Fifth Edition

SCIENCE

5

bju press
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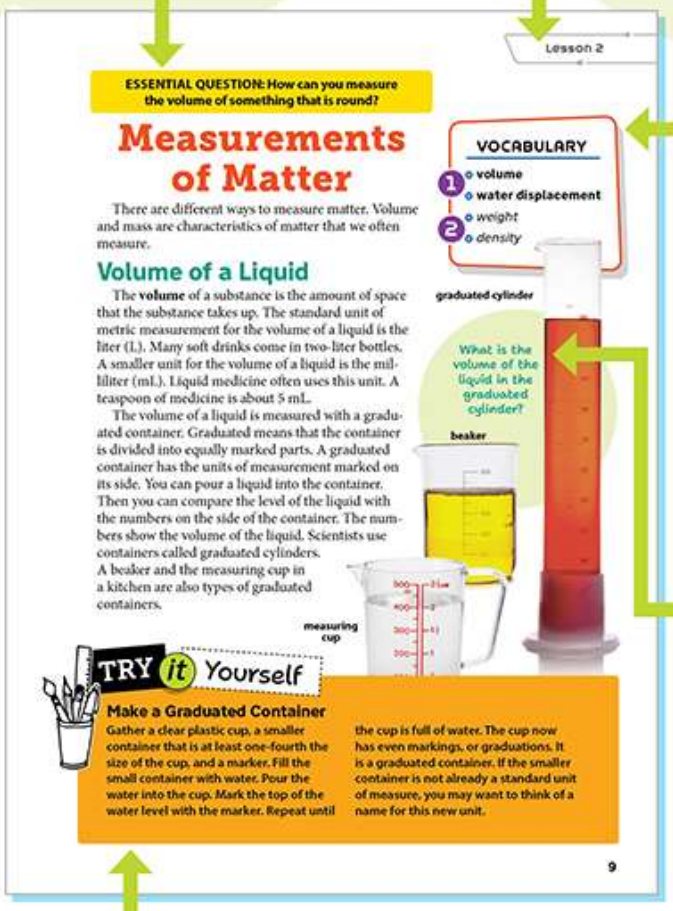
USING YOUR BOOK

Essential Questions
the "big questions" that you will find the answer to in each lesson

Lesson Numbers
identify the start of each new lesson



Lesson 2

ESSENTIAL QUESTION: How can you measure the volume of something that is round?

Measurements of Matter

There are different ways to measure matter. Volume and mass are characteristics of matter that we often measure.

Volume of a Liquid

The **volume** of a substance is the amount of space that the substance takes up. The standard unit of metric measurement for the volume of a liquid is the liter (L). Many soft drinks come in two-liter bottles. A smaller unit for the volume of a liquid is the milliliter (mL). Liquid medicine often uses this unit. A teaspoon of medicine is about 5 mL.

The volume of a liquid is measured with a graduated container. Graduated means that the container is divided into equally marked parts. A graduated container has the units of measurement marked on its side. You can pour a liquid into the container. Then you can compare the level of the liquid with the numbers on the side of the container. The numbers show the volume of the liquid. Scientists use containers called graduated cylinders. A beaker and the measuring cup in a kitchen are also types of graduated containers.

VOCABULARY
1. volume
1. water displacement
2. *weight*
2. *density*

graduated cylinder

What is the volume of the liquid in the graduated cylinder?

beaker

measuring cup

TRY it Yourself

Make a Graduated Container

Gather a clear plastic cup, a smaller container that is at least one-fourth the size of the cup, and a marker. Fill the small container with water. Pour the water into the cup. Mark the top of the water level with the marker. Repeat until the cup is full of water. The cup now has even markings, or graduations. It is a graduated container. If the smaller container is not already a standard unit of measure, you may want to think of a name for this new unit.

