gahanna–Jefferson Public Schools
Gahanna, Ohio

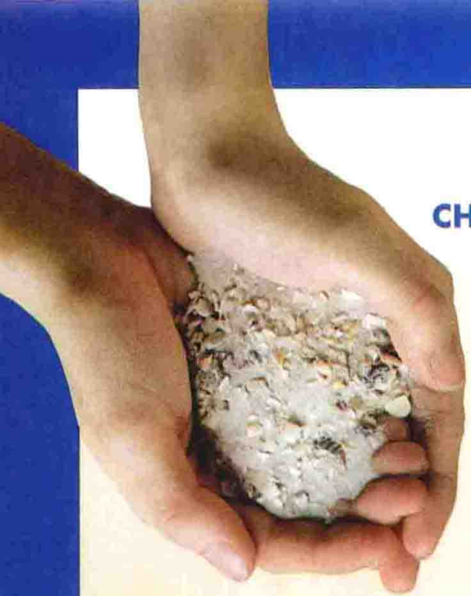
Judy Ratzenberger
Middle School Science Instructor
Gahanna Middle School West
Gahanna, Ohio

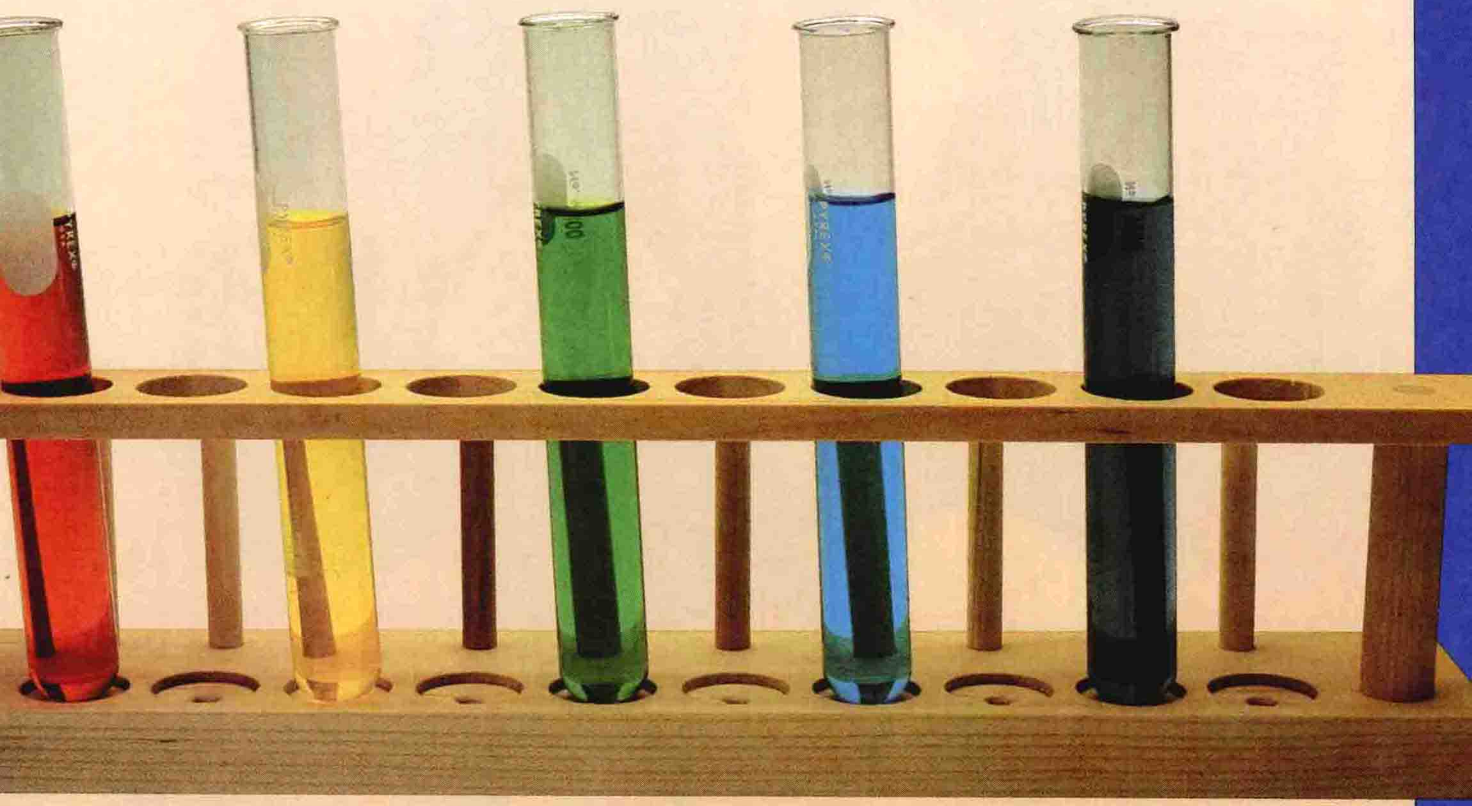
CONTENTS











CHAPTER

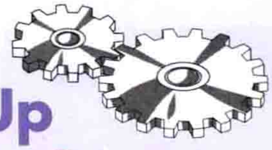
1 Moving Objects

Every day people and things move around you—cars go by, your classmates mill about in the halls, leaves blow in the wind. You know these things are moving because you see the motion. Now think about motion that you don't see. A magician makes an object seem to disappear by distracting the people in the audience so that they don't see where the object goes. If you don't see motion, how can you tell something has moved?

FIND OUT!

Do the following activity to find out if you can detect movement without seeing motion.

Close your eyes while a classmate moves something in the classroom. Now open your eyes and see if you can tell what was moved. Be aware of the clues you're using. Are you using only your eyes, or are other senses helping? If you figure out what was moved, can you tell how far it moved? How do you know?



Gearing Up

Previewing the Chapter

Use this outline to help you focus on important ideas in this chapter.

Section 1-1 Describing Motion
- Speed
- Calculating Speed
- Graphing Speed

Section 1-2 Velocity and Acceleration
- Velocity and Speed
- Acceleration

Section 1-3 Science and Society
Crashing to Save Lives
- Studying Crashes

Section 1-4 Force and Motion
- What Is a Force?
- Effects of Forces on Objects
- Inertia and Mass
- Newton's First Law
- Friction

Section 1-5 Effects of Gravity
- Gravitational Force
- Weight
- Measuring Forces

Previewing Science Skills

- In the **Skill Builders,** you will make a concept map, graph, outline, and observe and infer.
- In the **Activities,** you will observe, collect and organize data, and infer.
- In the **MINI-Labs,** you will observe and infer and make and use graphs.

