Science and Technology
Enhancing the Stone

Throughout history, gemstones have been heated to make them look clearer and to deepen their color. The ancient Romans heated agate, a variety of quartz, to enhance its color. In Sri Lanka, the current method for heating rubies dates back to about the year 1240.

Clear, deeply colored gems are very valuable. The color of any gemstone depends on the type and amount of particles present in the stone. So, if you can increase the number of certain kinds of particles present in a gem, you may be able to increase its value.

Not only heating, but other specialized techniques can heighten the clarity and color of gems. In one technique, colorless sapphires are packed in metal oxide powders. These precious packages are heated above 2,000°C for 25 days. During this process, the gemstones absorb particles from the metal oxides. The gems that result, shown in Figure 6.3, are polished to a deep, clear blue. Unfortunately, the gems are not completely transformed by this process. If you cut one in half, the inside is still colorless!

Figure 6.3 ▲
Gems such as sapphires begin as uncut stones (left). Before they become finished gems (center) they may go through a heating process (right).

Check and Explain

1. Define matter and give three examples of matter.
2. Make a list of ten objects in your classroom and name at least one physical property for each object.
3. **Classify** Organize ten different objects by grouping them by physical properties. Describe the properties on which you based your classification.
4. **Make a Model** Choose one property of matter and draw a diagram to show an arrangement of particles that could determine the property.

ACTIVITY

Comparing

Alike and Different

How are ice, steam, and ater alike? How are they ifferent? Make a table and st their similar and different roperties. Compare your ıble with that of a classmate.

SKILLS WARMUP

6.2 Phases of Matter

Objectives

- **Give examples** of solids, liquids, and gases.
- **Relate** the particle model to solids, liquids, and gases.
- **Make models** illustrating the gas laws.

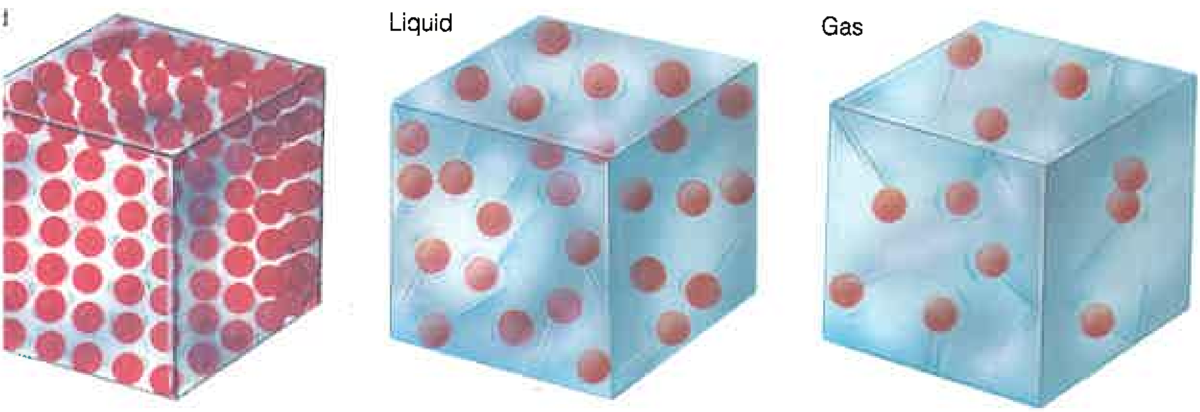
Imagine that you and your classmates represent particles of matter. During class, everyone is seated at desks in neatly arranged rows. This arrangement of students is like the arrangement of particles in a solid. You can move in your seats while at your desks, just as particles in a solid move about a fixed point.

At the end of class, you get up from your desks and move freely toward the door of the classroom. This close, but unorganized, movement resembles the motion of particles in a liquid. Finally, as you and your classmates leave the classroom, you travel in many different directions through the school grounds. This movement is similar to the way particles of a gas spread out to fill a space.

Familiar Phases of Matter

The three most familiar states of matter are solid, liquid, and gas. Each of these states of matter is called a phase. Like the students described above, particles of matter in each phase are arranged differently and have different ranges of motion.

ıre 6.4
ach phase of matter, the icles move about in a ɘrent way. ▼



Solids

The shape and volume of a rock are the same whether you put the rock in a shoe box or on a rock pile. When matter has a definite shape and a definite volume, it is a **solid**. A solid has these characteristics because of its closely packed particles. The particles can move slightly, but they do not change positions.

Most solids occur as crystals. Salt, bones, diamonds, computer chips, and snowflakes are all made up of crystals. Particles in a crystal are arranged in a regular, orderly way.

At some temperature, a solid substance melts to form a liquid. When the temperature of the melted substance is lowered, it becomes a solid again.

Materials such as glass, hard candy, and candle wax appear to be solid, but the arrangement of their particles is less regular. These materials are sometimes called amorphous (uh MOR fuhs) solids.

