PART 1 Characteristic Properties of Matter

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LESSON 1

Our Ideas About Matter

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Matter is everywhere on Earth. What type of matter is moving these trees?

INTRODUCTION

What is the meaning of the term "matter"? In this lesson, you will discuss the different meanings of this word and how it is used in science. You will also do a circuit of eight inquiries on the properties of matter. These inquiries are designed to get you thinking about what matter is, what its properties are, and how it behaves. The observations you make and ideas you discuss in this lesson will play a key role in the inquiries that take place later in this module.

OBJECTIVES FOR THIS LESSON

Discuss your definitions of the term "matter."

Observe some properties of matter.

Use your own words and ideas to explain these properties.

Getting Started

1. Your teacher will place you in groups of four. What does your group think the word "matter" means? Write all the definitions you can think of on the student sheet.

2. After you have written down your definitions, your teacher will conduct a brainstorming session.

3. In this lesson, you will investigate different properties of matter. Working with another student, you will complete eight inquiries. In each inquiry, you will observe one or more properties of matter. Each pair of students will start at a different inquiry station. Your teacher will tell you at which station to begin.

4. Each inquiry has instructions you need to follow and questions you should try to answer. The procedure for each inquiry follows (see pages 4–7). It is also printed on a card placed at each station. When you make observations or think you can explain what you are observing, you should discuss these ideas with your partner. Remember: Exchanging ideas with others is a very important part of science.

5. In your own words, you will write observations, explanations, and ideas on Student Sheet 1.1.

MATERIALS FOR LESSON 1

For you

- 1 copy of Student Sheet 1.1: Our Ideas About Matter
- 1 pair of safety goggles

6. When you have completed each inquiry, put the apparatus back as you found it at the beginning of the experiment.

7. You will have only 7 minutes to do each inquiry. When your teacher calls time, you must immediately go to the next experiment in the circuit. For example, if you are at Inquiry 1.3, move to 1.4, or if you are at Inquiry 1.8A, move to 1.1A.

SAFETY TIPS

Wear your safety goggles throughout the lesson.

The purple substance in Inquiry 1.4 can stain clothing and hands; use forceps when handling this substance.

If you are allergic to latex, notify your teacher.

Inquiry 1.1
The Bottle and the Balloon

PROCEDURE

1. Hold the bottle with the balloon attached to the top in the hot pot of hot water for 2 minutes (see Figure 1.1). Answer the following question on your student sheet: What happened when you placed the bottle in the pot of hot water?

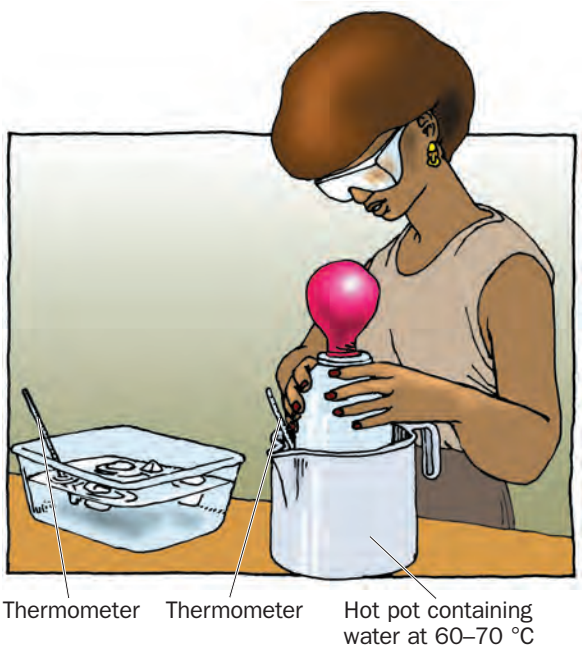


Figure 1.1 *Place the bottle in the hot pot of hot water and hold it there for 2 minutes.*

2. Hold the bottle in the ice water for 1 minute. (If the ice has melted, you may need to add more.) Answer the following question on the student sheet: What happened when you placed the bottle in the ice water?