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Vocabulary
lists vocabulary terms for the lesson

1 **Boldface Terms**
vocabulary terms that you will need to know

2 **Italicized Terms**
other important science terms

Captions
identify pictures or ask questions about pictures, diagrams, or infographics

Interest Boxes
provide extra information or hands-on activities related to a person or topic

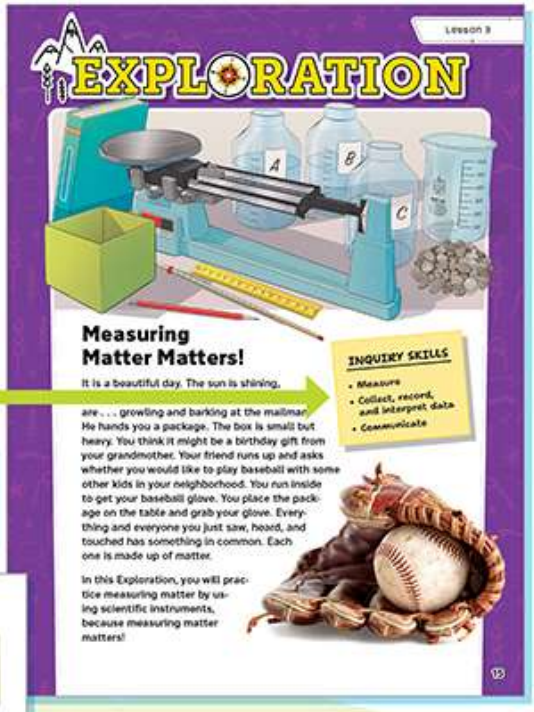
Investigation, Inquiry, Exploration, and STEM Pages introduce the hands-on activities by providing helpful background information

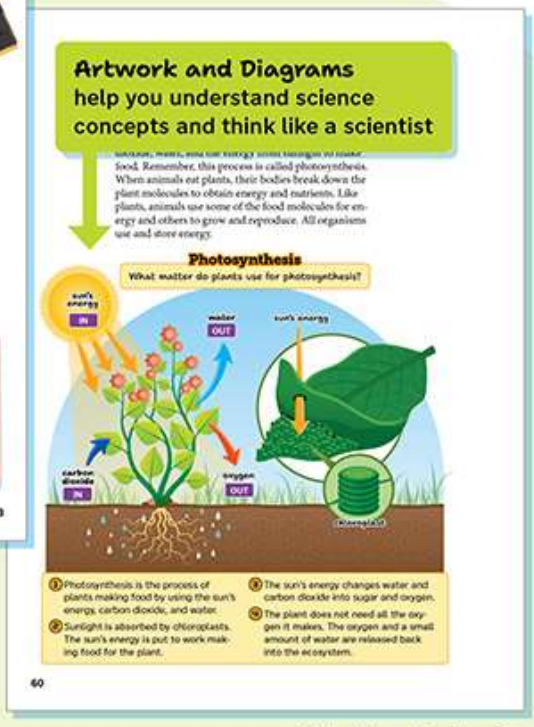
Inquiry Skills science skills emphasized in the Investigation, Inquiry, or Exploration activities

STEM Career Pages introduce different STEM careers that you may want to explore

Artwork and Diagrams help you understand science concepts and think like a scientist

Quick Checks review the lesson with questions to give you practice applying what you have learned





