CHAPTER 4

Study Guide

STUDY TO GO

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BIG Idea Minerals are an integral part of daily life.

Vocabulary

Section 4.1 What is a mineral?

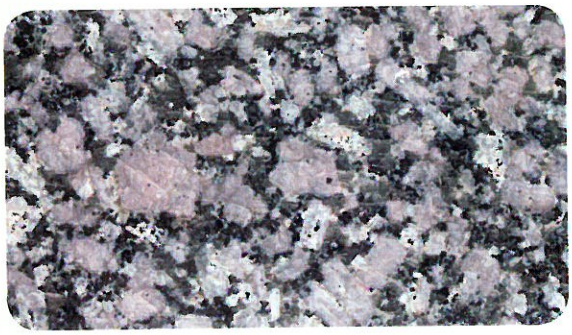
- cleavage (p. 92)
- crystal (p. 87)
- fracture (p. 93)
- hardness (p. 91)
- luster (p. 90)
- mineral (p. 86)
- specific gravity (p. 95)
- streak (p. 93)

Key Concepts

Section 4.1 What is a mineral?

MAIN Idea Minerals are naturally occurring, solid, inorganic compounds or elements.

- A mineral is a naturally occurring, inorganic solid with a specific chemical composition and a definite crystalline structure.
- A crystal is a solid in which the atoms are arranged in repeating patterns.
- Minerals form from magma or from supersaturated solutions.
- Minerals can be identified based on their physical and chemical properties.
- The most reliable way to identify a mineral is by using a combination of several tests.

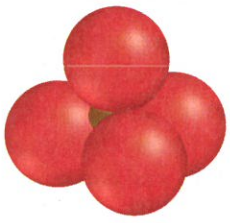


Section 4.2 Types of Minerals

- gem (p. 101)
- ore (p. 100)
- silicate (p. 96)
- tetrahedron (p. 96)

MAIN Idea Minerals are classified based on their chemical properties and characteristics.

- In silicates, one silicon atom bonds with four oxygen ions to form a tetrahedron.
- Major mineral groups include silicates, carbonates, oxides, sulfides, sulfates, halides, and native elements.
- An ore contains a valuable substance that can be mined at a profit.
- Gems are valuable minerals that are prized for their rarity and beauty.



Earth Science online Vocabulary PuzzleMaker glencoe.com

CHAPTER 4 Assessment

Vocabulary Review

Use what you know about the vocabulary terms listed on the Study Guide to answer the following questions.

1. What is a naturally occurring, solid, inorganic compound or element?
2. What term refers to the regular, geometric shapes that occur in many minerals?
3. What is the term for minerals containing silicon and oxygen?

Explain the relationship between the vocabulary terms in each pair.

4. ore, gem
5. silicate, tetrahedron

Complete the sentences below using vocabulary terms from the Study Guide.

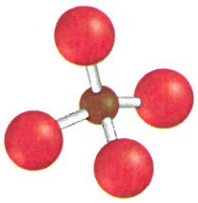
6. Minerals that break randomly exhibit _____.
7. The _____ test determines what materials a mineral will scratch.

Understand Key Concepts

Use the photo below to answer Question 8.

8. Which mineral property is being tested?
   - **A.** texture
   - **B.** hardness
   - **C.** cleavage
   - **D.** streak
9. Which property causes the mineral galena to break into tiny cubes?
   - **A.** density
   - **B.** crystal structure
   - **C.** hardness
   - **D.** luster
10. What characteristic is used for classifying minerals into individual groups?
    - **A.** internal atomic structure
    - **B.** presence or absence of silica tetrahedrons
    - **C.** chemical composition
    - **D.** density and hardness
11. A mineral has a mass of 100 g and a volume of 50 cm^3. What is its density?
    - **A.** 5000 g/cm^3
    - **B.** 2 g/cm^3
    - **C.** 5 g/cm^3
    - **D.** 150 g/cm^3
12. What is the correct chemical formula for a silica tetrahedron?
    - **A.** SiO_2
    - **B.** $Si_2O_2^{+4}$
    - **C.** SiO_4^{-4}
    - **D.** Si_2O_2

Use the diagram below to answer Questions 13 and 14.



