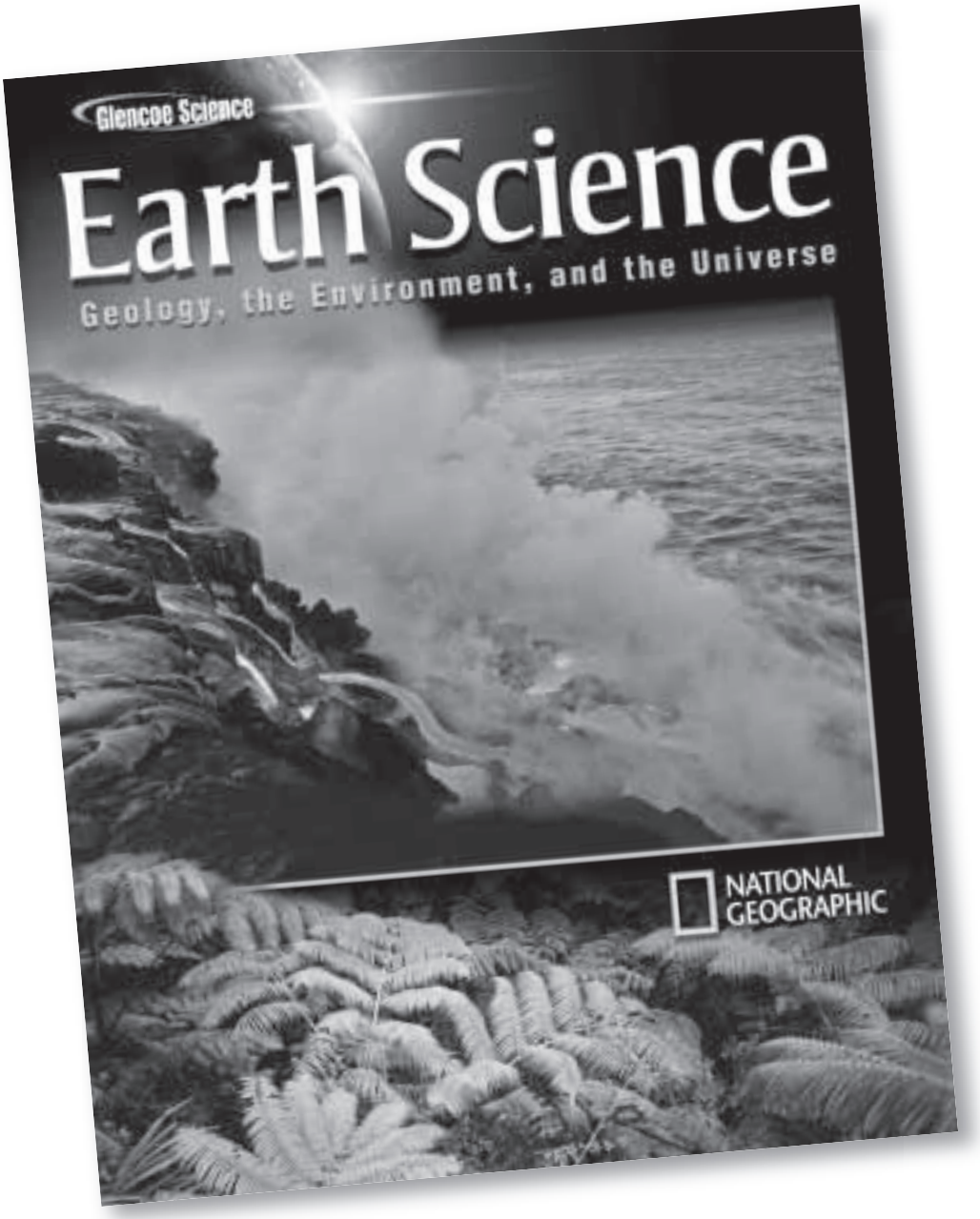
UNIT 2 RESOURCES

Composition of Earth



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Unit 2 Composition of Earth

Reproducible Student Pages

Teacher Guide and Answers

Teacher Approval Initials
Date of Approval

Lab Safety Form

Name: _____

Date: _____

Lab type (circle one) : Launch Lab, MiniLab, GeoLab

Lab Title: _____

Read carefully the entire lab and then answer the following questions. Your teacher must initial this form before you begin.

1. What is the purpose of the investigation?

_____

_____

_____

2. Will you be working with a partner or on a team? _____

3. Is this a design-your-own procedure? Circle: Yes No

4. Describe the safety procedures and additional warnings that you must follow as you perform this investigation.

_____

_____

_____

5. Are there any steps in the procedure or lab safety symbols that you do not understand? Explain.

_____

_____

_____

Table of Contents

Reproducible Pages

Chapter 3 Matter and Change

Name Class Date

MiniLab 3

Identify Elements

What elements are in your classroom? Most substances on Earth occur in the form of chemical compounds. Around your classroom, there are numerous objects or substances that consist mostly of a single element.

Procedure

1. Read and complete the lab safety form.
2. Create a data table with the following column headings: Article, Element, Atomic Number, Properties.
3. Name three objects in your classroom and the three different elements of which they are made.
4. List the atomic numbers of these elements and describe some of their properties.

Analysis

1. **Categorize** List two examples of a solid, a liquid, and a gaseous object or substance.

_____

_____

_____

2. **Compare and contrast** liquids, solids, and gases.

_____

_____

_____

Name Class Date

GeoLab Precipitate Salt

Many rocks on Earth form from salts precipitating out of seawater. Salt ions precipitate when a salt solution becomes saturated. Solubility is the ability of a substance to dissolve in a solution. When a solution is saturated, no more of that substance can be dissolved. What is the effect of temperature and evaporation on salt precipitation? How do precipitation rates affect the size of crystals?

PREPARATION

Problem

Under what conditions do salt solutions become saturated and under what conditions does salt precipitate out of solution?

Materials

halite (sodium chloride)
250-mL glass beakers (2)
distilled water
plastic wrap
laboratory scale
hot plate
shallow glass baking dish
refrigerator
glass stirring rod

Objectives

In this GeoLab, you will:

- **Observe** salt dissolving and precipitating from a saturated salt solution.
- **Identify** the precipitated salt crystals.
- **Compare** the salt crystals that precipitate out under different conditions.
- **Hypothesize** why different conditions produce different results.

Safety Precautions

Always wear safety goggles and an apron in the lab. Wash your hands after handling salt solutions. Use care in handling hot solutions. Use protection handling hot glassware.

PROCEDURE

1. Read and complete the lab safety form.
2. Make a data table to record your observations.
3. Pour 150 mL of distilled water into a 250-mL glass beaker. Add 54 g of sodium chloride to the distilled water in the beaker and stir until only a few grains remain on the bottom of the beaker.
4. Place the beaker on the hot plate and turn the hot plate on. As the solution inside the beaker heats up, stir it until the last few grains of sodium chloride dissolve. The salt solution will then be saturated.
5. Pour 50 mL of the warm, saturated solution into the second 250-mL glass beaker. Cover this beaker with plastic wrap so that it forms a good seal. Put this beaker in the refrigerator.
6. Pour 50 mL of the saturated solution into the shallow glass baking dish. Place the dish on the hot plate and heat the salt solution until all the liquid evaporates. *CAUTION: The baking dish will be hot. Handle with care.*
7. Place the original beaker with 50 mL of the remaining solution on a shelf or windowsill. Do not cover the beaker.
8. Observe both beakers one day later. If crystals have not formed, wait another day to make your observations and conclusions.
9. Once crystals have formed in all three containers, observe the size and shape of the precipitated crystals. Describe your observations in your data table.