About Matter

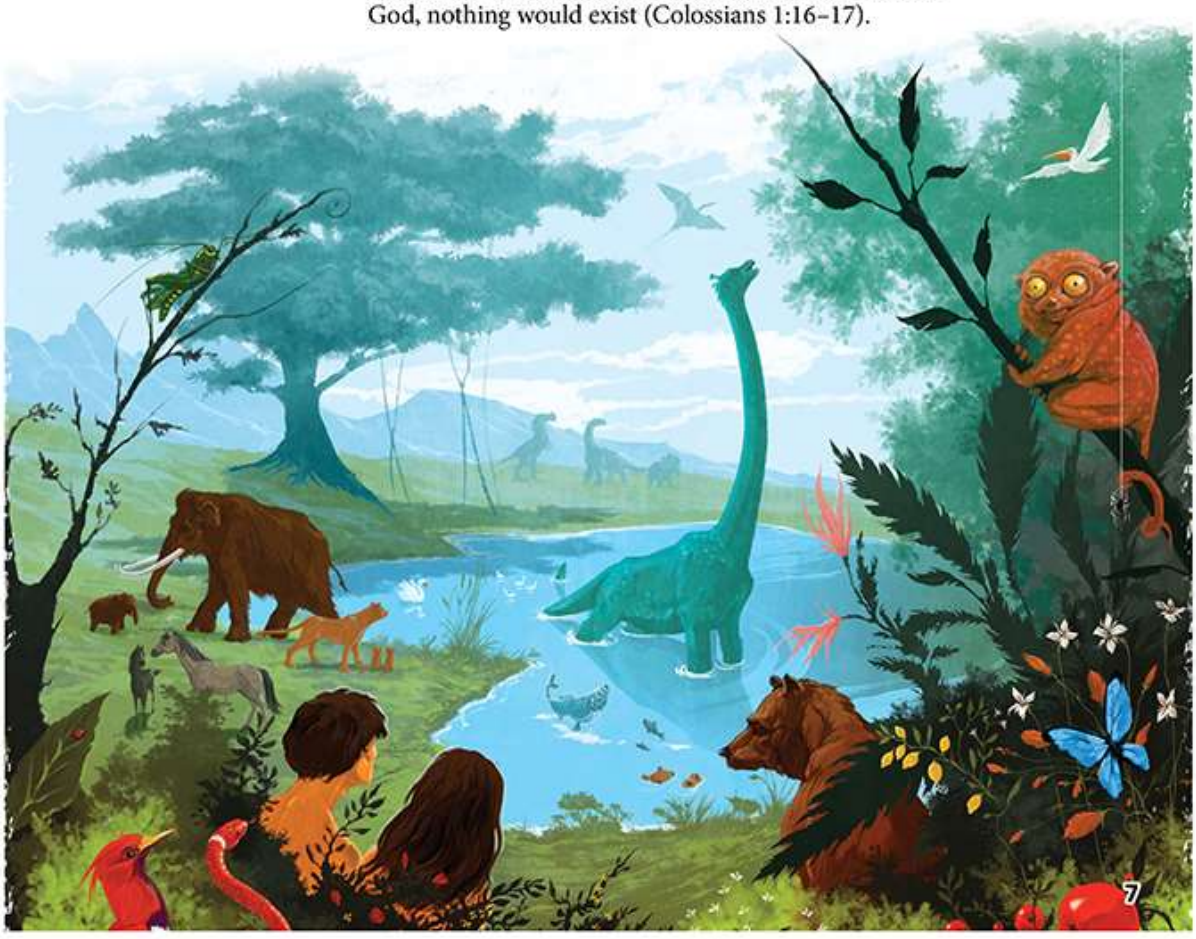
Your neighbor broke her ankle recently. Wanting to be helpful, you and your family have been doing yard work and running errands for her. Today you decided to encourage your neighbor by making her brownies. You need to melt some chocolate for the frosting.

How will you melt the chocolate? You will need different kinds of matter to help you with this task. You will need bits of chocolate, a pan to hold the chocolate, and a spatula to stir it. You will also need a stove to heat the pan that is holding the chocolate bits. But what if all kinds of matter melted at the same temperature? How would that change things for you? The pan, spatula, and chocolate would all melt at the same time. This type of problem would be unending. Learning about matter and how it works is important so that you will know how to use matter to serve others.

Origin of Matter

Biblical Worldview

A *worldview* is the way a person thinks about and understands the world. It comes from the story a person believes, and it guides how a person lives. A **biblical worldview** is a worldview that comes from the belief that the story of the Bible is true. The Bible shapes the way a person with a biblical worldview thinks, believes, and lives. People with a biblical worldview believe God created all matter a few thousand years ago. Creation is recorded in Genesis 1 and 2. God created the matter that makes up all living and nonliving things. He created the matter that makes up plants and animals and people. He created the matter that makes up air, water, and rocks. The Bible tells us that without God, nothing would exist (Colossians 1:16–17).



Naturalistic Worldview

A **naturalistic worldview** is a worldview that comes from the belief that Earth and space came into existence by natural processes. People with a naturalistic worldview believe that nature is all there is. The Bible does not shape the way they think, believe, or live. They think natural processes can explain everything because they do not believe in God. They believe the origin of the earth and space is the result of these natural processes. Most naturalists believe the matter you see is the result of an event called the big bang. They think the **big bang** happened about 14 billion years ago and was the start of everything in the universe. All the matter in the universe was condensed into one tiny point. The matter then rapidly expanded. A naturalist cannot explain where the original matter came from. This view of the origin of matter does not agree with what God says in the Bible.

