The Particle Model of Matter

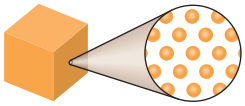
5.1

More than 2000 years ago in Greece, a philosopher named Democritus suggested that matter is made up of tiny particles too small to be seen. He thought that if you kept cutting a substance into smaller and smaller pieces, you would eventually come to the smallest possible particles—the building blocks of matter.

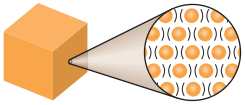
Many years later, scientists came back to Democritus' idea and added to it. The theory they developed is called the **particle model** of matter.

There are four main ideas in the particle model:

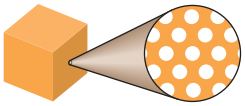
1. All matter is made up of tiny particles.



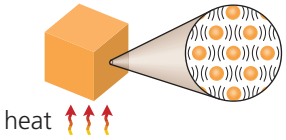
2. The particles of matter are always moving.



3. The particles have spaces between them.



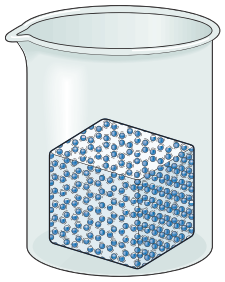
4. Adding heat to matter makes the particles move faster.



LEARNING TIP

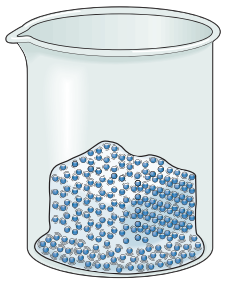
Are you able to explain the particle model of matter in your own words? If not, re-read the main ideas and examine the illustration that goes with each.

Scientists find the particle model useful for two reasons. First, it provides a reasonable explanation for the behaviour of matter. Second, it presents a very important idea—the particles of matter are always moving. Matter that seems perfectly motionless is not motionless at all. The air you breathe, your books, your desk, and even your body all consist of particles that are in constant motion. Thus, the particle model can be used to explain the properties of solids, liquids, and gases. It can also be used to explain what happens in changes of state (**Figure 1** on the next page).



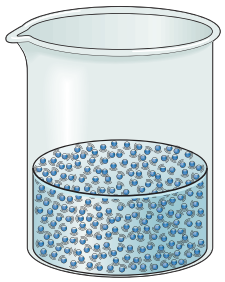
The particles in a solid are held together strongly. The spaces between the particles are very small.

A **solid** has a fixed shape and a fixed volume because the particles can move only a little. The particles vibrate back and forth but remain in their fixed positions.



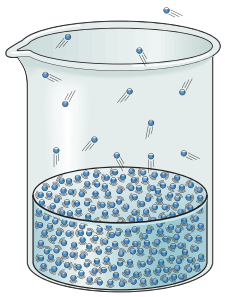
As a solid is heated, the particles vibrate faster and faster until they have enough energy to break away from their fixed positions. When this happens, the particles can move about more freely. The change from a solid to a liquid is called **melting.**

The reverse of melting is called **freezing** or solidification. This is the change from a liquid to a solid. As a liquid cools, the particles in the liquid lose energy and move more and more slowly. When they settle into fixed positions, the liquid has frozen or solidified.



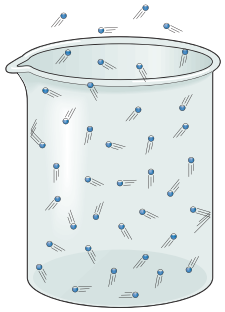
The particles in a liquid are separated by spaces that are large enough to allow the particles to slide past each other.

A **liquid** takes the shape of its container because the particles can move around more freely than they can in a solid. They are held close together, however. Therefore, a liquid has a fixed volume, like a solid.



When a liquid absorbs heat energy, the particles move about more and more quickly. Some of the particles gain enough energy to break free of the other particles. When this happens, the liquid changes to a gas. The change from a liquid to a gas is called **evaporation.**

The reverse process—the change from a gas to a liquid—is called **condensation.** As a gas cools, the particles in the gas lose energy and move more and more slowly until the gas condenses to a liquid.



The particles in a gas are separated by much larger spaces than the particles in a liquid or a solid. Therefore, a gas is mostly empty space.

A **gas** always fills whatever container it is in. Since the particles are moving constantly in all directions, they spread throughout their container, no matter what volume or shape their container is.

Figure 1
Explaining changes of state using the particle model