What's next?

You can tell that something has moved without actually seeing the motion. Now you will learn about how and why things move and how different forces affect motion.

1-1 Describing Motion

New Science Words

speed
instantaneous speed
constant speed
average speed

Objectives

- Describe speed as a rate.
- Perform calculations involving speed, time, and distance.
- Interpret distance-time graphs.

Figure 1-1. Although the tuning fork does not move from one place to another, the prongs of the fork are in motion.

EcoTip

When you have to go somewhere, move your muscles. Walk, bike, or skate to the store or to a friend's house instead of riding in a car or bus. It's good for you and for the environment.

Speed

When something moves, it changes position. It travels from one place to another, if only for an instant. Look at the tuning fork. Its prongs are vibrating—they are moving. You may not be able to see their motion, but the sound they produce tells you they are moving. If asked to describe the motion of a tuning fork, you would probably say something like "back-and-forth." How would you describe the motion of a rubber ball bouncing along a sidewalk?

You don't always have to see something move to know that motion has taken place. For example, suppose you look out a window and see a mail truck parked next to a mailbox. One minute later, you look out again and see the same truck parked down the street from the mailbox. Although you didn't observe the motion, you know the truck moved. How do you know? Its position relative to the mailbox has changed.

Motion can be described as a change in position. To know if the position of something has changed, you need a reference point. In the case of the mail truck, the mailbox was a reference point. You can also use the reference point to get a rough idea of how far the truck moved. But there's one thing you don't know. You don't know how *fast* the truck moved in reaching its new position.