> "The Creator did not need matter, large amounts of time, energy, or anything else. He created out of nothing in six literal normal-length days. . . ."
> —Answers in Genesis, "Creation"

1. How are matter and mass related?
2. Why is it good to know how matter works?
3. According to the biblical worldview, what is the origin of all matter?
4. According to the naturalistic worldview, what is the origin of all matter?

ESSENTIAL QUESTION: How can you measure the volume of something that is round?

Measurements of Matter

There are different ways to measure matter. Volume and mass are characteristics of matter that we often measure.

VOCABULARY

- **volume**
- **water displacement**
- *weight*
- *density*

Volume of a Liquid

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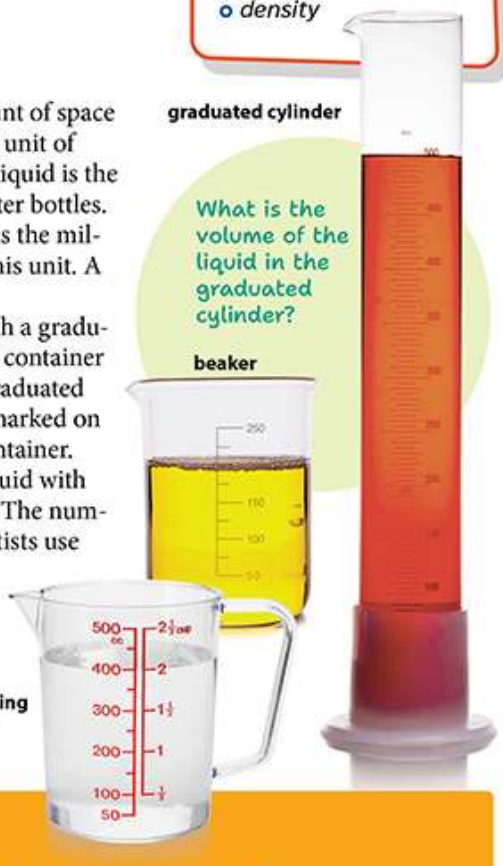

TRY it Yourself

Make a Graduated Container

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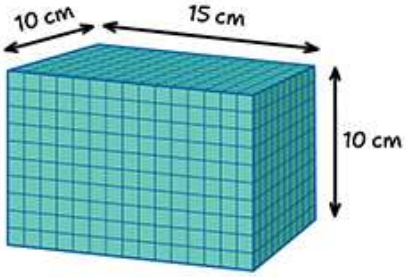
Volume of a Solid

There are two ways to measure the volume of solid objects. The volume of solid objects that have regular shapes is measured differently from the volume of solid objects that have unusual shapes.

Regular Shapes



A ruler is used to measure the volume of regular shapes, such as cubes and rectangular solids. The measurements of the length, width, and height of the object are multiplied. The volume is written as a cubic measurement. An object that is 15 centimeters (cm) long, 10 cm wide, and 10 cm high has a volume of 1,500 cubic centimeters. A cubic centimeter is written as cm^3.

length × width × height = volume

15 cm × 10 cm × 10 cm = 1,500 cubic centimeters

SCIENCE and HISTORY

Measuring in Meters

Down through history, people have used different units to measure length or distance. The cubit was an ancient unit of measurement. It used the human body. It was the length of the arm from the elbow to the fingertips. A cubit was not always the same length. People needed a unit that would be the same for everyone. In the 1790s the French government officially adopted the metric system.

The basic unit of length in the metric system is the meter. The name *meter* comes from a Greek word meaning "to measure." The meter is based on a decimal system. The first meter was equal to 1/10,000,000 of the distance from the North Pole to the Equator. A metal bar was designed in the 1870s. It was delivered around the world as the standard unit of length for a meter. A new distance was used as the measure of a meter in 1983. The length of a meter is now the distance that light travels in a vacuum in a fraction of a second—1/299,792,458 of a second, to be exact!

SCIENCE and TECHNOLOGY

What Is Technology?

Technology is something that people have designed and use. It is any item such as a tool, an instrument, or a piece of equipment or machinery. The item may be as simple as a paper clip. It may be as complex as a computer program. Technology applies scientific principles to solve problems and help people. Many inventions copy and use God's designs in nature.

Unusual Shapes

You cannot always measure a solid object by using its length, width, and height. For example, it would be hard to measure a rock or a marble in this way. The volume of a sphere or an unusually shaped object can be measured by using a method called **water displacement**.