Name Class Date

GeoLab Precipitate Salt

ANALYZE AND CONCLUDE

1. **Describe** the shape of the precipitated crystals in the three containers. Does the shape of the crystals alone identify them as sodium chloride?

2. **Infer** how heating the salt solution affected the solubility of the sodium chloride.

3. **Interpret** what effect cooling has on the solubility of salt. What effect does evaporation have on the solubility of salt?

4. **Evaluate** the relationship between rate of cooling and crystal size.

Name Class Date

GeoLab Precipitate Salt

INQUIRY EXTENSION

Use Other Substances Design an experiment to investigate other soluble substances. Test to see how much of the substance can be dissolved in a given amount of water, how long it takes for the solution to evaporate, and what crystal shapes form. Prepare a short report to share with your class.

Use with Chapter 3
Section 3.1

Atomic Structure of 14 Elements

Atomic Structure of 14 Elements

Element Name	Symbol	Atomic Number	Mass Number
Hydrogen	H	1	1
Helium	He	2	4
Oxygen	O	8	16
Carbon	C	6	12
Neon	Ne	10	20
Nitrogen	N	7	14
Magnesium	Mg	12	24
Silicon	Si	14	28
Iron	Fe	26	56
Sulfur	S	16	32
Sodium	Na	11	23
Chlorine	Cl	17	35
Potassium	K	19	39
Argon	Ar	18	40

Name Class Date

WORKSHEET 7 TEACHING TRANSPARENCY

Use with Chapter 3
Section 3.1

Atomic Structure of 14 Elements

1. How can you determine the number of protons in the nucleus of an atom of any of the elements listed in the table?

2. Which element has 14 protons in the nuclei of its atoms?

3. Explain how you can determine the number of electrons surrounding the nucleus of an atom of any of the elements listed in the table.

4. Which element has 19 electrons surrounding the nuclei of its atoms?

5. Explain how you can determine the number of neutrons in the nucleus of an atom of any of the elements listed in the table.

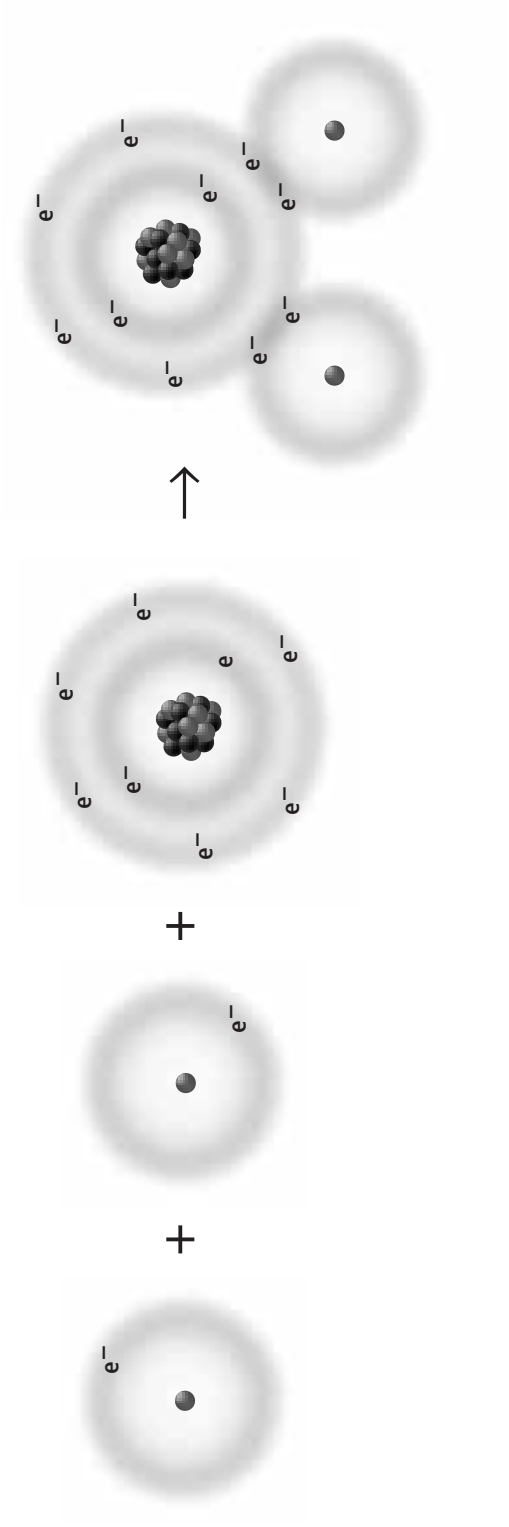
6. Which element does not have a neutron in the nuclei of its atoms?

7. How many neutrons are present in the nucleus of an iron atom?

8. How many protons, neutrons, and electrons are present in and surrounding the nucleus of a chlorine atom?

Use with Chapter 3
Section 3.2

Covalent and Ionic Bonds



Name Class Date

WORKSHEET 8 TEACHING TRANSPARENCY

Use with Chapter 3
Section 3.2

Covalent and Ionic Bonds

1. How many valence electrons are in a single hydrogen (H) atom and in a single oxygen (O) atom?

2. How many additional electrons does a hydrogen (H) atom need to complete its outermost energy levels? How many does an oxygen (O) atom need?

3. When two hydrogen atoms and one oxygen atom combine to form water, what type of bond forms between the atoms? How many electrons are involved in this bond?

4. What is a formed when two or more atoms are held together by covalent bonds?

5. Why does a sodium atom tend to form a positive ion, whereas a chlorine atom tends to form a negative ion?

6. When a sodium atom and a chlorine atom combine to form sodium chloride, what type of bond forms between the atoms?

7. What is the net electrical charge on the compound sodium chloride (NaCl)?

Name Class Date

CHAPTER 3 STUDY GUIDE

Matter and Change

SECTION 3.1 *Matter*

In your textbook, read about elements and atomic structure.
Use each of the terms below just once to complete the passage.

atom electrons element neutrons nucleus protons

A(n) **(1)** _____ is a substance that cannot be broken down into simpler substances. A(n) **(2)** _____ is the smallest particle of matter having all that element's characteristics. It is made up of smaller particles. The **(3)** _____ is made up of protons and neutrons. Small particles that have mass and positive electrical charges are **(4)** _____. Particles that have about the same mass as protons, but that are electrically neutral are **(5)** _____. Surrounding the nucleus of an atom are tiny particles called **(6)** _____, which have little mass, but have negative electrical charges that are exactly the same magnitude as the positive charges of protons.

In your textbook, read about atomic structure and isotopes.
Complete each statement.

7. The number of protons in an atom's nucleus is the _____.

8. When atoms of the same element have different mass numbers, they are known as _____ of that element.

9. The spontaneous process through which unstable nuclei emit radiation is called _____.

10. A(n) _____ represents the area in an atom where an electron is most likely to be found.

11. An atom that gains or loses an electron and has an electric charge is called a(n) _____.

12. The combined number of protons and neutrons is the _____.

13. The _____ is the average of the mass numbers of the isotopes of an element.

SECTION 3.1 *Matter continued*

In your textbook, read about electrons in energy levels and isotopes.
Circle the letter of the choice that best completes the statement or answers the question.