3. Explain your observations on the student sheet.

Inquiry 1.2
Similar Objects

PROCEDURE

1. Put exactly 50 milliliters (mL) of water into the graduated cylinder (see Figure 1.2). Record the volume of water in Table 1 on the student sheet.

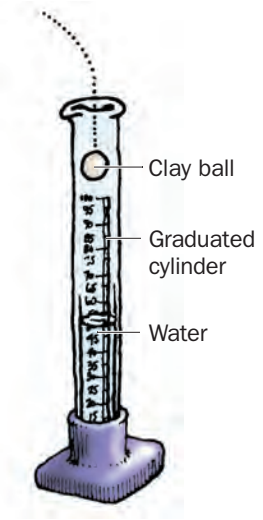


Figure 1.2 *Fill exactly half of the graduated cylinder with water. Measure and record the volume of water before adding the ball.*

2. Put the ball into the cylinder. Avoid splashing the water.

3. Record the volume of the water and the ball in Table 1 on the student sheet.

4. Repeat the procedure using the rectangular block.

5. Use the data you have collected to calculate the volumes of the two objects. Record your results in Table 1.

6. How could you find out whether the two objects contain the same amount of matter? Write your ideas on the student sheet.

7. Return the apparatus to its original condition for the next group.

Inquiry 1.3
The Burning Candle

PROCEDURE

1. Use a match to light the candle.

2. What can you see taking place at or near the top of the candle? Write all of your observations on the student sheet.

3. Place the open end of the beaker over the candle (see Figure 1.3). Let the beaker stay over the candle for a few minutes.

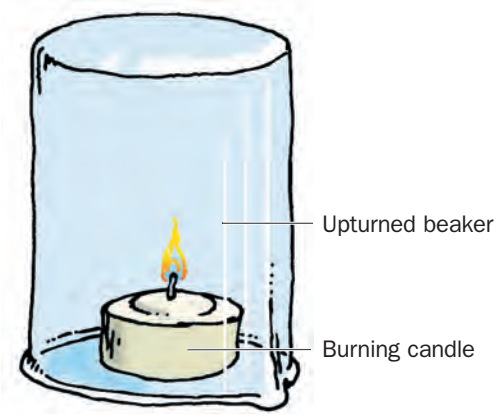


Figure 1.3 *After you have recorded your observations of the lit candle, place the beaker over the candle.*

4. What happened after the beaker was placed over the candle? Record your answer on the student sheet.

5. Why do you think the candle reacted the way it did? Write your answer on the student sheet.

6. Restore the apparatus to its original condition for the next group.

Inquiry 1.4
Describing Matter

PROCEDURE

1. Use a loupe to examine substances A and B (see Figure 1.4). Describe them on the student sheet in as much detail as possible.

Figure 1.4 *Hold the loupe close to your eye and to the substance you are examining.*

2. Answer the following question on the student sheet: Do you think either A or B is a pure substance? Justify your answer.

Inquiry 1.5
Adding Water

PROCEDURE

1. Place a clean, dry petri dish on the table in front of you.

2. Use the lab scoop to place a few grains of substance A on one side of the dish.

3. Use forceps to place a crystal of substance B on the other side of the dish.

4. Use the loupe to examine each substance. Draw a picture of what you see in Table 2 on the student sheet.

5. Use the pipette to slowly add 20 drops of water to each substance.

6. Look at the substances again using the loupe. Make a drawing of each substance on Table 2.

7. Answer the following questions on the student sheet: What happened to each substance when water was added to it? How did the two substances behave differently after water was added?

8. Place the used petri dish in the plastic box provided.

Inquiry 1.6
Mixing Liquids

PROCEDURE

1. Look at the contents of the bottle.

2. Shake the bottle two times. Allow it to stand for 2 minutes.

3. What do you observe? Write your description on the student sheet.

4. What do you know about the two substances in the bottle? Using your observations, write on the student sheet everything you know about the two substances.

