CHAPTER 3
LESSON 2

Minerals

How are minerals identified?

Key Concepts

- Why is it necessary to use more than one property for mineral identification?
- What properties can you use to identify minerals?

Before You Read

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statements or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	3. The best way to identify a mineral is by color.	
	4. Hardness, streak, and luster are among the properties used to identify minerals.	

Mark the Text

Build Vocabulary As you read this lesson, underline each key term. Then, highlight information about each term to use when you review the lesson.

Read to Learn

Physical Properties

You use minerals every day. How did scientists discover the valuable uses for mineral resources? **Mineralogists,** *scientists who study the distribution of minerals, mineral properties, and their uses*, have identified simple tests to help classify unknown minerals. Mineralogists use physical and chemical properties to identify minerals. You can use the same tests to help you discover a mineral's identity.

Color

The color of a mineral can help you identify the mineral. As you learn how to identify minerals, you will discover that color alone cannot be used to identify a mineral. Many different minerals can be the same color. For example, olivine and pyroxene are both green.

In contrast, the same mineral can be different colors. For example, quartz can be clear, white, smoky gray, purple, orange, or pink. The differences in color mean that different types of chemical impurities are in the mineral. Iron, chromium, and manganese are three chemicals that often affect the color of a mineral. If you use color alone to identify an unknown mineral, you might make an incorrect identification.

Key Concept Check

1. Explain Why can't the mineral quartz be classified based on color alone?

Luster

The way that a mineral reflects or absorbs light at its surface is called **luster.** The surfaces of minerals that are metals, such as copper, silver, and gold, reflect light. This produces the shiniest luster, called metallic luster. Nonmetallic minerals have luster that might also be shiny but are not as reflective as a metal. A cut and polished diamond has brilliant luster. A mineral's luster might also be described as waxy, silky, pearly, and vitreous (VIH tree us). A vitreous luster appears glassy. Minerals that do not appear shiny are called earthy or dull. Luster is a result of the chemical makeup of the mineral.

Streak

Some minerals, such as graphite, produce a powder when scratched. Rubbing a mineral across an unglazed porcelain plate will sometimes leave a colored streak on the surface of the plate. **Streak** *is the color of a mineral in powdered form.* Streak is useful only for identifying minerals that are softer than porcelain. Nonmetallic minerals usually produce a white streak. Many metallic minerals are easy to identify because of their streak color. Some minerals vary in color but have a streak that is always the same color.

Hardness

Streak relates to a mineral's makeup and hardness. **Hardness** *is the resistance of a mineral to being scratched.* Friedrich Mohs, a German mineralogist, developed a scale to compare the hardnesses of minerals. The Mohs scale ranges from 1 to 10. Talc is the softest mineral on the scale. It has a hardness value of 1. Diamond is the hardest mineral with a hardness value of 10.

Testing Hardness The mineral quartz has a hardness of 7. This means that when a piece of quartz is rubbed across the surface of a mineral with a hardness less than 7, the quartz will scratch the mineral. Quartz will scratch feldspar, calcite, and talc because each has a hardness less than 7. Quartz will not scratch topaz, corundum, or diamond because they each have a hardness greater than 7.

Comparing Hardness Mineralogists use ordinary objects such as steel and glass to test the hardness of unknown minerals. The hardness of a steel file, a piece of glass, a penny, and your fingernail are known. These objects are included on the Mohs scale. An unknown mineral that scratches a penny but not quartz has a hardness between 3 and 7. If that unknown mineral does not scratch glass, the mineral's hardness is between 3 and 5.5.

FOLDABLES®

Make a half-book to help you describe the physical properties used for identifying minerals.

Reading Check

2. Explain How are streak and color related?

Think it Over

3. Evaluate Why do you think mineralogists added ordinary objects to the Mohs hardness scale?

Visual Check

4. Identify Circle the minerals shown in the table that are hard enough to scratch glass.

Mohs Hardness Scale for Minerals		
Mineral	**Hardness**	**Hardness of Common Objects**
Talc	1 (softest)	
Gypsum	2	fingernail (2.5)
Calcite	3	penny (3.5)
Fluorite	4	iron nail (4.5)
Apatite	5	glass (5.5)
Feldspar	6	steel file (6.5)
Quartz	7	
Topaz	8	
Corundum	9	
Diamond	10 (hardest)	

Look at the Mohs hardness scale above. It lists ten common minerals. Each has been assigned a hardness value. Some common objects and their hardness values are also listed.