14. How many electrons can be held in the innermost energy level of atoms?
a. 2 **b.** 8 **c.** 18 **d.** 32

15. How many electrons can the fourth energy level hold?
a. 2 **b.** 8 **c.** 18 **d.** 32

16. Many elements are mixtures of
a. oxygen. **b.** electrons. **c.** neutrons. **d.** isotopes.

17. The chemical behavior of different elements is determined by the
a. number of electrons in the innermost energy level.
b. number of electrons in the middle energy level.
c. number of electrons in the outermost energy level.
d. total number of electrons in all of the energy levels.

18. How many electrons can an atom's third energy level hold?
a. 2 **b.** 8 **c.** 18 **d.** 32

19. Elements with a full outermost energy level are
a. unlikely to combine chemically with other elements.
b. likely to combine chemically with other elements.
c. likely to combine with inert elements.
d. likely to combine with many elements at one time.

20. The identity of an element is defined by its number of
a. electrons.
b. protons.
c. neutrons.
d. isotopes.

21. How many electrons can an atom's second energy level hold?
a. 2 **b.** 8 **c.** 18 **d.** 32

SECTION 3.2 *Combining Matter*

In your textbook, read about different types of bonds, chemical reactions, and mixtures.
For each item in Column A, write the letter of the matching item in Column B.

Column A		Column B
_____	**1.** A combination of two or more components that retain their identity	**a.** acid
_____	**2.** The attraction of two atoms for a shared pair of electrons that hold the atoms together	**b.** base
_____	**3.** A substance that is composed of atoms of two or more different elements that are chemically combined	**c.** chemical bonds
_____	**4.** A solution containing a substance that produces hydrogen ions (H^+) in water	**d.** chemical reaction
_____	**5.** Bond in which valence electrons are shared by all atoms	**e.** compound
_____	**6.** Composed of two or more atoms held together by covalent bonds	**f.** covalent bond
_____	**7.** A homogeneous mixture	**g.** metallic bond
_____	**8.** The attractive force between two ions of opposite charge	**h.** ionic bond
_____	**9.** The forces that hold the elements together in a compound	**i.** mixture
_____	**10.** A solid homogeneous mixture	**j.** molecule
_____	**11.** A solution characterized by the formation of hydroxide ions (OH^-)	**k.** solid solution
_____	**12.** The change of one or more substances into other substances	**l.** solution

SECTION 3.2 *Combining Matter, continued*

In your textbook, read about chemical bonds.
Complete the table below by writing the type or types of chemical bond found in the type of matter on the left. Use the following types of chemical bonds: *covalent, ionic, metallic*.

Matter	Type of Chemical Bond Present
13. Molecule	
14. Hydrogen gas (H_2)	
15. Magnesium oxide (MgO)	
16. Metal	
17. Table salt (NaCl)	
18. Sodium monoxide (Na_2O)	
19. Water	

In your textbook, read about chemical reactions and mixtures.
Examine equations A and B below. Then answer the questions.

(A) $2H_2 + O_2 \Rightarrow 2H_2O$ (B) $H_2CO_3 \rightarrow H^+ + HCO_3^-$

_____ **20.** Which equation represents the formation of water?

_____ **21.** Which equation represents the formation of an acid solution?

_____ **22.** How many atoms of oxygen (O) are on both sides of equation A?

_____ **23.** How many atoms of hydrogen (H) are on both sides of equation A?

_____ **24.** How many atoms of hydrogen (H) are on both sides of equation B?

_____ **25.** In which equation are carbonic acid molecules broken apart into hydrogen ions and bicarbonate ions?

SECTION 3.3 *States of Matter*

In your textbook, read about the cycles of matter and the different states of matter.
For each statement below, write *true* or *false*.

_____ **1.** Most solids have a crystalline structure in which the particles are arranged in regular geometric patterns.

_____ **2.** Hot, highly ionized, electrically conducting gas is called plasma.

_____ **3.** The change of state from solid to gas without an intermediate liquid state is called evaporation.

_____ **4.** A glass is a solid that consists of densely packed atoms arranged at random.

_____ **5.** The change from a solid to a liquid is called condensation.

_____ **6.** The process of changing from a liquid to a gas is called sublimation.

_____ **7.** There are only three states of matter in the universe.

_____ **8.** Matter cannot be created or destroyed.

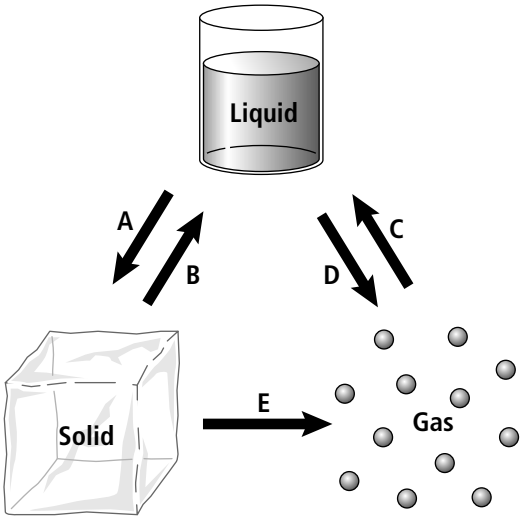
In your textbook, read about the states of matter.
Complete the table by filling in the missing information.

The States of Matter

State of Matter	Definition of State	Example
9.	Hot, highly ionized, electrically conducting gases	Lightning, neon sign, the Sun, other stars
10. Liquid		
11.	Made of densely packed particles arranged in a definite pattern; has both a definite shape and volume	
12.		Helium

SECTION 3.3 *States of Matter, continued*

In your textbook, read about changes of state.
Examine the diagram below. Then answer the questions.



13. What change of state is represented by arrow A?

14. What change of state is represented by arrow B?

15. What change of state is represented by arrow C?

16. What change of state is represented by arrow D?

17. What change of state is represented by arrow E?

18. How is thermal energy involved in the processes of melting and evaporation?

19. How is thermal energy involved in the processes of freezing and condensation?

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Reproducible Pages

Chapter 4 Minerals

Name Class Date

MiniLab 4

Recognize Cleavage and Fracture

How is cleavage used? Cleavage forms when a mineral breaks along a plane of weakly bonded atoms. If a mineral has no cleavage, it exhibits fracture. Recognizing the presence or absence of cleavage and determining the number of cleavage planes is a reliable method of identifying minerals.

Procedure 

Part 1

1. Read and complete the lab safety form.
2. Obtain five **mineral samples** from your teacher. Separate them into two sets–those with cleavage and those without cleavage.
3. Arrange the minerals that have cleavage in order from fewest to most cleavage planes. How many cleavage planes does each sample have? Identify these minerals if you can.
4. Examine the samples that have no cleavage. Describe their surfaces. Identify these minerals if you can.

Part 2

5. Obtain two more samples from your teacher. Are these the same mineral? How can you tell?
6. Use a **protractor** to measure the cleavage plane angles of both minerals. Record your measurements.

Analysis

1. **Record** the number of cleavage planes or presence of fracture for all seven samples.

2. **Compare** the cleavage plane angles for Samples 6 and 7. What do they tell you about the mineral samples?

3. **Predict** the shape each mineral would exhibit if you were to hit each one with a hammer.

Name Class Date

DESIGN YOUR OWN GeoLab

Make a Field Guide for Minerals

Have you ever used a field guide to identify a bird, flower, rock, or insect? If so, you know that field guides include far more than photographs. A typical field guide for minerals might include background information about minerals in general, plus specific information about the formation, properties, and uses of each mineral. In this activity, you'll create a field guide for minerals.

PREPARATION

Problem

How would you go about identifying minerals? What physical and chemical properties would you test? Which of these properties should be included in a field guide to help others to identify unknown minerals?