Inquiry 1.7
Floating and Sinking

PROCEDURE

1. Place the squashed pan and the regular pan into the tank of water.
2. Answer the following question on the student sheet: What did you observe about each pan after it was placed in the water?
3. Both pans are made from the same substance and have the same mass. Why do the pans behave differently? Write your answer on the student sheet.
4. Remove both pans from the water and place them on the desk for the next group.

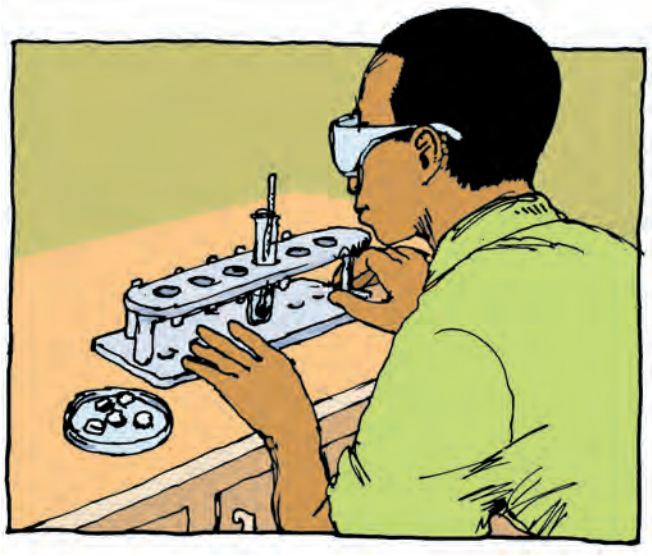


Figure 1.5 *Make sure you wait 30 seconds before you read the temperature.*

Inquiry 1.8
Reacting a Tablet

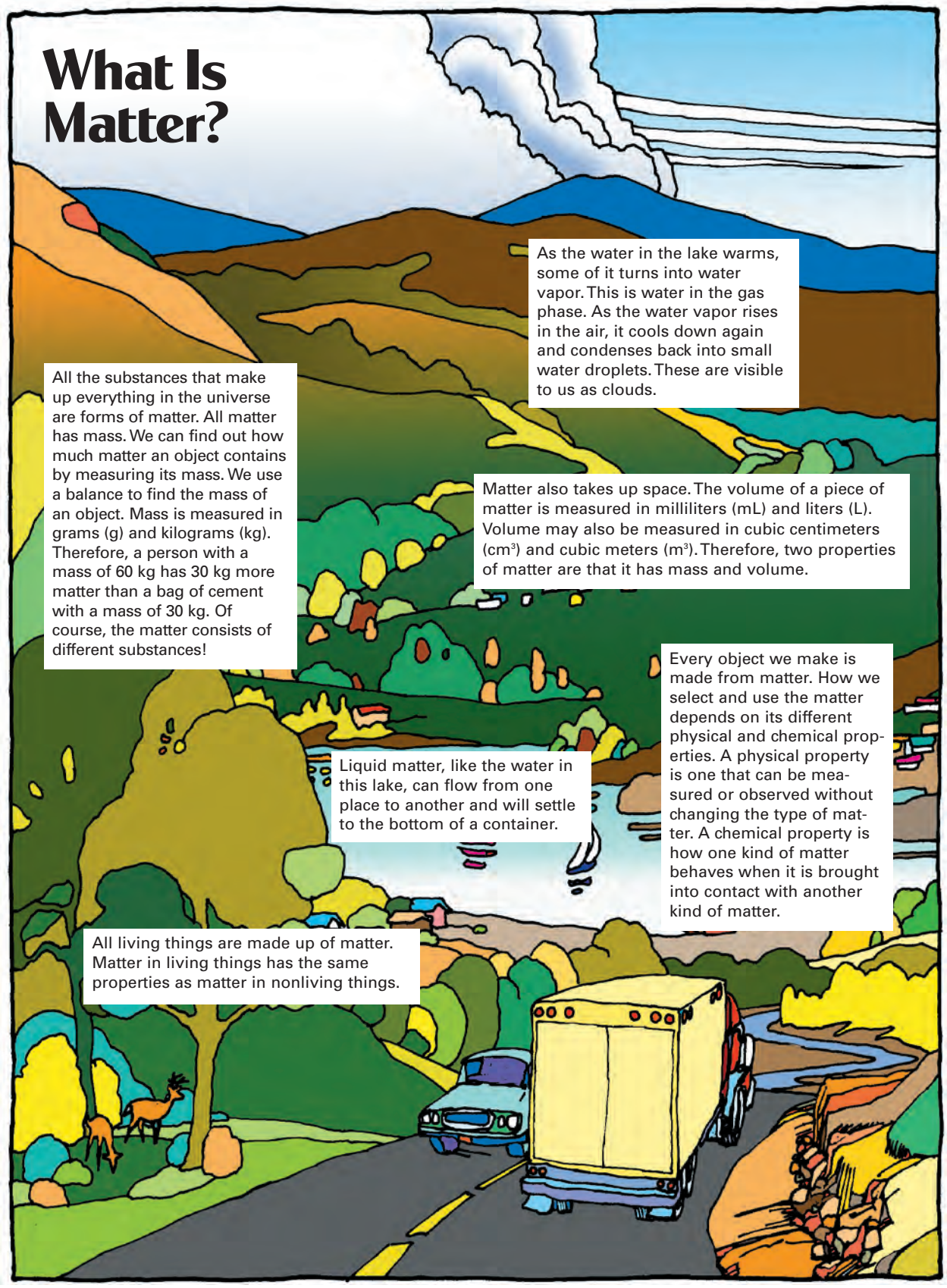
PROCEDURE

1. Fill the test tube in the test tube rack about half way with water.
2. Put the thermometer in the test tube (see Figure 1.5).
3. Wait 30 seconds and record the temperature on the student sheet.
4. Drop one piece of white tablet into the water.
5. For the next 3 minutes, carefully observe what happens.
6. What happened after the tablet was added to the water? Record your observations on the student sheet.
7. When no further changes take place, record the temperature of the water on the student sheet.
8. When you finish, empty the test tube for the next group.

REFLECTING ON WHAT YOU'VE DONE

1. When you have finished all eight inquiries, your teacher will ask your pair to return to your group.
2. Record your ideas about each experiment on the sheet of paper provided. Be prepared to contribute to a class discussion.

What Is Matter?



As the water in the lake warms, some of it turns into water vapor. This is water in the gas phase. As the water vapor rises in the air, it cools down again and condenses back into small water droplets. These are visible to us as clouds.

