Category V Physical Science Examples

Guiding student interpretation and reasoning

Material A
Most of the activities are followed by questions that may help students make sense of the activities (pp. **216s**, **219s**, **221s**, **224t**). These questions mostly prompt students to explain the phenomena presented with the kinetic molecular theory (pp. **216s**, **221s**, **224t**). No questions are posed that help students relate what they observe to their own ideas. There are no specific questions that are likely to help students make sense of the text they read. This is an important shortcoming, given that most of the sightings for phenomena that support the kinetic molecular theory are described in the text (pp. 214s, **215s**, 216s, **228s**). Students are never asked to think about these phenomena.

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.

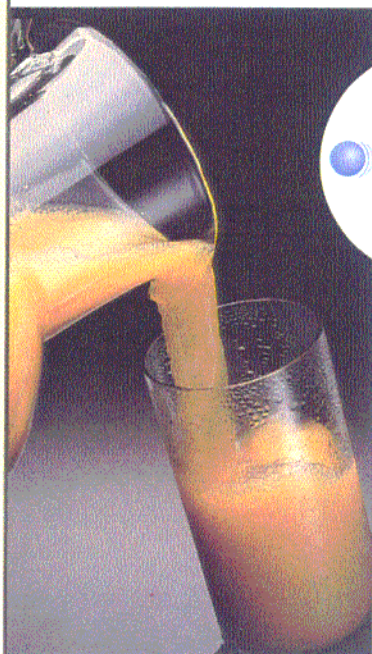
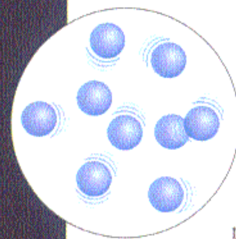


Figure 8-3

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.

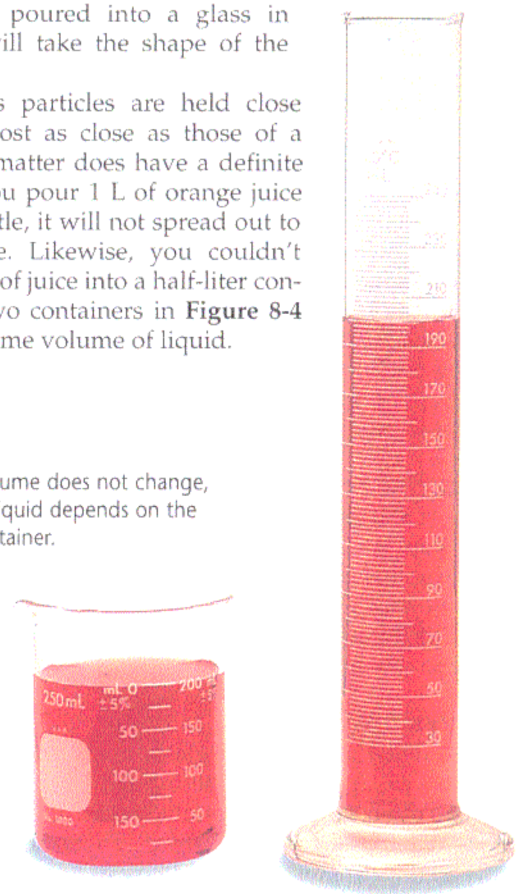


Figure 8-4

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.

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

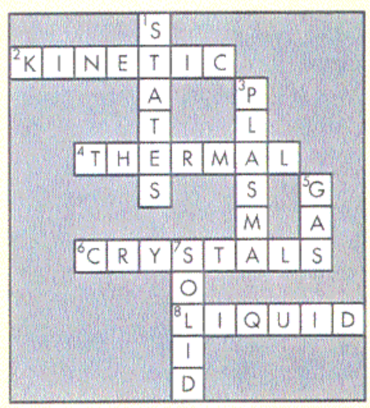
• MINI • QUIZ •

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.



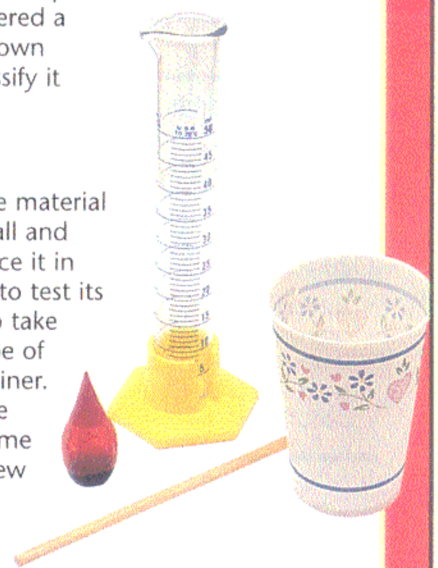
Extension

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

Activity 8-1

Properties of Liquids

Why is a soft drink considered a liquid? Why is a hamburger considered a solid? Each state of matter has its own characteristics that allow us to classify it as that state.