Possible Materials

mineral samples
magnifying lens
glass plate
streak plate
Mohs scale of mineral hardness
dilute hydrochloric acid (HCl)
steel file or nail
piece of copper
paper clip
magnet
Reference Handbook
dropper

Hypothesis

As a group, form a hypothesis about which property or properties might be most useful in identifying minerals. Write your hypothesis in the space below.

_____

_____

_____

Objectives

In this GeoLab, you will:

- **Conduct** tests on unknown minerals to determine their physical and chemical properties.
- **Identify** minerals based on the results of your tests.
- **Design** a field guide for minerals.

Safety Precautions

Review the safe use of acids. HCl may cause burns. If a spill occurs, rinse your skin with water and notify your teacher immediately.

Name Class Date

DESIGN YOUR OWN GeoLab

Make a Field Guide for Minerals

PROCEDURE

1. Read and complete the lab safety form.
2. As a group, list the steps that you will take to create your field guide. Keep the available materials in mind as you plan your procedure.
3. Should you test any of the properties more than once for any of the minerals? How will you determine whether certain properties indicate a specific mineral?
4. Design a data table to summarize your results. Be sure to include a column to record whether or not a particular test will be included in the guide. You can use this table as the basis for your field guide.
5. Read over your entire plan to make sure that all steps are in a logical order.
6. Have you included a step for additional research? You might have to use the library or **glencoe.com** to gather all the necessary information for your field guide.
7. What additional information will be included in the field guide? Possible data include how each mineral formed, its uses, its chemical formula, and a labeled photograph or drawing of the mineral.
8. Make sure your teacher approves your plan before you proceed.

ANALYZE AND CONCLUDE

1. **Interpret** Which properties were most reliable for identifying minerals? Which properties were least reliable? Discuss reasons why one property is more useful than others.

2. **Observe and Infer** What mineral reacted with the hydrochloric acid? Why did the mineral bubble? Write the balanced equation that describes the chemical reaction that took place between the mineral and acid.

Name Class Date

DESIGN YOUR OWN GeoLab

Make a Field Guide for Minerals

ANALYZE AND CONCLUDE

3. **Summarize** What information did you include in the field guide? What resources did you use to gather your data? Describe the layout of your field guide.

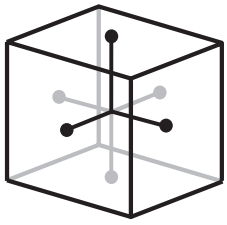
4. **Evaluate** the advantages and disadvantages of field guides.

5. **Conclude** Based on your results, is there any one definitive test that can always be used to identify a mineral? Explain your answer.

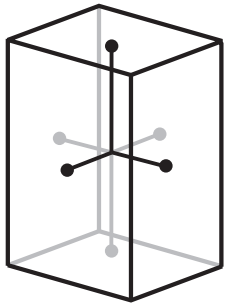
Use with Chapter 4
Section 4.1

Crystal Systems

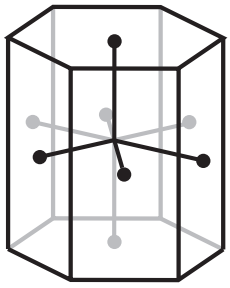
Crystal Systems



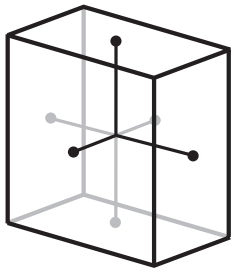
Cubic



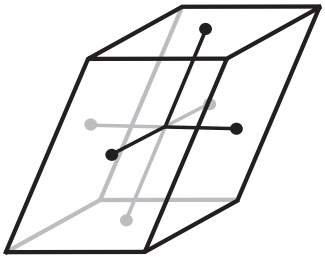
Tetragonal



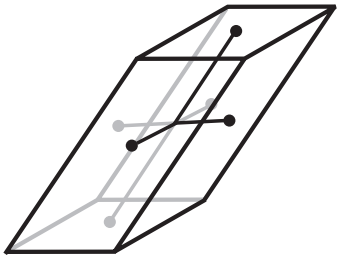
Hexagonal



Orthorhombic



Monoclinic



Triclinic

Name Class Date

WORKSHEET 9 TEACHING TRANSPARENCY

Use with Chapter 4
Section 4.1

Crystal Systems

1. What is a crystal?

2. How many sides do crystals of each of the six major crystal systems have?

3. Pyromophite is an example of what crystal system?

4. How would you use crystal structure to tell a crystal of pyrite from a crystal of gypsum?

5. Name a mineral in the triclinic crystal system.

6. Under what conditions can minerals grow to form well-defined crystal shapes like those pictured?

7. Do mineral crystals tend to appear in one of the six well-defined shapes shown in the table? Why or why not?

8. How are atoms arranged in crystalline structures?

Use with Chapter 4
Section 4.2

Mohs Hardness Scale

Mohs Hardness Scale			
	Hardness		Hardness of Common Objects
Talc	1	(softest)	
Gypsum	2		fingernail (2.5)
Calcite	3		piece of copper (3.5)
Fluorite	4		iron nail (4.5)
Apatite	5		glass (5.5)
Feldspar	6		steel file (6.5)
Quartz	7		streak plate (7)
Topaz	8		scratches quartz
Corundum	9		scratches topaz
Diamond	10	(hardest)	scratches all common materials

Name Class Date

WORKSHEET 10 TEACHING TRANSPARENCY

Use with Chapter 4
Section 4.2

Mohs Hardness Scale

1. What does the property of mineral hardness measure?

2. What is the softest mineral shown, and what is its hardness on the Mohs scale?

3. What is the hardest mineral shown, and what is its hardness on the Mohs scale?

4. Explain how you could estimate the hardness of a mineral that does not appear on the Mohs scale.

5. Which common object will scratch feldspar?

6. Which minerals on the Mohs scale will scratch apatite? Which will apatite scratch?

7. What is the hardness of a mineral that scratches gypsum but cannot scratch calcite? Explain your answer.

Name Class Date

CHAPTER 4 STUDY GUIDE

Minerals

SECTION 4.1 *What is a mineral?*

In your textbook, read about mineral characteristics.

Answer the following questions.

1. What is a mineral?

2. Why is salt classified as a mineral, but sugar is not?

3. Can minerals occur as liquids? Why or why not?

4. Can the chemical composition of a single mineral vary? Explain your answer.

5. What is a crystal?

6. How does forming in a restricted space affect the structure of a crystal?

7. What does the definite crystalline structure of a mineral consist of?

8. Why are feldspars considered to be minerals even though their compositions can vary?

SECTION 4.1 *What Is a mineral?, continued*

In your textbook, read about minerals that formed from magma and that formed from solution.
For each statement, write *true* or *false*.

_____ **9.** Minerals can form from the cooling of magma.

_____ **10.** Density differences can force magma upward into cooler layers of Earth's interior.

_____ **11.** If magma cools slowly, atoms do not have time to arrange themselves into large crystals.

_____ **12.** Small crystals form from rapidly cooling magma.

_____ **13.** When liquid evaporates from a solution, the remaining elements cannot form crystals.

_____ **14.** Minerals can form from elements dissolved in a solution.

_____ **15.** If a solution remains unsaturated, mineral crystals may precipitate.

CHAPTER 4 STUDY GUIDE

SECTION 4.1 *What is a Mineral?*

In your textbook, read about mineral identification.
Use each of the terms below just once to complete the passage.

cleavage	**color**	**fracture**	**hardness**
luster	**specific gravity**	**streak**	**texture**

Geologists use physical properties to identify minerals. For example, the **(16)** _____ of a mineral is caused by the presence of different trace elements. The way a mineral reflects light from its surface is called **(17)** _____, which is described as metallic or nonmetallic. How a mineral feels to the touch is called **(18)** _____. A mineral's **(19)** _____ is the color of a mineral when it is broken up and powdered. A measure of how easily a mineral can be scratched is called **(20)** _____.

