Category IV Physical Science Examples

Demonstrating use of knowledge

Material A

The student text includes several explanations of phenomena that use the kinetic molecular theory (pp. 215s, 216s, 217s, 219s, 224s, 229s). Often, the material will describe a phenomenon, restate a part of the kinetic molecular theory that pertains to it, and then explain the phenomenon in terms of the theory—an act of modeling or demonstrating how the theory is used to explain phenomena. These demonstrations are not explicitly labeled as such, but by saying that "this is how the kinetic theory explains ..." in some instances, the material comes close to being explicit (see for example, pp. **219s**). Some explanations are step-by-step (pp. **215s**, **216s**) while others are not (pp. **224s**, **229s**). The material does not provide students with criteria for judging the quality of explanations. Although still not satisfactory, this criterion is better attended to in this than all other physical science textbooks examined.

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

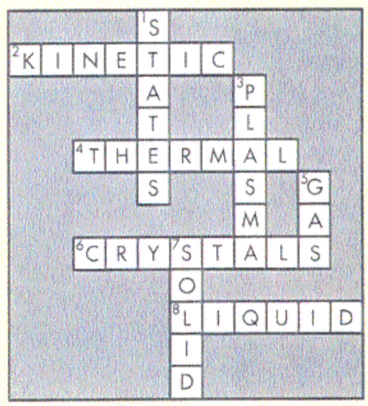
•MINI•QUIZ•

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.*

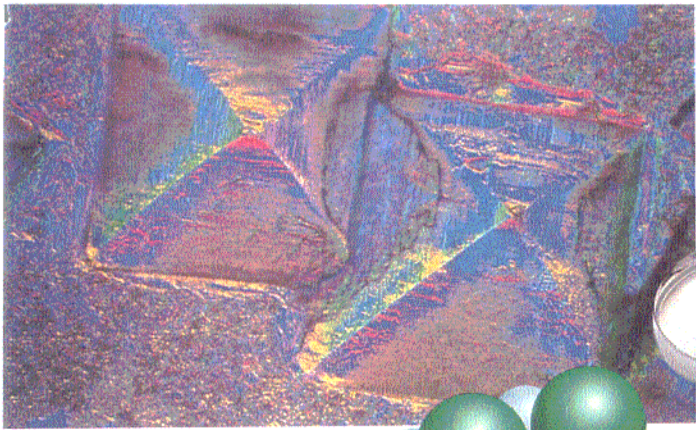
Reteach

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.



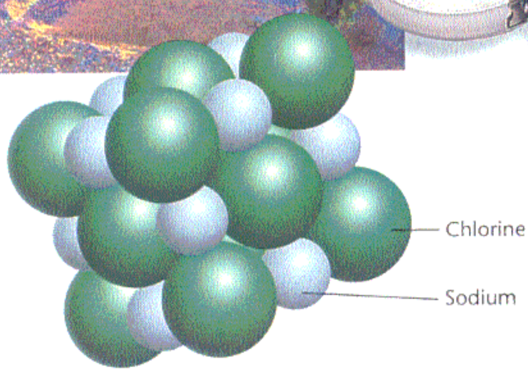


Figure 8-2

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.

Content Background

Visual-Spatial As you discuss liquids, melt moth crystals in an unstoppered test tube placed in a beaker of boiling water. Relate the role of energy to the melting process. Use the kinetic theory to explain to your students what is happening on a molecular level.

Activity

Interpersonal Have one student place 5 drops of vanilla flavoring into a balloon, blow up the balloon, and tie it closed. Have a second student smell near the surface of the balloon. The student should be able to detect the aroma of vanilla as it evaporates inside the balloon. The balloon may feel cool where the liquid is evaporating on the inside. Have the third student monitor, confirm, and record the group's observations. Ask the group to explain its observations using the kinetic theory. The students should conclude that the moving molecules of vanilla passed between the molecules of the stretched balloon. L1 LEP COOP LEARN

Revealing Preconceptions

- **Sometimes, expensive glassware is called crystal. Explain why this term is used incorrectly.** *Glass is not crystalline; it is amorphous.*
- **Is there anything wrong with saying, "This bottle is half-filled with carbon dioxide gas"?** *Yes, a gas occupies all the space available in its container.*

Science Journal

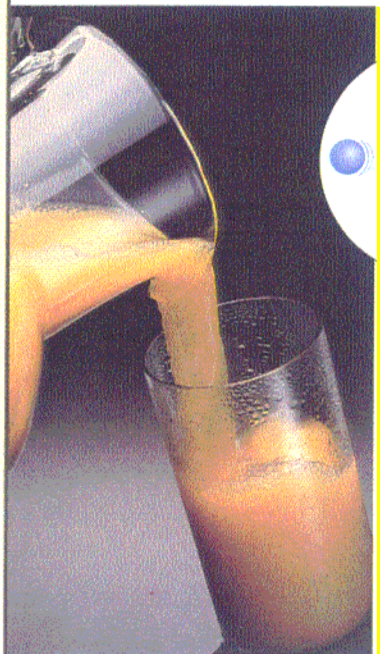
The particles move faster when a solid changes to a liquid or a gas. The particles move slower as a gas changes to a liquid or a solid.