You can see water displacement when you add marbles to the water in a graduated cylinder. The volume of the marbles is the difference between the level of the water after the marbles are added and the beginning level of the water. The volume can be written in milliliters or liters. For example, suppose a cylinder contains 250 mL of water. After the marbles are added, the level of the water is at 300 mL. The volume of the marbles is then 50 mL.

300 mL – 250 mL = 50 mL

In the metric system, one cubic centimeter is equal to one milliliter. Scientists usually use milliliters to describe the volume of a liquid. They use cubic centimeters to describe the volume of a solid. So the volume of the marbles in the example is also equal to 50 cubic centimeters.

Mass and Weight

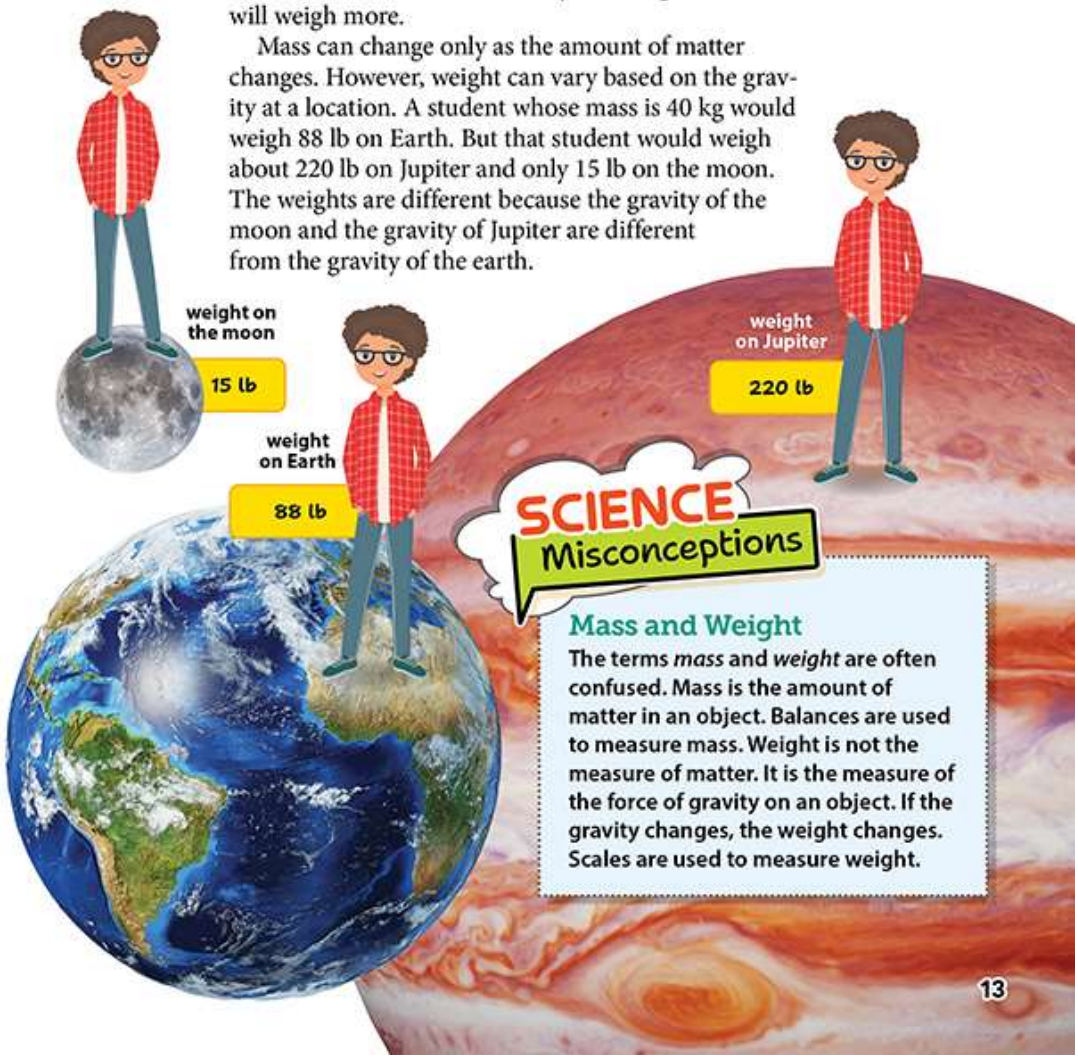
Mass is another way that matter is measured. It is usually measured by comparing an unknown mass with a known mass. This known mass is also called a standard mass, or a counterweight. For example, a student with an unknown mass can sit on one end of a seesaw. Matter with a known mass, such as a 32 kg sack of sand, can be placed on the other end. If the seesaw balances, then the mass of the student is the same as the mass of the sand.