Descriptions of motion often include speed—how "fast" something moves. If you think of motion as a change in position, then speed is an expression of how much time it takes for that change in position to occur. Any change over time is called a rate. **Speed,** then, is the rate of change in position. Speed can also be described as simply a rate of motion.

There are different "kinds" of speed. The speedometer in a car shows instantaneous speed. **Instantaneous**

speed is the rate of motion at any given instant. At the moment the picture in Figure 1-2 was taken, the car was traveling at a speed of 80 km/h. On a highway, a car may travel at the same speed for a fairly long period of time. A speed that does not vary is called a **constant speed.**

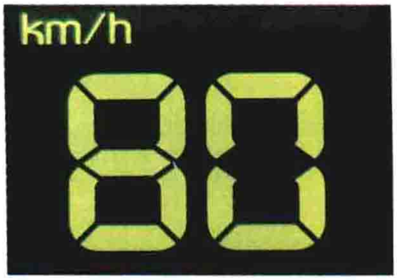


Figure 1-2. The speedometer of a car shows how fast the car is moving at any given instant.

Much of the time, the speeds you deal with are not constant. Think about riding your bicycle for a distance of 5 kilometers. As you start out, your speed increases from 0 km/h to, say, 30 km/h. You slow down to 18 km/h as you pedal up a steep hill and speed up to 45 km/h going down the other side of the hill. You stop for a red light, speed up again, and move at a constant speed for a while. As you near the end of the trip, you slow down and then stop. Checking your watch, you find that the trip took 15 minutes, or one-quarter of an hour. How would you express your speed on such a trip? Would you use your fastest speed, your slowest speed, or some speed in-between the two?

In cases where rate of motion varies a great deal, such as this bicycle trip, the best way to describe speed is to use average speed. **Average speed** is total distance traveled divided by total time of travel. On the trip just described, your average speed was 5 kilometers divided by 1/4 hour, or 20 km/h.

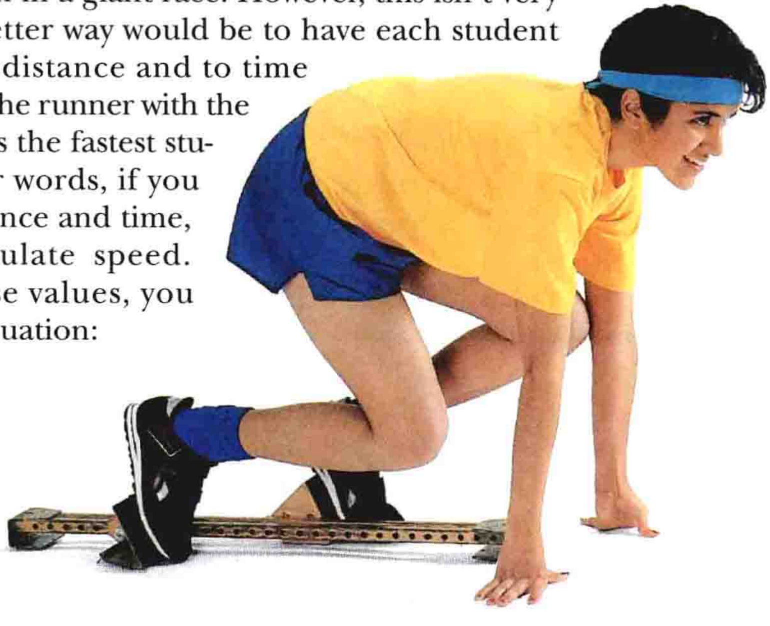
Did You Know?

In the finals of the 100-m dash of the 1988 Olympics, Ben Johnson and Carl Lewis each reached a peak speed of 43.37 km/h during one 10-m stretch.