Liquids

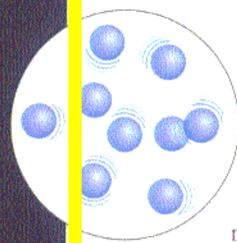
If you don't eat it quickly enough, a solid scoop of ice cream will turn into a liquid, taking the same shape as your bowl or cup. A liquid flows and takes the shape of its container. However, like solids, liquids can't normally be squeezed to a smaller volume. If you push down on a liter of water with a moderate amount of force, its volume remains a liter.

Figure 8-3

The particles in a liquid are close together, but they have enough energy to move over and around one another.



More Motion



Just as the kinetic theory explains the properties of solids, it also explains the properties of liquids. Because a liquid can't be squeezed, its particles must also be close together, like those of a solid. However, they have enough kinetic energy to move over and around each other. This movement of particles lets a liquid flow and take the shape of its container. Thus, the orange juice poured into a glass in **Figure 8-3** will take the shape of the glass.

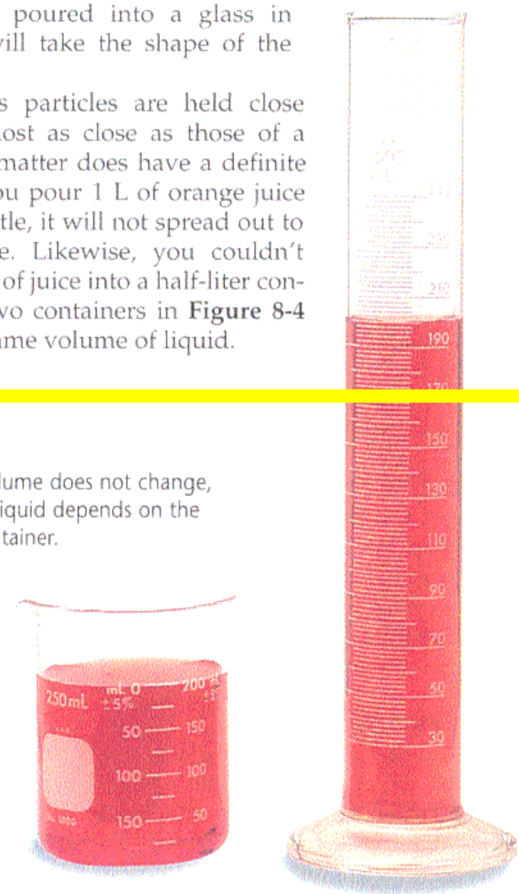
Because its particles are held close together, almost as close as those of a solid, liquid matter does have a definite volume. If you pour 1 L of orange juice into a 2-L bottle, it will not spread out to fill the bottle. Likewise, you couldn't force the liter of juice into a half-liter container. The two containers in **Figure 8-4** contain the same volume of liquid.

Science Journal

In your Science Journal, explain how the motion of particles changes when matter changes from one state to another.

Figure 8-4

Although its volume does not change, the shape of a liquid depends on the shape of its container.



Across the Curriculum

Art and Design As students visit shopping malls, have them observe how the states of matter are used to decorate and make shopping more pleasant. Have them write about what they saw, such as waterfalls, helium balloons, marble floors, and fluorescent and neon lighting. LS P

Use Lab 17 in the **Lab Manual** as you teach this lesson.

Section 8•3

Prepare

Section Background

Substances that have weak intermolecular forces evaporate easily and melt or boil at relatively low temperatures. Before a substance reaches its melting or boiling point, added energy increases the motion (kinetic energy) of the particles, and the temperature increases.

Preplanning

The MiniLAB requires rubbing alcohol and droppers.

1 Motivate

Bellringer

Before presenting the lesson, display **Section Focus Transparency 32** on the overhead projector. Assign the accompanying **Focus Activity** worksheet. L1 LEP

Demonstration

LS **Visual-Spatial** Place a few crystals of iodine in a stoppered test tube. A pale violet color will be visible. **CAUTION:** *Iodine vapors are toxic.* Ask students to suggest a mechanism for this phenomenon based on the particle models of the states of matter.

Tying to Previous Knowledge

- Ask students to recall how cold they felt when they got out of a pool when a strong breeze was blowing.
- Ask your class if anyone has seen dry ice subliming. Ask them to describe it. If possible, obtain a piece to observe. **CAUTION:** *Use gloves when handling dry ice. Never place dry ice in a closed container.*

8•3 Changes in State

Science Words

evaporation
condensation
heat of fusion
heat of vaporization

Objectives

- Interpret state changes in terms of the kinetic theory of matter.
- Account for the energy of the heats of fusion and vaporization in state changes.

