Category IV Physical Science Examples

Representing ideas effectively

Material A

The student text includes several drawings showing the arrangement and motion of particles of gases, liquids, and solids (e.g., Figure 8-2 p. **215s** and Figure 8-6, p. **217s**). It also uses an analogy of people in a crowd to represent the idea of thermal expansion (pp. **219–220s**). Although the representations contain some inaccuracies, the number and severity of them are much smaller compared to the other textbooks that were examined. For instance, unlike in other materials, balls representing molecules look the same (blue) in the solid, liquid, and gaseous states—only their arrangement changes (e.g., p. 217s).

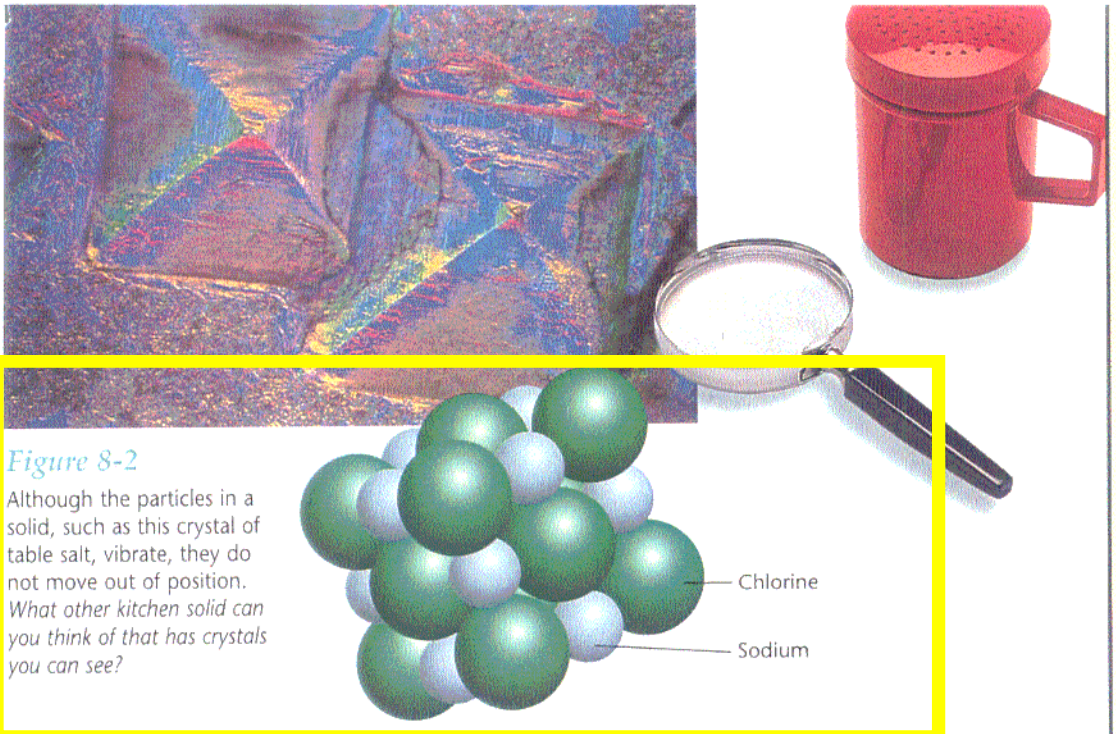


Figure 8-2

Although the particles in a solid, such as this crystal of table salt, vibrate, they do not move out of position. *What other kitchen solid can you think of that has crystals you can see?*

What accounts for the characteristics of solids? Tiny particles in constant motion make up all matter. This idea is called the **kinetic theory of matter.** The particles in solid matter are held close together by forces between them. This is why a solid can't be squeezed into a smaller space. The particles can vibrate close to their neighbors, but they lack enough energy to move out of position. Thus, they lack enough energy to move over or around each other. This explains why a solid holds its shape.

Crystalline Solids

In most solids, the particles are arranged in repeating geometric patterns. These arrangements are **crystals.** Different kinds of solids have crystals of different shapes. In the magnified view of **Figure 8-2,** you can see that crystals of table salt are little cubes. A snowflake is a crystal of water that has the shape of a hexagon.