Calculating Speed

How could you find out who is the fastest runner in your school? One way would be to get all the students together to run in a giant race. However, this isn't very practical. A better way would be to have each student run a certain distance and to time each runner. The runner with the shortest time is the fastest student. In other words, if you know the distance and time, you can calculate speed. Knowing these values, you can use this equation:

$$v = \frac{d}{t}$$



EXAMPLE PROBLEM: Calculating Speed

Problem Statement: Your neighbor says she can skate at a speed of 1 m/s. To see if you can skate faster, you have her time you as you skate as fast as you can for 100 m. Your time is 67 s. Who skates faster?

Known Information:
distance, $d = 100$ m
time, $t = 67$ s

Strategy Hint: Remember that speed is a rate.

Unknown Information: speed, v

Equation to Use: $v = \frac{d}{t}$

Solution: $v = \frac{100 \text{ m}}{67 \text{ s}} = 1.5 \text{ m/s}$

You skate faster than your neighbor.

PRACTICE PROBLEM

Strategy Hint: What units will your answer be given in?

1. Florence Griffith Joyner set a world record by running 200 m in 21.34 s. What was her speed?

EXAMPLE PROBLEM: Calculating Time from Speed

Problem Statement: Sound travels at a speed of 330 m/s. If a firecracker explodes 3630 m away from you, how long does it take for the sound of the explosion to reach you?

Known Information:
velocity, v = 330 m/s
distance, d = 3630 m

Strategy Hint: Rearrange equation to solve for time.

Unknown Information: time, t

Equation to Use: $v = \frac{d}{t}$ Rearranged becomes: $t = \frac{d}{v}$

Solution: $t = \frac{d}{v} = \frac{3630 \text{ m}}{330 \text{ m/s}} = 11 \text{ s}$

It takes 11 seconds for the sound of the explosion to reach you.

PRACTICE PROBLEM

Strategy Hint: Rearrange the equation.

1. The world's fastest passenger elevator operates at a speed of about 10 m/s. If the 60th floor is 219 m above the first floor, how long does it take the elevator to go from the first floor to the 60th floor?

Graphing Speed

A distance-time graph makes it possible to "see" the motion of an object over a period of time. For example, the graphs in Figure 1-3 show how two swimmers performed during a 30-minute workout. The smooth, red line represents the motion of a swimmer who swam at a constant speed during the entire workout. She swam 800 m during each 10-minute period. Her speed was constant at 80 m/min.

The blue line represents the motion of a second swimmer, who did not swim at a constant speed. She covered 400 m during the first 10 minutes of her workout. Then she rested for the next 10 minutes. During this time, her speed was 0 m/min. The steepness of the graph over the next 10 minutes shows that she swam faster than before. During this period she covered 800 m. How much distance did she cover during the workout? What was her average speed for the 30-minute period?

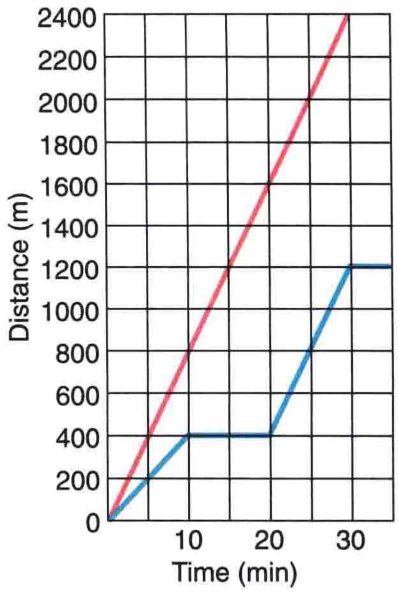


Figure 1-3. Distance-time graphs like the one shown here make it possible to visualize motion over a period of time.

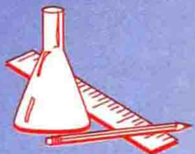
SECTION REVIEW

1. What units would you use to describe the speed of a car? Would you use different units to give the speeds of runners in a neighborhood race? Explain your answer.
2. In a skateboarding marathon, the winner covered 435 km in 36.75 h. What was the winner's average speed?
3. **Apply:** Make a graph of distance versus time for a 2-hour car trip. During the first 30 minutes the car covered 50 km. During the next 30 minutes the car was stopped. An additional 50 km was covered during the final 60 minutes of the trip. Note the three graph segments. Which graph segment slopes the most? Which one does not slope? What was the car's average speed?