Identifying Changes in State

If you've ever seen ice cream melt before you could eat it, you have seen matter change state. Solid ice crystals in the ice cream melt when they change from the solid state to the liquid state. When melting, a solid changes into a liquid. You put water in the freezer to make ice cubes. When freezing, matter changes from the liquid state to the solid state.

When you boil water, you observe another change of state, called vaporization. When boiling, you add heat to a liquid until it reaches a temperature at which it changes to bubbles of gas below its surface. Many liquids don't need to boil to change to a gas. During **evaporation,** a liquid changes to a gas gradually at temperatures below the boiling point. When you come out of a pool into warm air, water on your skin soon evaporates. You'll see later how this drying helps cool you. In **Figure 8-10,** evaporation helped dry, or solidify, the concrete.

Figure 8-10
Freshly poured concrete includes liquid water spread into a thin layer over a large surface area. As the water particles gain energy, they can overcome attractions to other particles and evaporate, leaving behind a dry, solid surface.

Program Resources

Reproducible Masters
Study Guide, p. 36 L1
Reinforcement, p. 36 L1
Enrichment, p. 36 L3
Activity Worksheets, p. 49 L1
Concept Mapping, pp. 21, 22

Transparencies
Section Focus Transparency 32 L1

Our Atmosphere—A Sea of Air

INTEGRATION
Earth Science

You can see right through it, and most of the time you can't even feel it. But the air we breathe and live in contains many gas particles that cause the air pressure you have just been reading about. The atmosphere closest to Earth's surface, up to approximately 16 to 17 km, is called the troposphere. In the troposphere, you come into direct contact with nitrogen, oxygen, argon, carbon dioxide, and water vapor. These particles are moving incredibly fast, approaching 1610 km per hour. At these speeds, one particle may collide with another, or you, as often as every billionth of a second. Millions of fast-moving, colliding particles create air pressure in every square meter of the troposphere.

Higher Altitudes Mean Less Pressure

Above the troposphere, there are fewer gas particles and fewer collisions, which means less pressure. The stratosphere continues to about 50 km above Earth's surface. At higher distances, the mesosphere and thermosphere continue. If the air pressure is measured at 5 km above Earth, the pressure will have dropped from 101 kPa at Earth's surface to approximately 54 kPa. At 50 km, the pressure may be only 0.15 kPa. An example of the effect of altitude on pressure is shown in **Figure 8-15.**

Boyle's Law

Suppose you have some gas in a sealed flexible container, such as a balloon. You can squeeze or stretch the container without changing the amount of gas trapped inside.

The pressure of a gas depends on how often its particles strike the walls of the container. If you squeeze some gas into a smaller space, its particles will strike the walls more often, giving an increased pressure. This behavior explains why when you squeeze a balloon into a smaller space, it causes the balloon to push back with more force. The reverse happens, too. If you give the gas particles more space, they will hit the walls less often and the gas pressure will be reduced. Robert Boyle (1627-1691), a British scientist, described this property of gases. According to **Boyle's law,** if you decrease the volume of a container of gas, the pressure of the gas will increase, provided the temperature does not change. Increasing the volume causes pressure to drop. As you'll see, it is important that the temperature remains constant.

Figure 8-15

At lower altitudes (bottom), air pressure increases. The air trapped inside the bottle during a high-altitude biking trip (top) exerts less pressure than the air back home. *Why does the bottle have less volume in the bottom photo?*

2 Teach

Demonstration

LS **Visual-Spatial** Put 20 mL of water into an empty aluminum soft-drink can, and place it on a hot plate to boil. After the can has filled with steam, grasp it with tongs or a hot pad and plunge the can inverted into a beaker of ice water. The sudden drop of pressure inside the can will crush the can. LEP

INTEGRATION Earth Science

Although the troposphere is important, the stratosphere should not be neglected. This is where most of the protective ozone layer is found. Ozone absorbs most of the harmful ultraviolet rays striking Earth from the sun.

Visual Learning

Figure 8-15 Why does the bottle have less volume in the bottom photo? *The pressure of the air inside is less than the pressure outside.* LEP LS

GLENCOE TECHNOLOGY

Videodisc

Glencoe Physical Science Interactive Videodisc

Side 1, Lesson 3

Boyle's Law

24161

24163-24258

24260-24491

Use **Science Integration Transparency** 8 as you teach this lesson.

Science Journal

Mnemonic Devices Have the students write a plan to help them remember that Charles's law relates temperature and volume and Boyle's law relates pressure and volume. *Plans may include relating the letter C to both Charles and Celsius, reflecting temperature. Or, when someone is under pressure, his or her emotions may be near the boiling point, relating pressure and Boyle's law.*