13. Where do the tetrahedra bond to each other?
    - **A.** the center of the silicon atom
    - **B.** at any oxygen atom
    - **C.** only the top oxygen atom
    - **D.** only the bottom oxygen atoms
14. What group of minerals is composed mainly of these tetrahedra?
    - **A.** silicates
    - **B.** oxides
    - **C.** carbonates
    - **D.** sulfates
15. Which is an example of a mineral whose streak cannot be determined with a porcelain streak plate?
    - **A.** hematite
    - **B.** gold
    - **C.** feldspar
    - **D.** magnetite

16. Which is one of the three most common elements in Earth's crust?
   A. sodium
   B. silicon
   C. iron
   D. carbon

Use the table below to answer Question 17.

Mineral Formulas

Name	Formula
Quartz	SiO_2
Feldspar	$NaAlSi_3O_8$— $CaAl_2Si_2O_8$ & $KalSi_3O_8$
Amphibole	$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$ $Fe_7Si_8O_{22}(OH)_2$
Olivine	$(Mg,Fe)_2SiO_4$

17. What is the main factor that determines the formation of the minerals listed in the table?
   A. rate of magma cooling
   B. temperature of the magma
   C. presence or absence of water
   D. changes in pressure

18. Calcite is the dominant mineral in the rock limestone. In which mineral group does it belong?
   A. silicates **C.** carbonates
   B. oxides **D.** sulfates

19. What mineral fizzes when it comes in contact with hydrochloric acid?
   A. quartz **C.** calcite
   B. gypsum **D.** fluorite

20. *Dull, silky, waxy, pearly,* and *earthy* are terms that best describe which property of minerals?
   A. luster
   B. color
   C. streak
   D. cleavage

21. For a mineral to be considered an ore, which requirement must it meet?
   A. It must be a common mineral.
   B. Its production must not generate pollution.
   C. It must be naturally occurring.
   D. Its production must generate a profit.

Constructed Response

22. **Explain** why rubies and sapphires, which are both forms of the mineral corundum, are different colors.

23. **Describe** the visual effect of placing a piece of clear, Iceland spar on top of the word *geology* in a textbook.

24. **Summarize** the process of sugar crystals forming in a glass of sugar-sweetened hot tea.

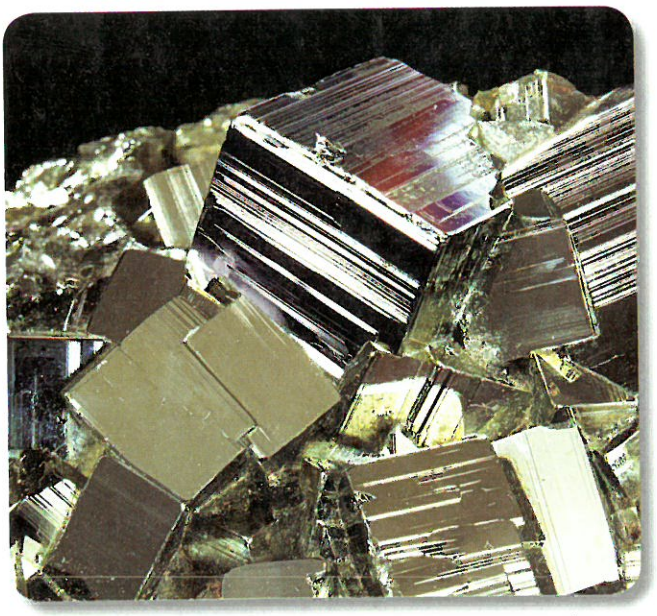
25. **Hypothesize** which mineral properties are the direct result of the arrangement of atoms or ions in a crystal. Explain your answer.

26. **Compare and Contrast** Diamond and graphite have the same chemical composition. Compare and contrast these two to explain why diamond is a gem and graphite is not.