Concept Mapping

Skill Builder

Make a network tree concept map that shows and defines the three kinds of speed described in this section. If you need help, refer to Concept Mapping in the **Skill Handbook** on pages 267 and 268.



ACTIVITY 1-1
Measuring Speed

Problem: *How slow can you make a glider fly?*

Materials

- stopwatch or timer with second hand
- metric tape measure or meterstick
- string
- paper sheets of various types, weights, and sizes
- transparent tape
- paper clips and stapler

Procedure

1. Design a paper glider. Construct your glider using the materials provided.
2. Test fly the glider following all rules that have been established by the class.
3. Measure the distance of flight in centimeters and time of flight in seconds. Record this data in a table like the one shown here.
4. Calculate the speed of the glider.
5. Make any adjustments in the glider to achieve the slowest possible speed. If necessary, redesign the glider.
6. Repeat Steps 2, 3, and 4.
7. When you are satisfied with your design, fly the glider, record the measurements, and calculate the speed. Compare your results with those of other teams.

Data and Observations

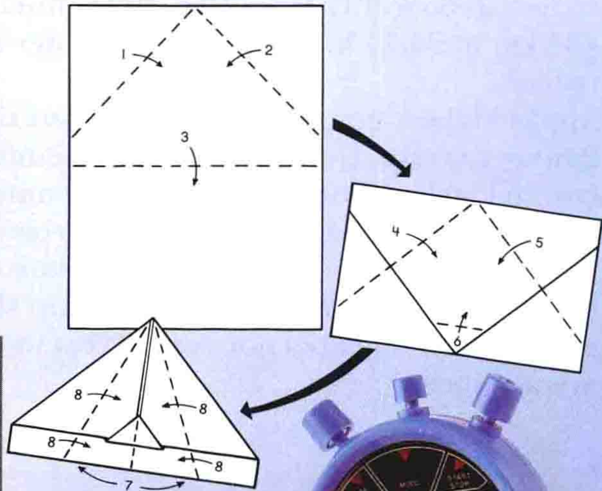
	Distance (cm)	Time (s)	Speed (cm/s)
Test 1			
Test 2			
Final			

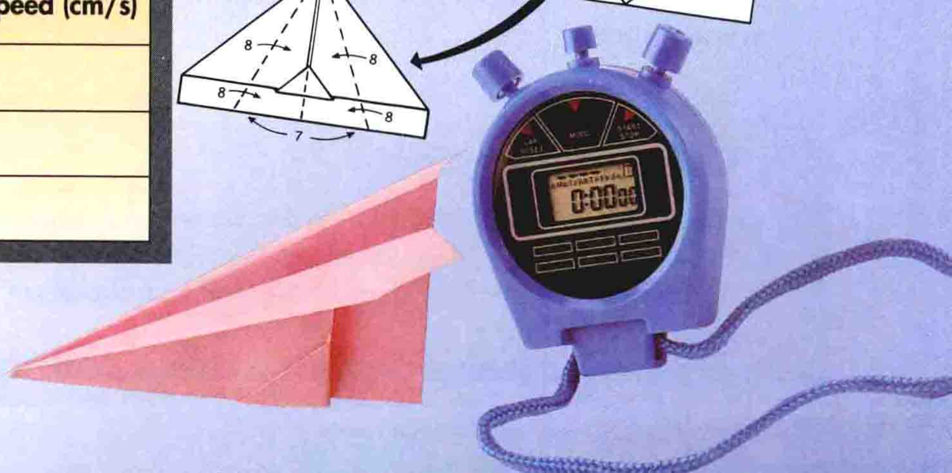
Analyze

1. If your glider travels a curved path, which distance measurement will give the slowest speed calculation—along the curved path or along a straight line between the starting point and landing point? Explain your reasoning.
2. Which is more important in glider speed—how hard you throw the glider or the design of the glider?

Conclude and Apply

3. When calculating the speed of your glider, did you find its fastest speed, slowest speed, or average speed?
4. In designing a slow glider, which should you try for, long distance or long time?
5. What factors affected the flight of your glider? Which of these factors were you able to control or influence, and by what means?