Cleavage and Fracture

Sometimes the way a mineral breaks helps identify it. The arrangement of atoms or ions and the strengths of the bonds between atoms determine how a mineral breaks. Minerals break where bonds between atoms or ions are weak. *If a mineral breaks with smooth, flat surfaces, it has* **cleavage.** An example of cleavage is shown in the figure below. The mineral on the left forms a flat surface where it breaks. This characteristic helps identify the mineral.

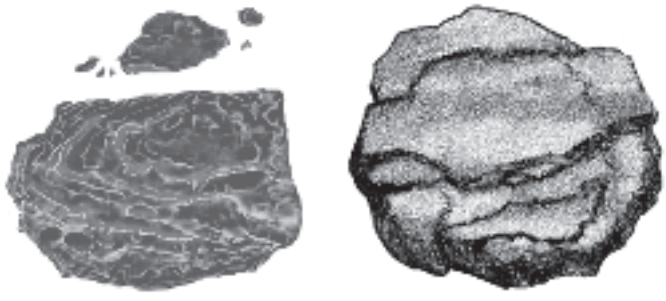
WORD ORIGIN

cleavage
from Old English *cleofan*, means "to split, separate"

Other minerals, such as the one shown below on the right, break unevenly because their bonds are equally strong throughout. *If a mineral breaks to form uneven surfaces, it has* **fracture.** Not all fracture patterns are predictable. Some minerals fracture into splinters or fibers. Others, such as quartz, break like thick glass with smooth and curved surfaces.

Visual Check

5. Identify Write *cleavage* below the correct mineral on the right that shows characteristics of cleavage.



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Density

A bowling ball and a volleyball are about the same size. But a bowling ball is heavier than a volleyball. Why is the volleyball lighter? The volleyball is lighter because it is less dense than a bowling ball. *The* **density** *of an object is equal to its mass divided by its volume* (g/cm^3). A bowling ball has a greater density than a volleyball. The volumes of both balls are almost equal, but the mass of the bowling ball is greater. By measuring the mass and the volume of any object, you can calculate the object's density.

You can compare the densities of two different minerals that are about the same size without having to measure their mass and volume. Hold one mineral in each of your hands. The one that feels heavier is the one with greater mass and a greater density. With practice, you will be able to identify certain minerals based on how heavy they feel.

Special Properties

Some minerals have special properties that help you to identify them, as shown in the table below. For example, graphite feels greasy when you touch it, but talc feels smooth. Some minerals react when they come into contact with certain substances. Other minerals can be identified by their odors, by their magnetic properties, or by their reaction to light. For example, fluorescence is a mineral's ability to glow when exposed to ultraviolet light.

Mineral	Special Properties
Calcite	fizzes and produces gas when it contacts hydrochloric acid; can fluoresce
Fluorite	can fluoresce
Graphite	feels greasy
Kaolinite	smells like clay
Magnetite	is magnetic
Sulfur	smells like a match
Talc	feels smooth

Reading Check

6. Distinguish What is an easy way to decide which one of two minerals has a greater density?

Key Concept Check

7. Identify all the properties used to classify an unknown mineral.

Visual Check

8. Identify Name the two minerals in the table that have similar special properties.

Mini Glossary

cleavage: the breakage of a mineral along smooth, flat surfaces

density: the mass of an object divided by its volume (g/cm^3)

fracture: the breakage of a mineral to form uneven surfaces

hardness: the resistance of a mineral to being scratched

luster: the way a mineral reflects or absorbs light at its surface

mineralogist: a scientist who studies the distribution of minerals, mineral properties, and their uses

streak: the color of a mineral in powdered form

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes how minerals can be identified using luster.

2. Suppose you have three objects—*A*, *B*, and *C*—that are made of unknown materials, and you test their hardness. Object *A* scratches gypsum but does not scratch fluorite. Object *B* scratches object *A*, but not feldspar. Object *C* scratches objects *A* and *B*, but not quartz. Place objects *A*, *B*, and *C* in the chart close to where they would be ranked in hardness.

Hardness Tests

Mineral	Hardness	Hardness of Unknown Objects
Talc	1	
Gypsum	2	
Calcite	3	
Fluorite	4	
Apatite	5	
Feldspar	6	
Quartz	7	

3. Explain the difference between fracture and cleavage.

What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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END OF LESSON