Noncrystalline Solids

Some materials, such as glass, many plastics, and some kinds of wax, appear to be solids but are not made of crystals. They are often called amorphous solids. The word *amorphous* means "having no form." Many scientists think some of these noncrystalline materials should be classified as thick liquids.

USING MATH

A hexagon is a six-sided figure that occurs in ice crystals and honeycombs. It is an efficient shape that *tessellates* a surface; that is, it covers the surface with no overlapping or gaps. Name another shape that tessellates a surface. What shape that you see in the salt crystals will also tessellate a surface?

2 Teach

Demonstration

LS **Visual-Spatial** If possible, obtain some moth crystals to use in teaching this section. As you discuss solids, have a student place some moth crystals in a test tube. Stopper the tube and pass it around the class so students can observe the crystalline form. LEP

LS **Visual-Spatial** Have students observe the regular shape of salt crystals under a microscope or with a hand lens. LEP

Visual Learning

Figure 8-1 What states do you see in this photo? *solid, liquid, and gas*

Figure 8-2 What other kitchen solid can you think of that has crystals you can see? *sugar* LEP LS

USING MATH

Rectangles and equilateral triangles tessellate. A square is in salt crystals.

Use **Multicultural Connections,** pp. 19, 20 as you teach this lesson.

Use **Teaching Transparency 15** as you teach this lesson.

Inclusion Strategies

Gifted Have each team prepare a written statement explaining how refineries solve the problems of fuel-line freeze-up and vapor lock. They will find that refineries change gasoline blends for different seasons and different geographical locations. L3 COOP LEARN

GLENCOE TECHNOLOGY

CD-ROM

Physical Science CD-ROM

Have students perform the interactive exploration for Chapter 8 to reinforce chapter concepts and thinking processes.

Gases

You may have pumped air into a basketball, tire, or balloon and noticed that the air takes the shape of the object. Gases are "springy"—they expand or contract to fill the space available to them and can be squeezed into a smaller space. A gas has neither a definite shape nor a definite volume.

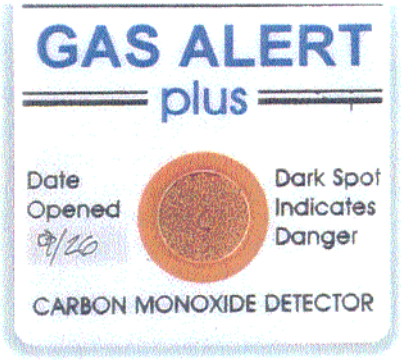
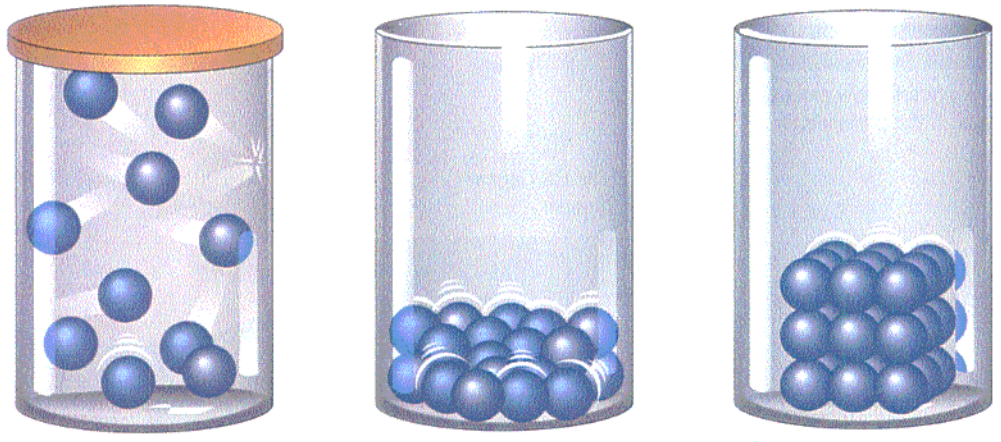


Figure 8-5
This test disk is used to detect released carbon monoxide in all parts of a building. *Why would a detector be effective even if it were not right next to the gas leak?*

According to the kinetic theory of matter, the particles of a gas have enough energy to separate completely from one another. Therefore, the particles are free to move in all directions until they have spread evenly throughout their container. **Figure 8-5** shows a test for a gas that has filled a room as its particles spread. Because the particles of a gas are not close together, they can also be squeezed into a smaller space. When you pump up a bicycle tire, you are forcing more and more air particles into the same space.