Think Critically

27. **Describe** the differences that might be exhibited by the garnets listed in **Table 4.1.**

Use the figure below to answer Question 28.



28. **Illustrate** what the atomic structure might be if the crystal shape is an external reflection of it.

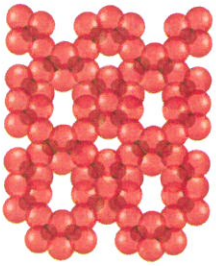
29. **Recommend** which minerals, other than diamond, would be best for making sandpaper. Explain your answer. Refer to **Table 4.2.**

30. **Decide** which of the following materials are not minerals, and explain why: petroleum, wood, coal, steel, concrete, and glass.

31. **Infer** how early prospectors used density to determine whether they had found gold or pyrite in a mine.

32. **Assess** Imagine that a new gem is discovered that is more beautiful than the most stunning diamond or ruby. Assess the factors that will determine its cost compared to other known gems.

Use the figure below to answer Questions 33–34.



33. **Infer** Mica is a mineral with a sheet silicate structure. The atomic arrangement is shown above. Infer what is holding these sheets, which consist of negatively charged silicon-oxygen tetrahedra, together.

34. **Describe** the type of cleavage that occurs in minerals with the atomic arrangement shown.

Concept Mapping

35. Create a concept map using the following terms: *silicates, oxides, halides, sulfates, sulfides, native elements,* and *carbonates.* Add any other terms that are helpful. For more help, refer to the *Skillbuilder Handbook.*

Challenge Question

36. **Arrange** In addition to sheet silicates, there are chain silicates, tectosilicates, and cyclosilicates. Arrange six silica tetrahedra in a cyclosilicate form. Be sure to bond the oxygen atoms correctly.

Additional Assessment

37. **WRITING in Earth Science** Imagine that you are planning a camping trip. What tools should you pack if you want to identify interesting minerals? How would you use these tools?

DBQ Document–Based Questions

Data obtained from: Plunkert, P.A. 2005. Mineral resource of the month: Aluminum. *Geotimes* 50:57.

Aluminum is an abundant metallic element in Earth's crust. It is lightweight, ductile [bendable], corrosion resistant, and a good conductor of electricity. It is used most often in the manufacture of cars, buses, trailers, ships, aircraft, railway and subway cars. Other uses include beverage cans, aluminum foil, machinery, and electrical equipment.

Aluminum is produced from bauxite (hydrated aluminum-oxide) deposits, located mostly in Guinea, Australia, and South America. The United States does not have bauxite deposits; it imports it from Brazil, Guinea, and Jamaica. Total world aluminum production is approximately 30 million metric tons per year. U.S. aluminum production is less than U.S. aluminum consumption. Leading aluminum producers are China and Russia. A major part (3 million metric tons per year) of the U.S. aluminum supply comes from recycling.

38. Interpret the relationship between aluminum's resistance to corrosion and its use in transportation vehicles.

39. Propose a plan for how the United States can increase aluminum production without increasing the amount it imports.

40. Predict the possible effects an increase in U.S. production would have on Guinea, Jamaica, and China.

Cumulative Review

41. How do different isotopes of an element differ from each other? **(Chapter 3)**

42. Why is an understanding of the study of Earth science important to us as residents of Earth? **(Chapter 1)**

Standardized Test Practice

Multiple Choice

1. What is the second most abundant element in Earth's crust?
   - A. nitrogen
   - B. oxygen
   - C. silicon
   - D. carbon

Use the table below to answer Questions 2 and 3.

Mineral Characteristics			
Mineral	**Hardness**	**Specific Gravity**	**Luster/Color**
Feldspar	6–6.5	2.5–2.8	nonmetallic/colorless or white
Fluorite	4	3–3.3	nonmetallic/yellow, blue, purple, rose, green, or brown
Galena	2.5–2.75	7.4–7.6	metallic/grayish black
Quartz	7	2.65	nonmetallic/colorless in pure form

2. What is the hardest mineral in the table?
   - A. feldspar
   - B. fluorite
   - C. galena
   - D. quartz

3. Which mineral most likely has a shiny appearance?
   - A. feldspar
   - B. fluorite
   - C. galena
   - D. quartz

4. What can be inferred about an isotope that releases radiation?
   - A. It has unstable nuclei.
   - B. It has stable nuclei.
   - C. It has the same mass number as another element.
   - D. It is not undergoing decay.