Another property describes how a mineral will break. If a mineral splits easily and evenly along one or more planes, it has the property of **(21)** _____, while minerals that break along jagged edges are said to have **(22)** _____. The density of a mineral is usually expressed as **(23)** _____, which is the ratio of the weight of a substance to the weight of an equal volume of water at 4°C.

In your textbook, read about mineral identification.
Answer the following questions.

24. Can all minerals produce a streak on a porcelain plate? Why or why not?

_____

_____

25. Can minerals with cleavage have more than one cleavage plane? If so, give an example.

_____

_____

26. What is the difference between density and specific gravity?

_____

_____

_____

27. How many minerals are represented on the Mohs scale of mineral hardness? What is the range of hardness of those minerals?

_____

_____

SECTION 4.1 *What is a Mineral?, continued*

Circle the letter of the choice that best completes the statement.

28. Identification tests for minerals are based on their
- **a.** scientific names.
- **b.** physical and chemical properties.
- **c.** color.
- **d.** chemical composition.

29. The appearance of milky quartz is caused by
- **a.** its high density.
- **b.** its hardness.
- **c.** its magnetism.
- **d.** trapped bubbles of gas and liquid.

30. A mineral's hardness with respect to other minerals can be determined by
- **a.** its specific gravity.
- **b.** its cleavage planes.
- **c.** the Mohs scale of mineral hardness.
- **d.** its magnetic properties.

31. Minerals break along planes where atomic bonds are
- **a.** weak.
- **b.** strong.
- **c.** dense.
- **d.** magnetic.

32. Minerals, such as quartz, that break along jagged edges are said to have
- **a.** cleavage.
- **b.** density.
- **c.** fracture.
- **d.** special properties.

33. The ratio of the weight of a substance to the weight of an equal volume of water at 4°C is its
- **a.** chemical composition.
- **b.** weight.
- **c.** specific gravity.
- **d.** hardness.

In your textbook, read about special properties of minerals.
Circle the letter of the choice that best completes the statement or answers the question.

34. In double refraction, light is
- **a.** bent in two directions.
- **b.** bent in one direction.
- **c.** obscured by gas bubbles in the crystal.
- **d.** changed to a magnetic field.

35. Which mineral bubbles when it comes in contact with hydrochloric acid because the calcite releases?
- **a.** quartz.
- **b.** calcite.
- **c.** feldspar.
- **d.** mica.

36. Lodestone can pick up iron filings. What special property does lodestone have?
- **a.** a sticky texture
- **b.** extreme heaviness
- **c.** magnetism
- **d.** a rotten-egg smell

SECTION 4.2 *Types of Minerals*

In your textbook, read about mineral uses.
Answer the following questions.

1. What makes a mineral an ore?

2. Is aluminum an ore? Explain your answer.

3. Can the classification of a mineral as an ore change? If so, how?

4. How are ores deep beneath Earth's surface removed?

5. How are ores near Earth's surface removed?

6. What two problems can result from removing waste material from ores?

In your textbook, read about mineral groups.
Complete the table by filling in the following terms: *silicates*, *carbonates*, *oxides*.

Mineral Group	Description
7. _____	Calcite, dolomite, and rhodochrosite are examples.
8. _____	Readily form silica tetrahedrons
9. _____	Composed of one or more metallic elements with the carbonate compound CO_3
10. _____	Composed of silicon, oxygen, and another element
11. _____	Compounds of oxygen and a metal
12. _____	Magnetite and hematite, both sources of iron, are examples.
13. _____	The most common minerals, feldspar and quartz, are examples.
14. _____	Primary minerals in limestone and marble

SECTION 4.2 *Types of Minerals, continued*

In your textbook, read about mineral uses.
Use each of the terms below to complete the statements.

open-pit mines **ore** **underground mining** **overlourden**

15. A(n) _____ is a mineral that contains a useful substance that can be mined at a profit.

16. An ore located deep within Earth's crust is removed by _____.

17. An ore near Earth's surface is obtained from large _____.

18. Unwanted rock and dirt, known as _____, are dug up along with valuable ore.

In your textbook, read about gems.
Use each of the terms below to complete the statements.

abrasive **emeralds** **gem** **trace elements**

19. A(n) _____ is a valuable mineral prized for its rarity and beauty.

20. Because of their relative rareness, rubies and _____ are more valuable than diamonds.

21. The presence of _____ can make one variety of a mineral more colorful and thus more prized than other varieties of the same mineral.

22. The mineral corundum, which is often used as a(n) _____, can also be found as rubies and sapphires.

Table of Contents

Reproducible Pages

Chapter 5 Igneous Rocks

Name Class Date

MiniLab 5

Compare Igneous Rocks

How do igneous rocks differ? Igneous rocks have many different characteristics. Color and crystal size are some of the features that differentiate igneous rocks.

Procedure

1. Read and complete the lab safety form.
2. Obtain a set of igneous rock samples from your teacher.
3. Carefully observe the following characteristics of each rock: overall color, crystal size, and, if possible, mineral composition.
4. Design a data table to record your observations.

Analysis

1. **Classify** your rock samples as basaltic, andesitic, or rhyolitic. [Hint: the more silica in the rock, the lighter it is in color.]

2. **Compare and contrast** your samples using the data from the data table. How do they differ? What characteristics do each of the groups share?

3. **Speculate** in which order the samples crystallized. [Hint: Use Bowen's reaction series as a guide.]

Name Class Date

DESIGN YOUR OWN GeoLab

Model Crystal Formation

The rate at which magma cools has an effect on the grain size of the resulting igneous rock. Observing the crystallization of magma is difficult because molten rock is very hot and the crystallization process is sometimes very slow. Other materials, however, crystallize at lower temperatures. These materials can be used to model crystal formation.

PREPARATION

Problem

Model the crystallization of minerals from magma.

Materials

clean, plastic petri dishes
saturated alum solution
200-mL glass beaker
magnifying glass
piece of dark-colored construction paper
thermometer
paper towels
water
hot plate

Objectives

In this GeoLab, you will:

- **Determine** the relationship between cooling rate and crystal size.
- **Compare** and **contrast** different crystal shapes.

Safety Precautions

The alum mixture can cause skin irritation and will be hot when it is first poured into the petri dishes. If splattering occurs, wash skin with cold water. Always wear safety goggles and an apron in the lab.

PROCEDURE

1. Read and complete the lab safety form.
2. As a group, plan how you could change the cooling rate of a hot solution poured into a petri dish. For instance, you may want to put one sample in a freezer or refrigerator for a designated period of time. Assign each group member a petri dish to observe during the experiment. Make sure your teacher approves your plan before you begin.
3. Place a piece of dark-colored construction paper on a level surface where it won't be disturbed. Place the petri dishes on top of the paper.
4. Carefully pour a saturated alum solution that is about 95°C to 98°C, or just below boiling temperature, into each petri dish so that it is half-full. Use caution when pouring the hot liquid to avoid splatters and burns.
5. Observe the petri dishes. On the next page, draw a data table on which to record your observations. Below your data table, draw what you observe happening in the petri dish assigned to you.
6. Every 5 minutes for 30 minutes, record your observations of your petri dish. Make accurate, full-sized drawings of any crystals that begin to form.