Figure 8-6 explains the relationship between particles and energy in a solid, in a liquid, and in a gas.

Figure 8-6
The energy of particles is different for each state of matter.



A In gas samples, the particles have enough energy to overcome attractive forces that would hold them together.

B The particles composing a liquid don't have enough energy to overcome all attractive forces, but they do have enough energy to move around each other.

C Solids are made up of particles that do not have enough energy to move from one place to another. *How does that affect the shape of a solid?*

Demonstration

LS **Visual-Spatial** On the overhead projector, in a clear plastic dish, place five marbles. Agitate the box to simulate gas molecules in motion. Increase agitation to simulate the effect of increasing the temperature. Point out the change in collisions. Relate student observations to the properties and particle model of a gas. LEP

Enrichment

Cryogenics is the study of matter at low temperatures. Ask a student to research how a solid's properties change near absolute zero. L3

Teacher F.Y.I

At room temperature, oxygen gas molecules have an average speed of 1700 km/h.

Visual Learning

Figure 8-5 **Why would a detector be effective even if it were not right next to the gas leak?** *because the particles of a gas spread to fill a room*

Figure 8-6 **How does that affect the shape of a solid?** *It does not change.* LEP LS

GLENCOE TECHNOLOGY

Videodisc

Glencoe Physical Science
Interactive Videodisc
Side 1, Lesson 3
Gases Expand to Fill Container

23416

23418-23508

Thermal Expansion

You have learned how the kinetic theory accounts for characteristics of different states of matter you see and touch every day. The kinetic theory also explains other things you may have observed. For example, have you ever noticed the strips of metal that run across the floors and up the walls in long hallways of concrete and steel buildings? Maybe you've seen these strips in your school. These strips usually cover gaps in the building structure called expansion joints. Expansion joints allow the building to expand in hot weather and shrink in cold weather without cracking the concrete. As you drive onto or off a bridge, you will usually pass over a large steel expansion joint.

The Heat and Motion Connection

Almost all matter expands as it gets hotter and contracts when it cools. This characteristic of matter is called **thermal expansion.** You can compare thermal expansion to a crowd of people. When the people are quiet and still, they are able to stand close

Problem Solving

Mind over Matter

Martin, Rita, and L.J. were working on fixing up an old car and they needed some nuts and bolts to make their repairs. L.J. found a jar of assorted nuts and bolts in the garage, but they had trouble removing the metal lid. After struggling for a few minutes, Rita suggested that running hot water over the metal lid might make it easier to open.

Solve the Problem:

1. **Think about the effect of energy on the motion of particles. How would you describe the effect of heat energy on the metal?**
2. **After the hot-water treatment, the jar easily opened. Why did this work better than just forcing the lid off the jar?**

Think Critically:

Sealing containers is important in preserving freshness and preventing spoilage. Explain two reasons why a food container that was closed when it was warm might become tight as it cooled.

Use Lab 18 in the **Lab Manual** as you teach the lesson.

3 Assess

Check for Understanding

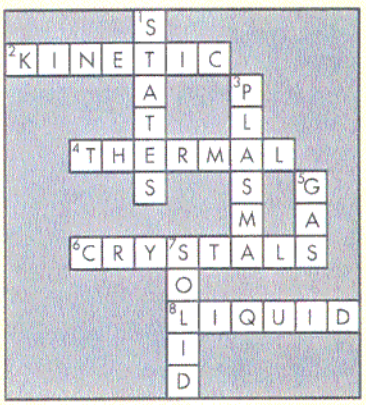
•MINI•QUIZ•

Use the Mini Quiz to check students' recall of chapter content.

1. **Name the four states of matter.** *solid, liquid, gas, plasma*
2. **Which state of matter has definite shape and definite volume?** *solid*
3. **According to the kinetic theory, what is all matter composed of?** *tiny particles in constant motion*
4. **What happens to the average speed of the particles of matter as it is heated?** *It increases.*
5. **What happens to most matter when it is heated?** *It expands.*

Reteach

LS **Linguistic** Provide the students with the crossword puzzle and have them write the clues for each word. Then give the entire class a blank crossword and the clues to solve it.