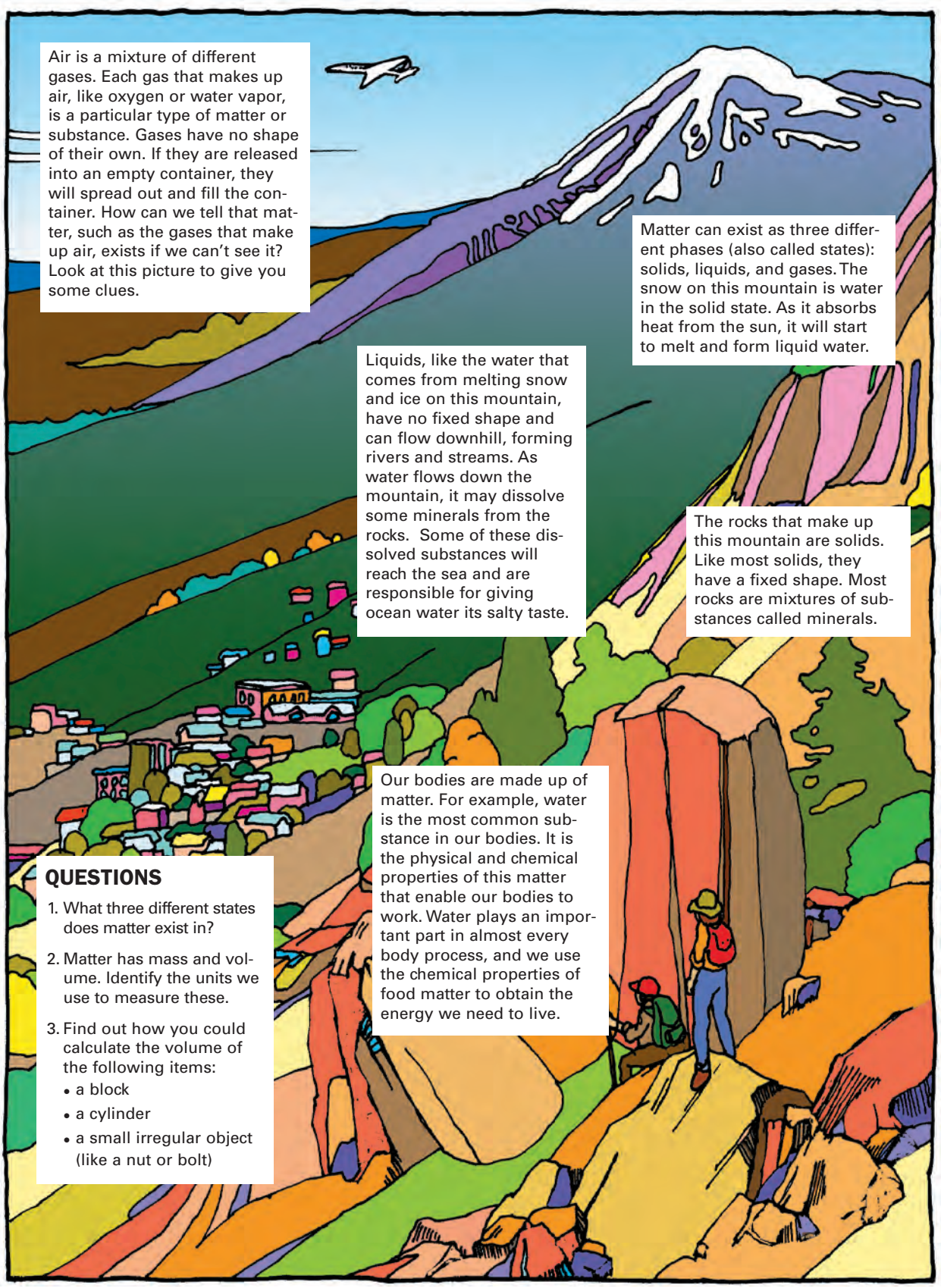
All the substances that make up everything in the universe are forms of matter. All matter has mass. We can find out how much matter an object contains by measuring its mass. We use a balance to find the mass of an object. Mass is measured in grams (g) and kilograms (kg). Therefore, a person with a mass of 60 kg has 30 kg more matter than a bag of cement with a mass of 30 kg. Of course, the matter consists of different substances!

Matter also takes up space. The volume of a piece of matter is measured in milliliters (mL) and liters (L). Volume may also be measured in cubic centimeters (cm^3) and cubic meters (m^3). Therefore, two properties of matter are that it has mass and volume.

Every object we make is made from matter. How we select and use the matter depends on its different physical and chemical properties. A physical property is one that can be measured or observed without changing the type of matter. A chemical property is how one kind of matter behaves when it is brought into contact with another kind of matter.

Liquid matter, like the water in this lake, can flow from one place to another and will settle to the bottom of a container.

All living things are made up of matter. Matter in living things has the same properties as matter in nonliving things.



Air is a mixture of different gases. Each gas that makes up air, like oxygen or water vapor, is a particular type of matter or substance. Gases have no shape of their own. If they are released into an empty container, they will spread out and fill the container. How can we tell that matter, such as the gases that make up air, exists if we can't see it? Look at this picture to give you some clues.

Matter can exist as three different phases (also called states): solids, liquids, and gases. The snow on this mountain is water in the solid state. As it absorbs heat from the sun, it will start to melt and form liquid water.

Liquids, like the water that comes from melting snow and ice on this mountain, have no fixed shape and can flow downhill, forming rivers and streams. As water flows down the mountain, it may dissolve some minerals from the rocks. Some of these dissolved substances will reach the sea and are responsible for giving ocean water its salty taste.