Name Class Date

DESIGN YOUR OWN GeoLab

Model Crystal Formation

DATA TABLE

OBSERVATIONS

ANALYZE AND CONCLUDE

1. **Compare** your methods of cooling with those of other groups. Did one method appear to work better than others? Eplain.

2. **Examine** your alum crystals. What do the crystals look like? Are they all the same size? Do all the crystals have the same shape?

Name Class Date

DESIGN YOUR OWN GeoLab

Model Crystal Formation

ANALYZE AND CONCLUDE

3. **Draw** the most common crystal shape in your science journal. Compare your drawings with those of other groups. Describe any patterns you see.

4. **Deduce** what factors asffected the size of the crystals in the different Petri dishes. How do you know?

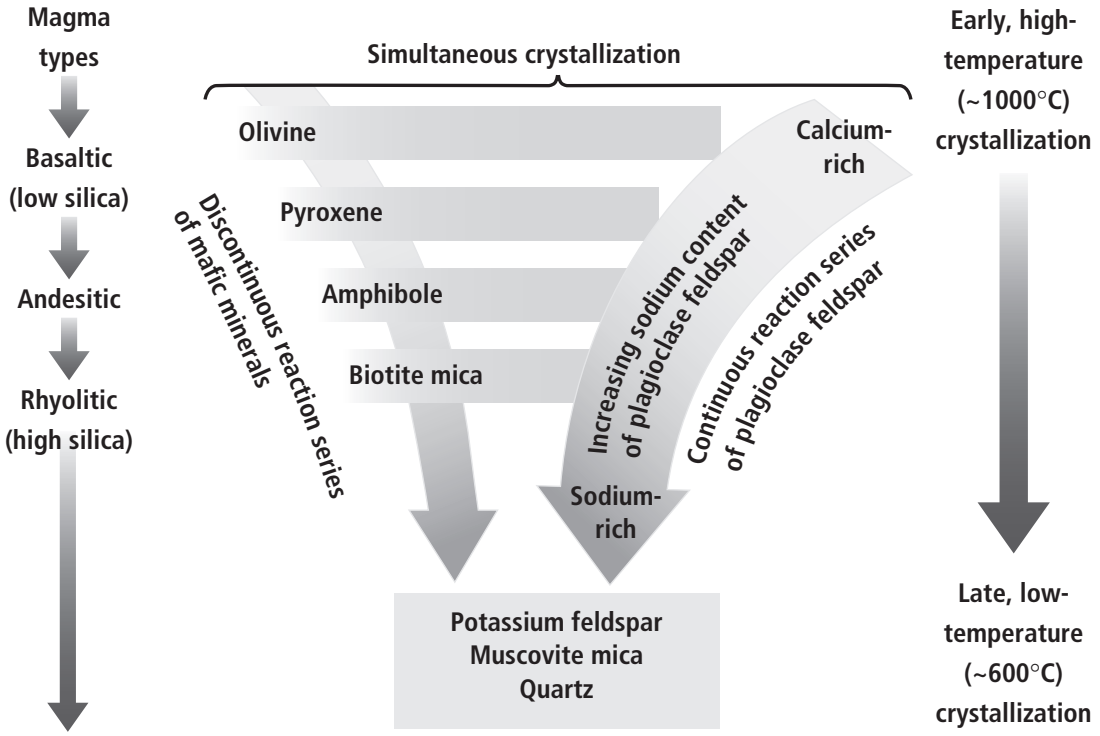
5. **Infer** why the crystals changed shape as they grew.

6. **Compare and contrast** this experiment with the magma crystallization.

7. **Evaluate** the relationship between cooling rate and crystal formation.

Use with Chapter 5
Section 5.1

Bowen's Reaction Series



Name Class Date

WORKSHEET 11 TEACHING TRANSPARENCY

Use with Chapter 5
Section 5.1

Bowen's Reaction Series

1. In Bowen's reaction series, how do the two main branches of crystallization differ?

2. As magma cools, which are the first feldspars to crystallize?

3. Describe the composition of a zoned crystal that developed during feldspar crystallization. What caused it to form?

4. As magma cools, what is the first iron-rich mineral to crystallize?

5. Which crystallizes at a higher temperature—amphibole or pyroxene?

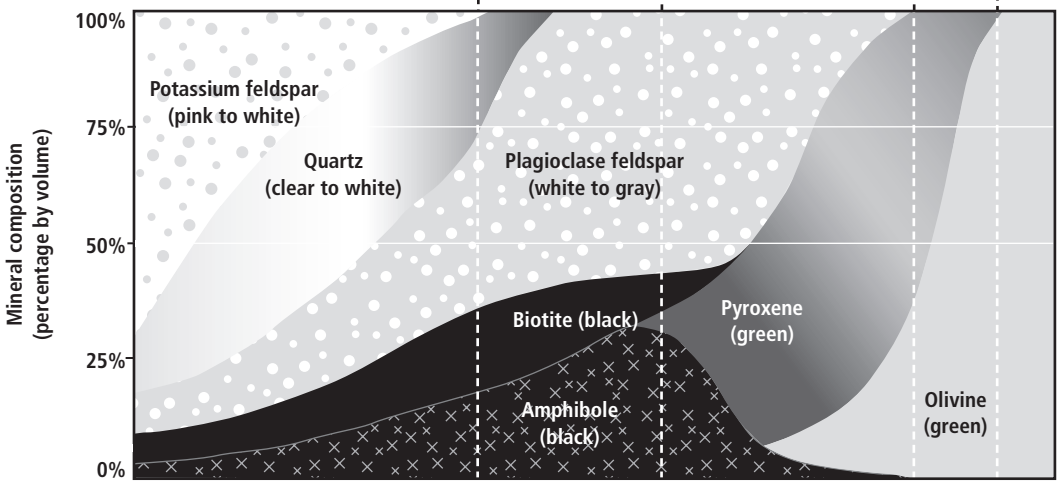
6. What happens to amphibole when temperatures drop?

7. What elements remain in the melt at the end of the reaction series? What forms when this melt finally crystallizes?

Use with Chapter 5
Section 5.2

Classification of Igneous Rocks

Classification of Igneous Rocks						
	Felsic	Intermediate	Mafic	Ultramafic		Texture
Extrusive	Obsidian		Basaltic glass			Glassy (non-crystalline)
Extrusive	Rhyolite	Andesite	Basalt			Fine-grained
Intrusive	Granite	Diorite	Gabbro	Peridotite	Dunite	Coarse-grained
Intrusive	Pegmatite					Very coarse-grained



Name Class Date

WORKSHEET 12 TEACHING TRANSPARENCY

Use with Chapter 5
Section 5.2

Classification of Igneous Rocks

1. What four types of igneous rocks are represented in the table and graph?

2. Use the table to compare and contrast the textures of the extrusive rocks and intrusive rocks.

3. How do basaltic glass and gabbro differ? How are they similar?

4. Which types of igneous rocks are composed of at least 50 percent olivine?

5. Use the graph to explain why felsic rocks are usually light-colored and mafic rocks are usually dark-colored.

6. How would you classify a fine-grained, igneous rock that contains approximately 25 percent amphibole, 15 percent biotite, and 60 percent plagioclase feldspar?

7. Approximately how much biotite is a sample of gabbro likely to contain?

8. Which contains a greater percentage of quartz—granite or diorite?

Name Class Date

CHAPTER 5 STUDY GUIDE

Igneous Rocks

SECTION 5.1 *What are igneous rocks?*

In your textbook, read about the nature of igneous rocks.
Use each of the terms below just once to complete the following statements.

basaltic **igneous rock** **rhyolitic**
lava **magma**

1. Molten rock inside Earth's crust is called _____.

2. A(n) _____ is formed from the crystallization of magma.

3. Magma that flows out onto Earth's surface is called _____.

4. Magma that has a low silica content is called _____.

5. _____ magma has the highest silica content .