Mass is measured with an instrument called a balance. Some metric units of mass are the gram (g) and the kilogram (kg). The mass of a paper clip is about 1 g. A one-liter bottle of water has a mass of about 1 kg. To measure the unknown mass of a bottle of water, you would place the bottle on a balance. You would use standard masses, or counterweights of known masses, to balance the unknown mass of the bottle. The mass of the bottle is equal to the sum, or total amount, of the counterweights.

It is usually easy to determine which of two objects has the greater mass. A large dog has more matter than a small cat does and therefore has more mass. The dog also weighs more than the cat. But the dog's mass and the dog's weight are not actually the same.

Mass and weight are related. But mass and weight measure different things. Remember that mass measures the amount of matter. *Weight* measures the force of gravity on the matter in an object. Weight is measured with a scale. If you measure two items at the same location on a scale, the object with greater mass will weigh more.

Mass can change only as the amount of matter changes. However, weight can vary based on the gravity at a location. A student whose mass is 40 kg would weigh 88 lb on Earth. But that student would weigh about 220 lb on Jupiter and only 15 lb on the moon. The weights are different because the gravity of the moon and the gravity of Jupiter are different from the gravity of the earth.



SCIENCE Misconceptions

Mass and Weight

The terms *mass* and *weight* are often confused. Mass is the amount of matter in an object. Balances are used to measure mass. Weight is not the measure of matter. It is the measure of the force of gravity on an object. If the gravity changes, the weight changes. Scales are used to measure weight.

Density

Density is the mass of an object in a certain volume, or space. Suppose you are given the task of carrying one of two boxes in a race. The two boxes are the same size and look the same on the outside. However, one box is filled with feathers. The other box is filled with rocks. You would probably choose the box with the feathers inside. The two boxes have the same volume, but the box with feathers has less mass than the box with rocks. This difference in mass makes the box of feathers less dense than the box of rocks.

Creation CORNER

Density of Ice

Most substances have a greater density in a solid form than in a liquid form. One exception is water. During the winter, ice floats on top of lakes and rivers instead of sinking. If the ice sank, it would displace the liquid water. The water on top would continue to freeze and sink. All the living things in the water would die. However, God designed ice, or frozen water, to be less dense than liquid water. In this way, He provided a top layer to preserve the life under the ice in the winter.

1. What is volume?
2. How is the volume of a liquid measured?
3. What scientific instrument is used to measure the volume of a regularly shaped solid like a cube?
4. What is density?

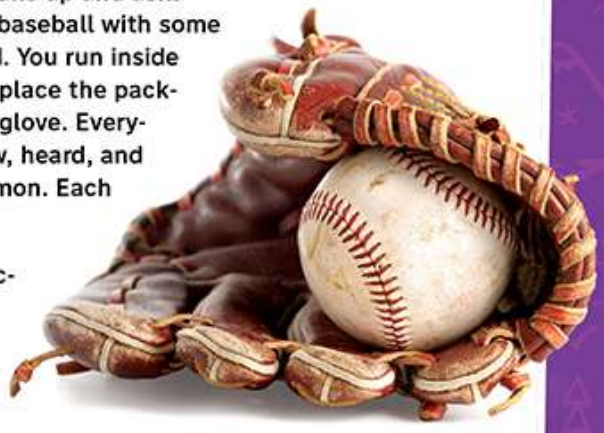
EXPLORATION

Measuring Matter Matters!