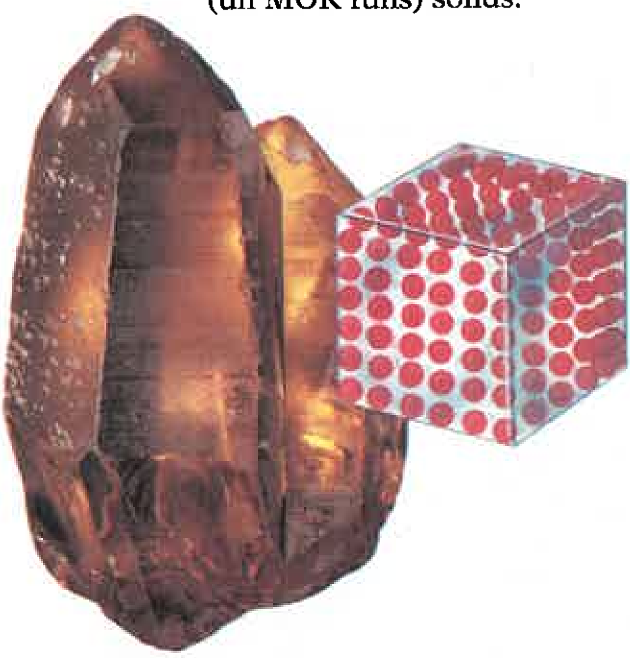


Figure 6.5 ▲
A quartz crystal is a typical solid. Why do its shape and volume remain the same?

Liquids

Matter with a definite volume, but no definite shape, is a **liquid**. Particles in a liquid behave something like bird seed in a sack. Like the bird seed, the liquid particles easily slide over each other. As a result, a liquid will take the shape of its container.

Look at Figure 6.6. It shows that th particles in a liquid are close together, but move enough so they do not stay i fixed positions. The particles flow free past one another. Some liquids, like water, flow quickly. Other liquids, such as syrup, molasses, or motor oil, flow more slowly because the particles tend to stick together.

In most liquids at room temperatu some of the particles move fast and ca escape into the air. This process, calle evaporation, forms a vapor or gas. Th opposite of evaporation is condensati (KAHN duhn SAY shuhn). When conde sation occurs, a gas forms a liquid.

Figure 6.6 ▲
Why do liquids take on shapes but keep the same volume?

ACTIVITY

Classifying

hasing In

Make a list of the things ›u used today that were in e gas phase. Then make ts of things you used that ere solids and liquids. Did ›u use the same substance two different phases? How this possible?

KILLS WORKOUT

ıre 6.7 ▶

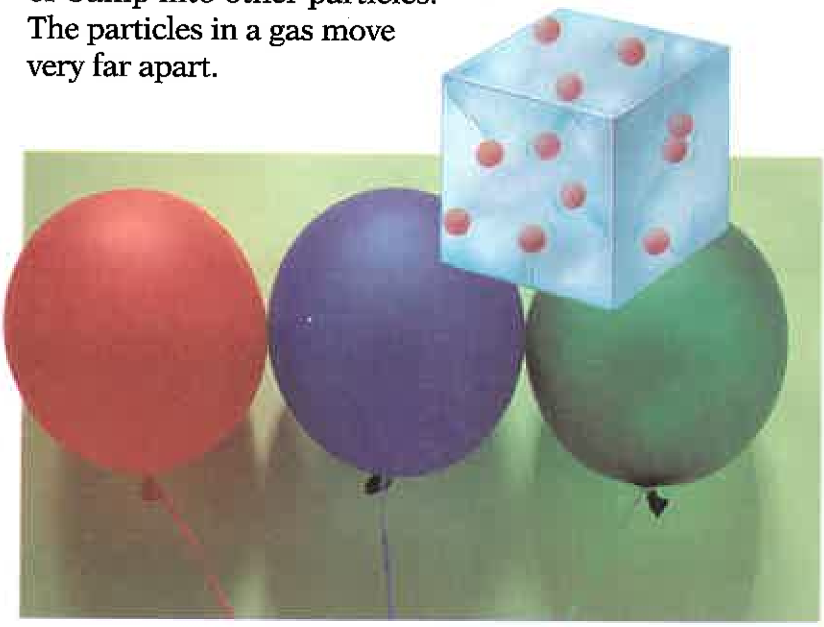
/ do you know that a blown-balloon contains matter?

Gases

Matter that has no definite shape and no definite volume is a **gas**. Like a liquid, a gas will take the shape of any container. Unlike a liquid, a gas expands to fill whatever space is available. The scent of a flower and the odor of a rotten egg come from gases that can fill a room.

The air is made up of several different gases. Although air is invisible, you can feel the effect of gas particles striking you when the wind blows. Gases fill balloons, propel rockets, and enable your cells to release energy from nutrients.

Look at the gas particles shown in Figure 6.7. Notice that the particles do not stick to one another. They move in straight lines, flying all over. They change direction only when they strike the walls of their containers or bump into other particles. The particles in a gas move very far apart.



Unlike the particles in a solid or liquid, each gas particle is mostly unaffected by its neighbors. Only temperature and pressure can affect the way the particles move and the volume they occupy. Because each gas particle is independent of other gas particles, the behavior of gases can be described by general laws. These laws, called gas laws, hold true for a wide range of temperatures and pressures. However, at very high or very low temperatures or pressures, gases behave differently than the gas laws predict.