In your textbook, read about the composition and origins of magma.
For each statement below, write *true* or *false*.

_____ **6.** Magma is often a slushy mix of molten rock, gases, and mineral crystals.

_____ **7.** The elements found in magma are quite different from those found in Earth's crust.

_____ **8.** Silica is the most abundant compound found in magma.

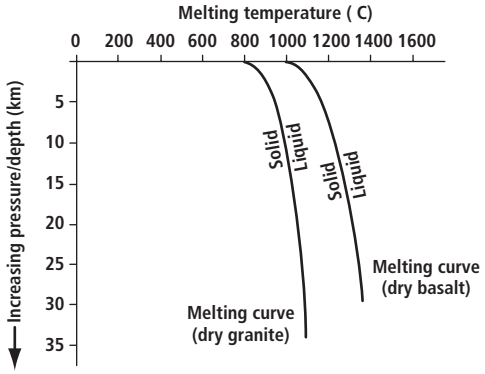
_____ **9.** Magmas are classified as basaltic, andesitic, or rhyolitic.

_____ **10.** In the laboratory, rocks must be heated from 8000°C to 12 000°C before they melt.

_____ **11.** Heat in the upper mantle and lower crust may come, in part, from the decay of radioactive elements.

SECTION 5.1 *What are igneous rocks?, continued*

In your textbook, read about factors that affect magma formation.
Use the diagram to answer the following questions.



12. How does pressure affect the melting point of rock?

_____

13. Do all minerals have the same melting point?

_____

14. How does temperature change with depth in Earth's crust?

_____

15. How does pressure change with depth, and why?

_____

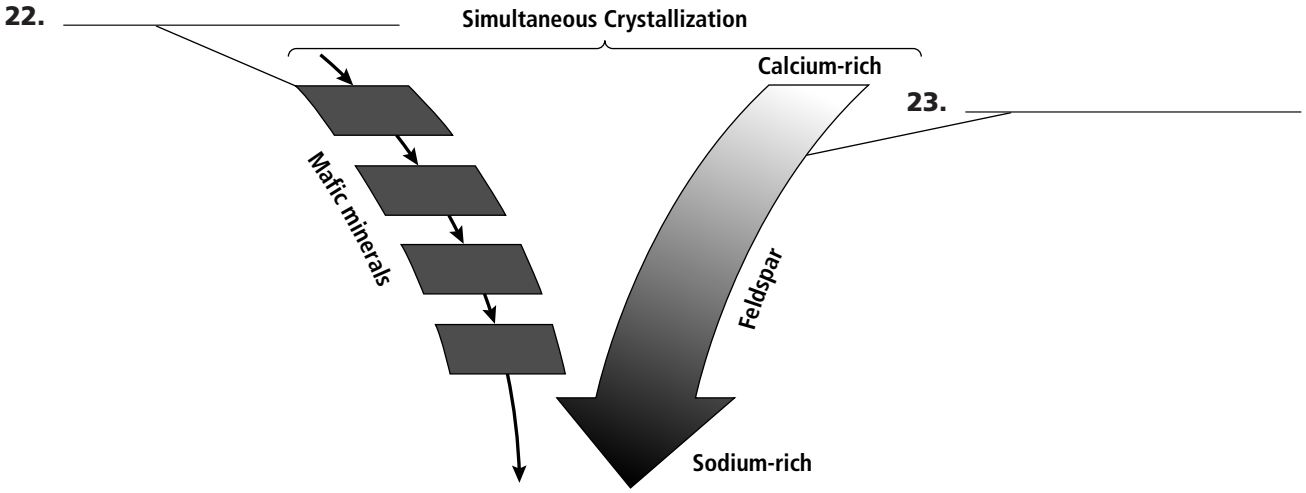
In your textbook, read about how rocks melt.
Use each of the terms below just once to complete the passage.

elements	**fractional crystallization**	**reverse**
magma	**melting points**	**partial melting**

Because different minerals have different **(16)** _____, not all parts of a rock melt at the same time. The process whereby some minerals melt at low temperatures while other minerals remain solid is called **(17)** _____. As each group of minerals melts, different **(18)** _____ are added to the magma mixture changing its composition. When the magma cools, it crystallizes in the **(19)** _____ order of partial melting. The process wherein different minerals form at different temperatures is called **(20)** _____. As each group of minerals crystallizes, it removes elements from the remaining **(21)** _____ instead of adding new elements.

SECTION 5.1 *What are igneous rocks?, continued*

In your textbook, read about Bowen's reaction series.
Label the diagram using either *continuous reaction series* or *discontinuous reaction series.*



Answer the following questions. Use the diagram to answer questions 24 and 25.

24. The first feldspars to form are rich in what mineral?

25. The second feldspars to form are rich in what mineral?

26. What causes a zoned crystal?

27. How is quartz formed?

SECTION 5.2 *Classification of Igneous Rock*

In your textbook, read about the mineral composition of igneous rocks.
Complete the table by filling in one of the following terms: *granitic*, *basaltic*, *intermediate*, or *ultramafic*.

Description	Type of Igneous Rock
1. May be formed by fractional crystallization of olivine and pyroxene	
2. Contains moderate amounts of biotite, amphibole, and pyroxene	
3. Light-colored, high silica content, contains quartz	
4. Contains plagioclase, biotite, amphibole, pyroxene, and olivine	
5. Peridotite and dunites are examples.	
6. Dark-colored, low silica content, rich in iron and magnesium	
7. Diorite in an example.	
8. Gabbro is an example.	
9. Granite is an example.	
10. Low silica content, very high iron and magnesium content	

In your textbook, read about the grain size of igneous rocks.
Answer the following questions.

11. Does obsidian, a glassy rock, have a large grain size or a small grain size?

12. Is obsidian an intrusive or extrusive igneous rock? How do you know?

13. How does the texture of gabbro compare to that of obsidian?

14. Is gabbro an intrusive or extrusive igneous rock? How do you know?

SECTION 5.2 *Classification of Igneous Rocks, continued*

In your textbook, read about classifying igneous rocks.
For each item in Column A, write the letter of the matching item in Column B.

Column A	Column B
_____ **15.** Rock such as peridotite, which has low silica content and very high levels of iron and magnesium	**a.** granitic
_____ **16.** Rock with two different-sized grains of the same mineral	**b.** basaltic
_____ **17.** Rock such as gabbro, which is dark-colored, has low silica content, and is rich in iron and magnesium.	**c.** ultramafic
_____ **18.** Vein of extremely large-grained minerals	**d.** porphyritic
_____ **19.** Rare type of ultramafic rock that can contain diamonds	**e.** pegmatite
_____ **20.** Rock such as granite, which is light-colored and has high silica content	**f.** kimberlite

In your textbook, read about the texture of igneous rocks.
Answer the following questions.

21. Why do geologists make thin sections?

22. Describe the differences in how an intrusive igneous rock and an extrusive igneous rock form.

23. Why can minerals that form early in fractional crystallization grow distinct crystal shapes?

24. What does a rock with a porphyritic texture look like?

25. How do porphyritic textures form?

SECTION 5.2 *Classification of Igneous Rocks, continued*

In your textbook, read about igneous rocks as resources.
Circle the letter of the choice that best completes the statement or answers the question.