Velocity and Acceleration

1-2

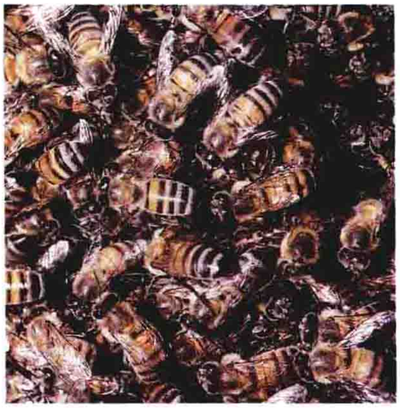
Objectives

- **Compare and contrast speed, velocity, and acceleration.**
- **Calculate acceleration.**

New Science Words

velocity
acceleration

Velocity and Speed



You turn on the radio and hear the tail-end of a news story about a swarm of killer bees. The swarm, moving at a speed of 60 km/h, has just left a town 60 kilometers north of your location. Should you be worried? What should you do? Unfortunately, you don't have enough information. Knowing the speed of the swarm isn't much help. Speed only describes how fast something is moving. You also need to know the direction the swarm is moving. In other words, you need to know the velocity of the swarm. **Velocity** describes both speed and direction.

Picture a motorcycle racing down the highway at 100 km/h. It passes another motorcycle going 100 km/h in the opposite direction. The speeds of the motorcycles are the same, but their velocities are different because the motorcycles are not moving in the same direction.

You learned earlier that speed isn't always constant. Like speed, velocity may also change. Unlike speed, the velocity of an object can change, even if the speed of the object remains constant! How can this be? Read on and you'll find out.

Acceleration

At the starting line of a drag strip, a driver sits, idling the dragster's engine. With the starting signal, the driver presses the gas pedal to the floor. The car leaps forward and builds up speed, moving faster and faster until it crosses the finish line. Then the driver releases a drag chute, and the car rapidly slows down and comes to a stop. All the while the car gains speed, it is accelerating. Strange as it may seem, the car is also accelerating as it slows down! How is this possible?

Acceleration is the rate of change of velocity. Keep in mind that velocity includes both speed and direction. If the direction of motion stays the same, as with the dragster, then acceleration is just the rate of change in speed. Because "slowing down" is a change in speed, the dragster is accelerating as it slows down. If the acceleration is opposite in direction to the velocity, then the speed decreases.

MINI-Lab

Does greater velocity require greater acceleration?

Make a ramp by propping a board on a textbook. Let a marble roll down the ramp and across a hard, flat surface. Make two time measurements: travel time of the marble down the ramp and travel time of the marble across the flat surface for a distance of 1 m from the bottom of the ramp. Calculate the marble's velocity across the flat surface. Change the starting point of the marble on the ramp and repeat the procedure. Does acceleration change? Does velocity change?

Because velocity includes both speed and direction, if *either* value changes, velocity will change. For example, if a car goes around a curve, its direction changes. So even if its speed remains constant, the velocity of the car changes. In other words, acceleration occurs.

The size of an acceleration depends on both the change in velocity and the time interval. The *time interval* is the amount of time that passed while the change in velocity was taking place. If the change in velocity is large, the acceleration will be large. Acceleration will also be large if the change in velocity occurs in a small time interval.

To calculate acceleration, divide the change in velocity by the time interval. To find the *change in velocity,* subtract the initial velocity (starting velocity) from the final velocity.

$$a = \frac{v_f - v_i}{t} = \frac{\Delta v}{t}$$

The symbol Δ is the Greek letter *delta* and stands for "change in."

When an object is slowing down, its final velocity will be less than its initial velocity. Thus, the acceleration will have a negative value. When calculating acceleration, be sure to include all proper units and algebraic signs. The unit for velocity is meters/second (m/s) and the unit for time is seconds (s). Thus, the unit for acceleration is

$$\frac{\text{meters/second}}{\text{second}}.$$

This unit is usually written as m/s^2 and is read as "meters per second square" or "meters per second per second."