Problem

How can the properties of a material be used to classify it as a solid, a liquid, or a gas?

Materials

- dropper
- food coloring
- wooden stick
- graduated cylinder
- 4% solution of powdered borax in water
- 4% solution of polyvinyl alcohol (PVA) in water
- paper cup
- goggles
- apron

Procedure

1. Copy the data table and use it to record your observations.
2. Using a graduated cylinder, measure 30 mL of PVA solution into a paper cup. Add 2 drops of food coloring.
3. Using a dropper, add about 3 mL of borax solution to the PVA in the cup, and begin to stir vigorously with a wooden stick.
4. After it has been stirred for 2 minutes, what is the consistency of the material?
5. Transfer the material to your hand. **CAUTION:** *Do not taste or eat the material, and be sure to wash your hands after the activity.* Rate the ease with which the material flows.
6. Form the material into a ball and then place it in the cup to test its ability to take the shape of its container.
7. Compare the volume of the new material with the volume of the original material before stirring.

Data and Observations

Sample Data

Property	Observation	Interpretation
Ability to flow	Yes, but slowly (high viscosity)	Molecules hold to each other, but not as much as solids
Shape change	Does change shape	Molecules do allow movement
Volume change	No change	Molecules are not totally free to fill up any volume

Analyze

1. Is the new material most like a gas, a liquid, or a solid?
2. What other materials have you seen that have similar properties to this one?
3. Considering the flow of the new material, how would you rate the strength of the attraction among its particles?

Conclude and Apply

4. Using the kinetic theory of matter, describe the closeness of the particles of matter in the new material.
5. How can properties of this material be used to **classify** it?

Activity 8-1

Purpose

Visual-Spatial Observe the properties of a material and classify it according to state. L1 LEP COOP LEARN

Process Skills

measuring, classifying, formulating models, formulating operational definitions, observing and inferring, making and using tables, comparing and contrasting, recognizing cause and effect

Time

35 minutes

Activity Worksheets, pp. 5, 44, 45

Teaching Strategies

Troubleshooting In order to properly mix the borax and PVA, students must stir the solutions quickly and continuously. Do not allow students to taste the resulting gel or take it out of the classroom. Spills may be cleaned up with water.

- The new material is a polymer that is much like products sold in toy stores under names such as Slime. Encourage students to make comparisons to commercial products.
- To prepare 4% borax solution, dissolve 12 g of sodium borate in 288 mL of hot water with constant stirring. Cool before using.
- To prepare 4% PVA solution, add 40 g of 98% hydrolyzed PVA to 960 mL of H_2O. Heat to 80°C with constant stirring. Cool before using.

Answers to Questions

1. a liquid
2. Slime, gelatin dessert, jellies, mucus
3. The particles are fairly strongly attracted. They remain a certain volume and do not fill the container as a gas would. However, unlike a solid, they are not attracted strongly enough to mold the material into a definite shape.
4. The particles are close together because the material cannot be pressed into a smaller space.
5. It exhibits the properties of flow, indefinite shape, and constant volume. Therefore, it is classified as a liquid.

Assessment

Portfolio Students should make a table with the following three headings: GAS, LIQUID, SOLID. Under each, describe the general properties and include three examples from home or school. Use the Performance Task Assessment List for Data Table in **PASC,** p. 37. P

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

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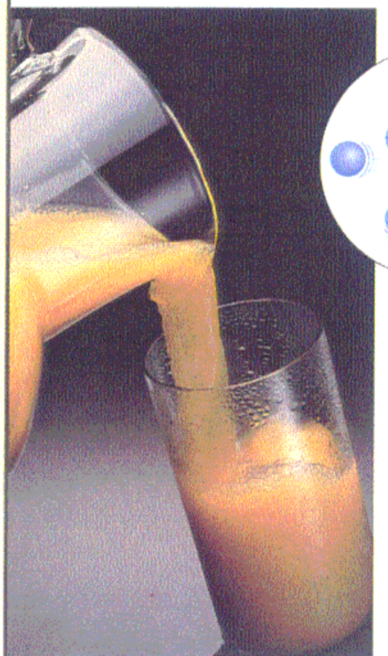

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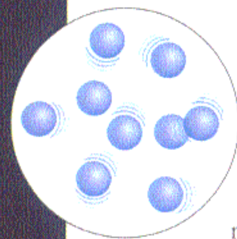