5. How do electrons typically fill energy levels?
   - A. from lowest to highest
   - B. from highest to lowest
   - C. in no predictable pattern
   - D. all in one energy level

6. What is the most reliable clue to a mineral's identity?
   - A. color
   - B. streak
   - C. hardness
   - D. luster

Use the table below to answer Questions 7 and 8.

Mineral	Hardness
Talc	1
Gypsum	2
Calcite	3
Fluorite	4
Apatite	5
Feldspar	6
Quartz	7
Topaz	8
Corundum	9
Diamond	10

7. Which mineral will scratch feldspar but not topaz?
   - A. quartz
   - B. calcite
   - C. apatite
   - D. diamond

8. What can be implied about diamond based on the table?
   - A. It is the heaviest mineral.
   - B. It is the slowest mineral to form.
   - C. It has the most defined crystalline structure.
   - D. It cannot be scratched by any other mineral.

9. A well-planned experiment must have all of the following EXCEPT
   - A. technology
   - B. a control
   - C. a hypothesis
   - D. collectible data

10. What name is given to the imaginary line circling Earth halfway between the north and south poles?
    - A. prime meridian
    - B. equator
    - C. latitude
    - D. longitude

Short Answer

Use the conversion factor and table below to answer Questions 11–13.

1.0 carat = 0.2 grams

Diamond	Carats	Grams
Uncle Sam: largest diamond found in United States	40.4	?
Punch Jones: second largest; named after boy who discovered it	?	6.89
Theresa: discovered in Wisconsin in 1888	21.5	4.3
2001 diamond production from western Australia	21,679,930	?

11. List the three diamonds from least to greatest according to carats, and list the carats.

12. How many kilograms of diamonds were produced in western Australia in 2001?

13. Why would a diamond excavator want to convert the diamond measurement from carats to grams?

14. Why are map scales important parts of a map?

15. Discuss how a scientist might use a Landsat satellite image to determine the amount of pollution being produced by a city.

16. Why might a mineral no longer be classified as an ore?

Reading for Comprehension

Silicon Valley

Silicon (Si) is the second most abundant element in Earth's crust, but we didn't hear much about it until Silicon Valley. It is present in measurable amounts in nearly every rock, in all natural waters, as dust in the air, in the skeletons of many plants and some animals, and even in the stars. Silicon is never found in the free state like gold or silver, but is always with oxygen (O), aluminum (Al), magnesium (Mg), calcium (Ca), sodium (Na), potassium (K), iron (Fe), or other elements in combinations called the silicates. Silicates are the largest and most complicated group of minerals. Silicon is dull gray in appearance and has a specific gravity of 2.42. It has valence electrons like carbon (C) and can form a vast array of chemical compounds like silicon carbide abrasive, silicon rubber and caulking, oils and paints. Pure silicon is used in semiconductors, as solar panels to generate electricity from light, and in microchips for transistors.

Information obtained from: Ellison, B. Si and SiO_2...or what a difference a little O makes. (online resource accessed October 2006.)

17. According to the text, what is the most challenging aspect of silicon?

A. It has valence electrons.
B. It is dull gray in appearance.
C. It is never found in its free state.
D. It is present in many places.

18. Which is NOT a use of silicon as a chemical compound given in this passage?

A. silicon rubber and caulking
B. silicon carbide abrasive
C. microchips for transistors
D. oils and paints

19. Why was silicon not widely known until Silicon Valley?

NEED EXTRA HELP?																
If You Missed Question . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Review Section . . .	4.2	4.1	4.1	3.1	3.6	4.1	4.1	4.1	1.2	2.1	4.2	4.2	1.2	2.2	2.3	3.2