The rocks that make up this mountain are solids. Like most solids, they have a fixed shape. Most rocks are mixtures of substances called minerals.

Our bodies are made up of matter. For example, water is the most common substance in our bodies. It is the physical and chemical properties of this matter that enable our bodies to work. Water plays an important part in almost every body process, and we use the chemical properties of food matter to obtain the energy we need to live.

QUESTIONS

1. What three different states does matter exist in?
2. Matter has mass and volume. Identify the units we use to measure these.
3. Find out how you could calculate the volume of the following items:
   - a block
   - a cylinder
   - a small irregular object (like a nut or bolt)

WHERE DID MATTER COME FROM?

CORBIS/PENNY TWEEDIE

These Australian Aborigines are painting images of their Dreamtime story.

Where did all the stuff in the universe—Earth, the sun, rocks, plants, animals, even you—come from? Was it made at a certain time? If so, how long has it been around? Has it always been there? People have asked these questions since the earliest times.

Most cultures have stories of how the universe was created. For instance, Australian Aborigines tell a story about the sun, moon, and stars sleeping beneath the ground. Their ancestors also slept there. One day the ancestors woke up and came to the surface. The Aborigines call this the Dreamtime. During the Dreamtime, the ancestors walked the Earth as animals such as kangaroos, lizards, and wombats. Out of beings that were half animal and half plant, the ancestors made people. They then went back to sleep. Some went underground, but some became objects such as trees and rocks. The Dreamtime is an important part of Australian Aboriginal culture.

Scientists have also tried to answer the question of how the universe began. When scientists try to answer questions, they sometimes make observations of what happens and

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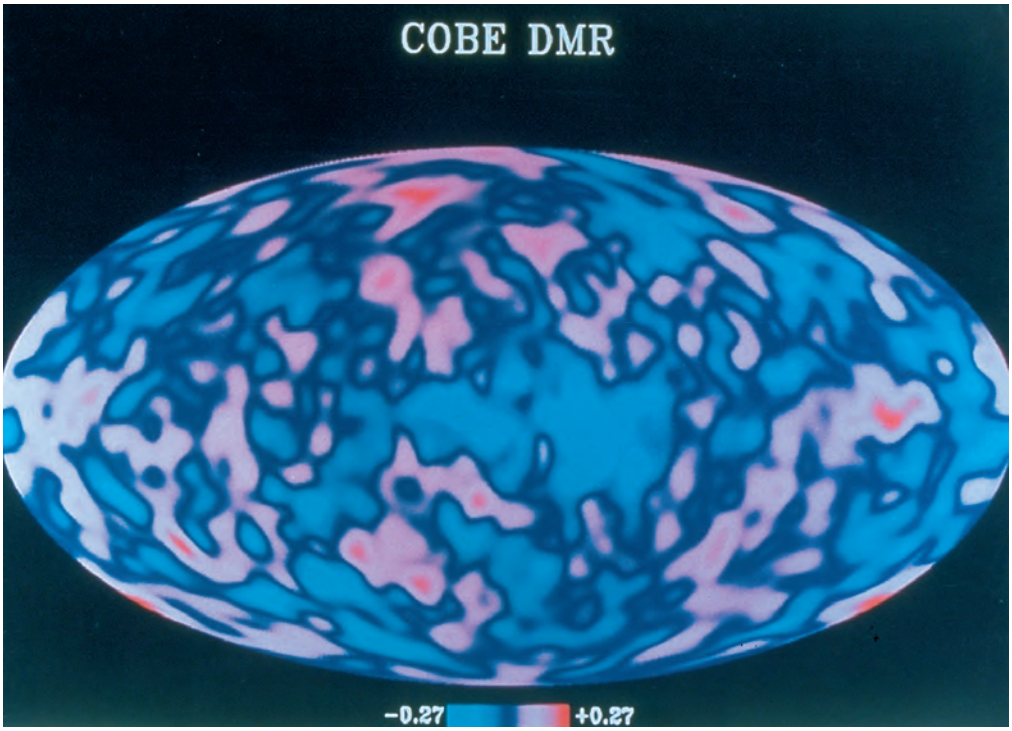