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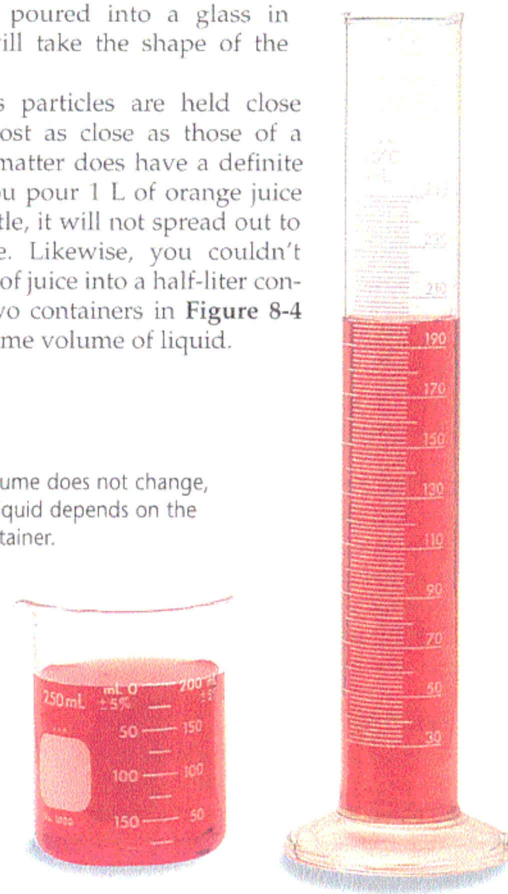

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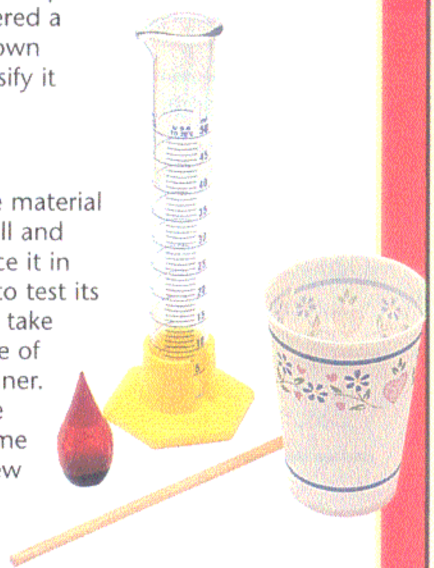

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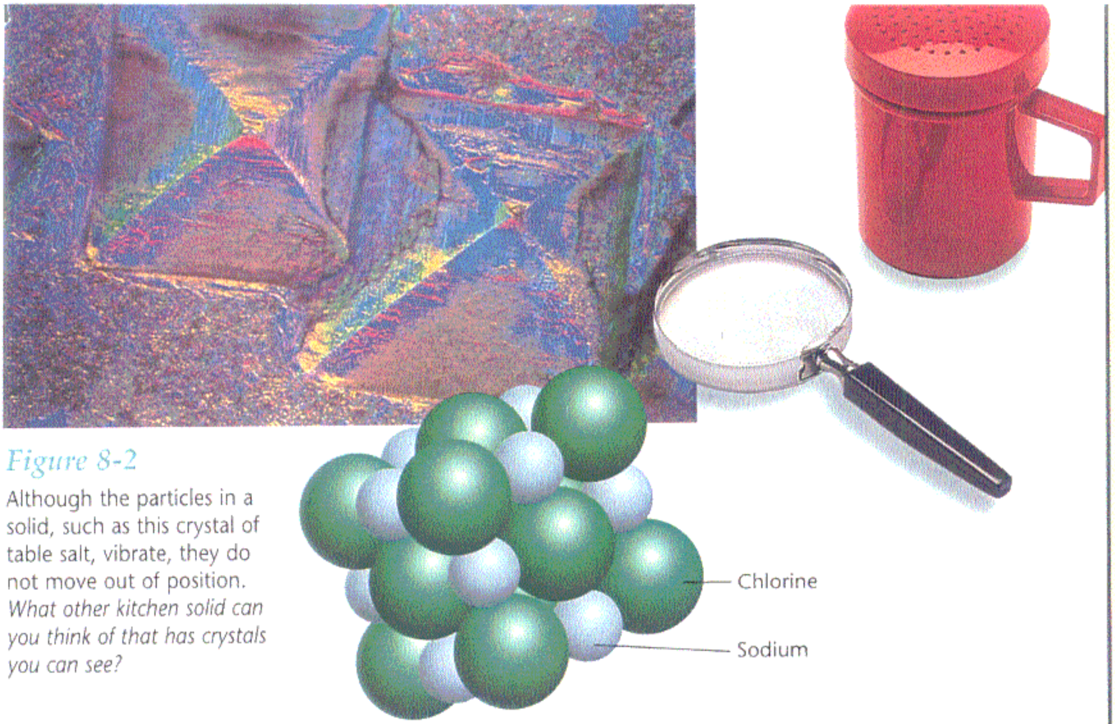

Figure 8-2

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.