INQUIRY SKILLS

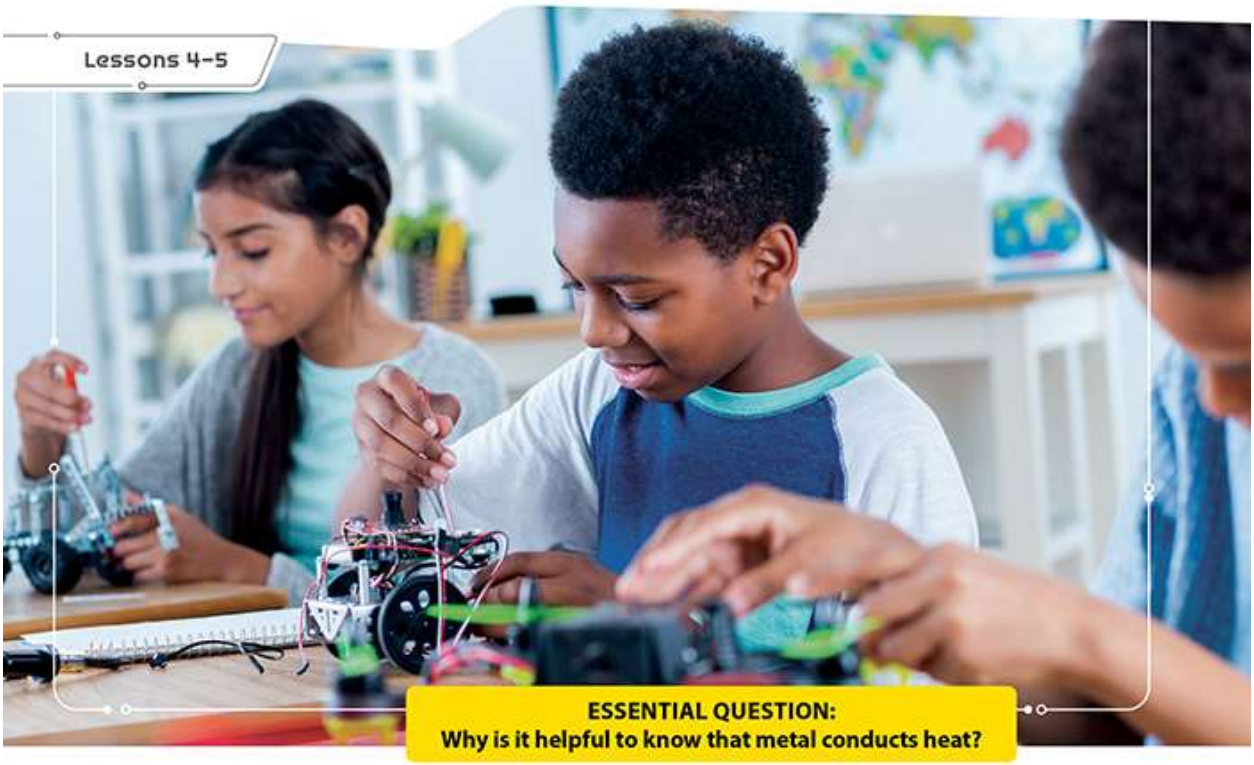
- Measure
- Collect, record, and interpret data
- Communicate

It is a beautiful day. The sun is shining, the flowers are blooming, and the dogs are . . . growling and barking at the mailman! He hands you a package. The box is small but heavy. You think it might be a birthday gift from your grandmother. Your friend runs up and asks whether you would like to play baseball with some other kids in your neighborhood. You run inside to get your baseball glove. You place the package on the table and grab your glove. Everything and everyone you just saw, heard, and touched has something in common. Each one is made up of matter.



In this Exploration, you will practice measuring matter by using scientific instruments, because measuring matter matters!

Lessons 4–5



ESSENTIAL QUESTION:
Why is it helpful to know that metal conducts heat?

Classification of Matter

VOCABULARY

- **atom**
- **element**
- **molecule**
- **compound**
- **physical property**
- *texture*
- *reflectivity*
- *flexibility*
- *conductivity*
- **solid**
- **liquid**
- **gas**
- **materials engineer**

Atoms and Elements

All matter is made up of tiny particles called atoms. An **atom** is the smallest particle of any substance. Atoms are much too small for you to see. Carbon, hydrogen, and iron are examples of atoms. Most matter contains more than one kind of atom. The paper used to make a book is made up of different kinds of atoms. Your chair is made up of a variety of atoms. Even you are made up of dozens of different kinds of atoms.

one atom of hydrogen

Some matter is made up of only one kind of atom. This type of matter is called an **element**. Gold, silver, iron, and oxygen are all elements. Scientists have named more than 100 different elements.