Extension

For students who have mastered this section, use the **Reinforcement** and **Enrichment** masters.

4 Close

Section Wrap-up

Review

1. Both solids and liquids have a definite volume because their particles are closely packed. Solids have a definite shape, but liquids take the shape of the container. The particles of solids are held in place by attractive forces. The particles of liquids have enough energy to tumble over and around one another.
2. The material is a gas because it expanded to occupy all the space available in the container.
3. The particles of copper move more slowly as it cools. Attractive forces then pull them closer together.
4. **Think Critically** Glass lacks the rigid crystal structure shown in a crystalline solid. Over time, it flows downward.

USING MATH

Liquid water is 323 times more dense than water vapor. In the liquid, the water molecules are much closer together than in the vapor.

Skill Builder

Possible Solution

State	Properties	Particle description	Examples
Solid	Definite shape and volume	Closely packed; do not easily change position	ice, sugar
Liquid	Definite volume; takes shape of container	Closely packed; able to move past one another	milk, mercury in thermometer
Gas	Occupies shape and volume of container	Spread apart; free to move in all directions	oxygen, steam
Plasma	Occupies shape and volume of container	Gaslike mix of negatively and positively charged particles	mercury vapor in fluorescent tube, sun and stars

together. As the people become restless, they jostle one another and the crowd spreads out.

How does the kinetic theory of matter explain thermal expansion? In a solid, forces between the particles hold them together. As the solid is heated, these particles move faster and faster and vibrate against each other with more force. As a result, the particles spread apart slightly in all directions, and the solid expands. This explains why expansion joints are needed in buildings and on bridges. The same effect also occurs in liquids and gases. A common example of this is shown in the thermometers in **Figure 8-8.**

As the liquid in a bulb is heated, the energy causes more movement of the particles. This energy is transferred to other parts of the liquid. The liquid in the narrow part has to expand only slightly to show a large change on the temperature scale.

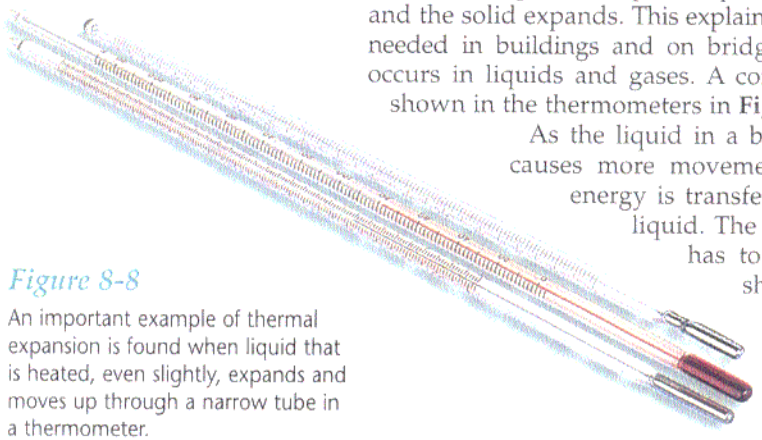


Figure 8-8

An important example of thermal expansion is found when liquid that is heated, even slightly, expands and moves up through a narrow tube in a thermometer.

Section Wrap-up

Review

1. Compare the characteristics of solids and liquids.
2. You pour 500 mL of a green material into a 1-L flask and stopper it. The material completely fills the flask. What state of matter is the material? Explain how you know.
3. In terms of particle motion, explain why copper shrinks when it cools.
4. **Think Critically:** In old houses, the window glass is thicker at the bottom of the panes than at the top. What accounts for this thickening?

USING MATH

The density of a sample of water vapor is 0.0031 g/mL. The density of a second sample of liquid water is 1.0 g/mL. How many times more dense is the liquid than the vapor? How does this relate to the spacing of the water molecules?

Skill Builder

Making and Using Tables

Make a table to classify several materials as a solid, liquid, gas, or plasma. Include columns for properties and a description of particles for each state. If you need help, refer to Making and Using Tables in the **Skill Handbook.**

Assessment

Oral After students have made their tables, select objects from the classroom and ask students to describe the particles and their movements within the selected objects. Use the Performance Task Assessment List for Data Table in **PASC,** p. 37. P