Section 8•4

Prepare

Section Background

The gas laws treat gases as ideal. In ideal gases, each molecule has no volume, and there is no attraction between molecules.

Preplanning

Ice will be needed for Activity 8-2. Two balloons will be needed per lab team.

1 Motivate

Bellringer

Before presenting the lesson, display **Section Focus Transparency 33** on the overhead projector. Assign the accompanying **Focus Activity** worksheet. L1 LEP

Demonstration

LS **Visual-Spatial** Fill a small glass to overflowing with water. Hold a 3" × 5" card on top of the glass and invert it. Ask your students what will happen if you take your hand away. Remove your hand. Air pressure will hold the card on the inverted glass. LEP

GLENCOE TECHNOLOGY

Videodisc

Glencoe Physical Science Interactive Videodisc

Side 1, Lesson 3

Gases Exert Pressure

23604-23778

8•4 Behavior of Gases

Science Words

- pressure
- pascal
- Boyle's law
- Charles's law

Objectives

- Explain how a gas exerts pressure on its container.
- State and explain how the pressure of a container of gas is affected when the volume is changed.
- Explain the relationship between the temperature and volume of a gas.

Pressure

Every time you feel the wind on your face, you observe the behavior of a gas—rather, the mixture of gases that is Earth's air, or atmosphere. Even when the wind is calm, the air exerts a force called pressure.

What causes the pressure of a gas? Particles of matter are small—many billions of particles of air fill an inflated toy balloon. When riding on a bike, you're riding on pockets of colliding air particles inside your tires. You have learned that the particles of air, like those in all gases, are constantly moving. They're free to fly about and collide with anything in their way. The collisions with the inside walls keep the balloons or tires inflated and cause the force that you feel when you squeeze them. The motion of the particles in air is illustrated in **Figure 8-14.**

The total amount of force exerted by a gas depends on the size of its container. **Pressure** is the amount of force exerted per unit of area.

$$P = \frac{F}{A}$$

Measuring Pressure

The **pascal** (Pa) is the SI unit of pressure. One pascal of pressure is a force of one newton per square meter. This is a small pressure unit, so most pressures are given in kilopascals (kPa).

Earth's atmosphere exerts pressure on everything within it. At sea level, atmospheric pressure is 101.3 kPa. This means that at Earth's surface, the atmosphere exerts a force of about 100 000 N on every square meter. This amount of force is equal to a weight of 100 000 N—about the weight of a large truck.

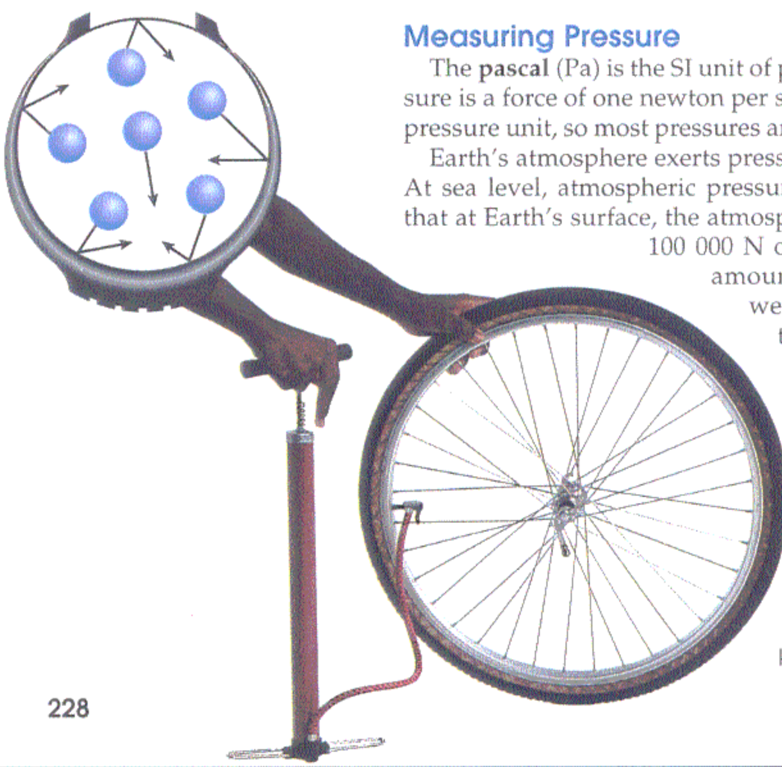

Figure 8-14

The force of particles of air in constant motion colliding with the inside walls of the tire keeps a tire inflated.

Program Resources

Reproducible Masters

Study Guide, p. 37 L1
Reinforcement, p. 37 L1
Enrichment, p. 37 L3
Activity Worksheets, pp. 46, 47 L1
Lab Manual 19

Transparencies

Section Focus Transparency 33 L1
Science Integration Transparency 8