This background radiation map of the universe was produced using data collected by COBE (see photo below). The purple spots represent energy at the farthest edges of the expanding universe, giving a "picture" of the universe about 1 million years after the Big Bang. This image shows that even then, "structures" were being formed.

collect data. Scientists use their observations and data to try to explain the phenomena they are studying. One important part of science is the ability for different scientists to make the same observations and collect the same data when they are studying the same phenomena. When many scientists have made the same observations over a period of time, their explanations of these observations are called theories. As new knowledge is gained, theories are tested and retested. Sometimes the theories don't stand up to the new information. These theories are then replaced with new theories.

Over the years, as scientists have gained new knowledge about the universe, new theories have replaced old theories. Currently, many scientists think the universe started with the "Big Bang." The Big Bang theory suggests that all the matter and energy in the universe exploded out from one point. As the explosion occurred, energy and matter spread outward and formed the universe. The

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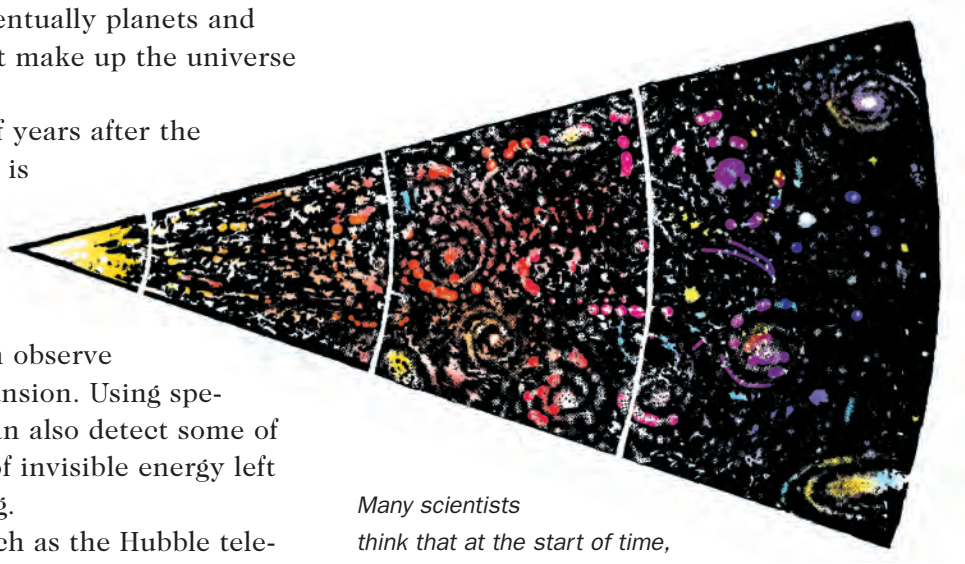
The Cosmic Background Explorer (COBE) satellite was launched in 1989. Its mission: Find out more about the origins of the universe by looking for background radiation left over from the Big Bang.

matter from the Big Bang formed clouds of gas. As these gases cooled and condensed, stars, galaxies, and eventually planets and other "structures" that make up the universe were formed.

Even now, billions of years after the Big Bang, the universe is still spreading out. By looking at light from distant stars and galaxies, scientists can observe and measure this expansion. Using special apparatus, they can also detect some of the background glow of invisible energy left over from the Big Bang.

Space telescopes, such as the Hubble telescope and X-ray telescopes in orbit around Earth, are constantly making new and exciting observations. Ideas about the formation of the universe and the Big Bang may change as these instruments are used to discover more about our evolving universe. □



Many scientists think that at the start of time, all matter and energy were contained within a single point. The point exploded in the Big Bang. The energy of this explosion caused the matter to spread out in all directions, forming galaxies, planets, and other objects. Using specialized instruments, scientists are able to measure the expansion of the universe.

QUESTIONS

1. Use information from this reader and any other information you can find from books, CD-ROMs, or the Internet to list the evidence for the Big Bang theory.
2. In science, the term "theory" has a special meaning. Find a definition of this term and give two examples of other theories that are used in physical science.