26. Igneous rocks are strong because of their
- **a.** temperature.
- **b.** color.
- **c.** water content.
- **d.** interlocking grain textures.

27. Which of the following is one of the most durable igneous rocks?
- **a.** granite
- **b.** sandstone
- **c.** marble
- **d.** limestone

28. Igneous rocks tend to be
- **a.** radioactive.
- **b.** full of gold.
- **c.** resistant to weathering.
- **d.** vulnerable to weathering.

29. Igneous intrusions often are associated with valuable
- **a.** radioactive elements.
- **b.** ore deposits.
- **c.** oil reservoirs.
- **d.** fossil deposits

30. Ore deposits such as gold sometimes are found as a(n)
- **a.** vein.
- **b.** extrusion.
- **c.** obsidian deposit.
- **d.** molten rock.

31. Metal-rich quartz veins are formed at the end of
- **a.** volcanic eruptions.
- **b.** radioactive decay.
- **c.** magma crystallization
- **d.** the cooling of Earth's crust.

32. What are pegmatites?
- **a.** veins of extremely large-grained minerals
- **b.** magmas of differing densities
- **c.** microscopic, interlocking crystal grains
- **d.** small volcanoes

33. What are kimberlites?
- **a.** felsic rocks
- **b.** mafic rocks
- **c.** intermediate rocks
- **d.** ultramafic rocks

34. Diamonds can form only
- **a.** under very low pressure.
- **b.** under very high pressure.
- **c.** above ground.
- **d.** near radioactive elements.

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Reproducible Pages

Chapter 6 Sedimentary and Metamorphic Rocks

Name Class Date

MiniLab 6

Model Sediment Layering

Identify how layers form from particles that settle in water.

Procedure

1. Read and complete the lab safety form.
2. Obtain 100 mL of **sediment** from a location specified by your teacher.
3. Place the sediment in a **200 mL jar with a lid.**
4. Add water to the jar until it is three-fourths full.
5. Place the lid on the jar securely.
6. Pick up the jar with both hands and turn it upside down several times to mix the water and sediment. Hesitate briefly with the jar upside down before tipping it up for the last time. Place the jar on a flat surface.
7. Let the jar sit for about 5 min.
8. Observe the settling process.
9. Use the space below to illustrate what you learned in a diagram.

Analysis

1. Describe what type of particles settle out first.

_____

_____

2. Describe what type of particles form the topmost layers.

_____

_____

Name Class Date

GeoLab Interpret Changes in Rocks

As the rock cycle continues, and rocks change from one type to another, more changes occur than meet the eye. Color, grain size, texture and mineral composition are easily observed and described visually. Yet, with mineral changes come changes in crystal structure and density. How can these be accounted for and described? Studying pairs of sedimentary and metamorphic rocks can show you how.

PREPARATION

Problem

How do the characteristics of sedimentary and metamorphic rocks compare?

Materials

samples of sandstone, shale, limestone, quartzite, slate and marble
magnifying glass
paper
beam balance
100-mL graduated cylinder or beaker large enough to hold the rock samples
water

Objectives

In this GeoLab, you will:

- **Describe** the characteristics of sedimentary and metamorphic rocks.
- **Determine** the density of different rock types.
- **Infer** how metamorphism changes the structure of rocks.

Safety Precautions

Always wear safety goggles and an apron in the lab.

PROCEDURE

1. Read and complete the lab safety form.
2. Use the data table on the next page. Add rows to the table if you are examining more than four samples.
3. Observe each rock sample. Record your observations in the data table.
4. Recall that density = mass/volume. Make a plan that will allow you to measure the mass and volume of a rock sample.
5. Determine the density of each rock sample and record this information in the data table.

Name Class Date

GeoLab Interpret Changes in Rocks

Data Table

Sample number	Rock type	Specific characteristics	Mass	Volume	Density
1					
2					
3					
4					

ANALYZE AND CONCLUDE

1. **Compare and contrast** a shale and a sandstone.

2. **Describe** how the grain size of a sandstone changes during metamorphism.

3. **Describe** the textural differences you observe between a shale and a slate.

4. **Infer** Compare the densities you calculated with other students. Does everybody have the same answer? What are some of the reasons that answers may vary?

Name Class Date

GeoLab Interpret Changes in Rocks

ANALYZE AND CONCLUDE

5. Why does the color of a sedimentary rock change during metamorphism?

6. Compare the densities of shale and slate, sandstone and quartzite, and limestone and marble. Does density always change in the same way? Explain the results that you observed.

Use with Chapter 6
Section 6.1

Classification of Clastic Sediments

Classification of Clastic Sediments			
Particle Size	**Sediment**		**Rock**
> 256 mm 256–64 mm 64–2 mm	Gravel	Boulder Cobble Pebble	Conglomerate
2–0.062 mm	Sand		Sandstone
0.062–0.0039 mm	Silt		Siltstone
<0.0039 mm	Clay		Mudstone or shale

Name Class Date

WORKSHEET 13 TEACHING TRANSPARENCY

Use with Chapter 6
Section 6.1

Classification of Clastic Sediments

1. How are clastic sediments classified?

2. What type of clastic sediment has the largest particle size?

3. What type of clastic sediment has the smallest particle size?

4. What size particles are classified as sand?

5. What rock type is made up of cobbles?

6. How would you classify a clastic sediment particle that is 0.0020 mm in size?

7. You find a rock that consists mostly of clastic sediments of about 0.05 mm in size. What type of rock is it likely to be?

8. Why do clastic sediment particles usually have worn surfaces and rounded corners?

9. What process produces clastic sediments?

Use with Chapter 6
Section 6.2

Classification of Sedimentary Rocks

Classification of Sedimentary Rocks

Classification	Texture/Grain Size	Composition	Rock Name
Clastic	coarse (> 2 mm)	Fragments of any rock type — quartz chert and quartzite common } rounded / angular	conglomerate / breccia
	medium (1/16 mm to 2 mm)	quartz and rock fragments quartz, k-spar and rock fragments	sandstone arkose
	fine (1/256 mm – 1/16 mm)	quartz and clay	siltstone
	very fine (< 1/256 mm)	quartz and clay	shale
Biochemical	microcrystalline with conchoidal fracture	calcite ($CaCO_3$)	micrite
	abundant fossils in micrite matrix	calcite ($CaCO_3$)	fossiliferous limestone
	oolites (small spheres of calcium carbonate)	calcite ($CaCO_3$)	oolitic limestone
	shells and shell fragments loosely cemented	calcite ($CaCO_3$)	coquina
	microscopic shells and clay	calcite ($CaCO_3$)	chalk
	variously sized fragments	highly altered plant remains, some plant fossils	coal
Chemical	fine to coarsely crystalline	calcite ($CaCO_3$)	crystalline limestone
	fine to coarsely crystalline	dolomite (Ca, Mg) CO_3 (will effervesce if powdered)	dolostone
	very finely crystalline	quartz (SiO_2) — light colored — dark colored	chert flint
	fine to coarsely crystalline	gypsum ($CaSO_4 \cdot 2H_2O$)	rock gypsum
	fine to coarsely crystalline	halite (NaCl)	rock salt

Name Class Date

WORKSHEET 14 TEACHING TRANSPARENCY

Use with Chapter 6
Section 6.2

Classification of Sedimentary Rocks

1. Name the three types of sedimentary rocks.

2. What is the most common sedimentary rock, and what is its method of formation?

3. How are clastic sedimentary rocks classified?

4. Compare and contrast conglomerate with breccia.

5. How do chemical sedimentary rocks form?

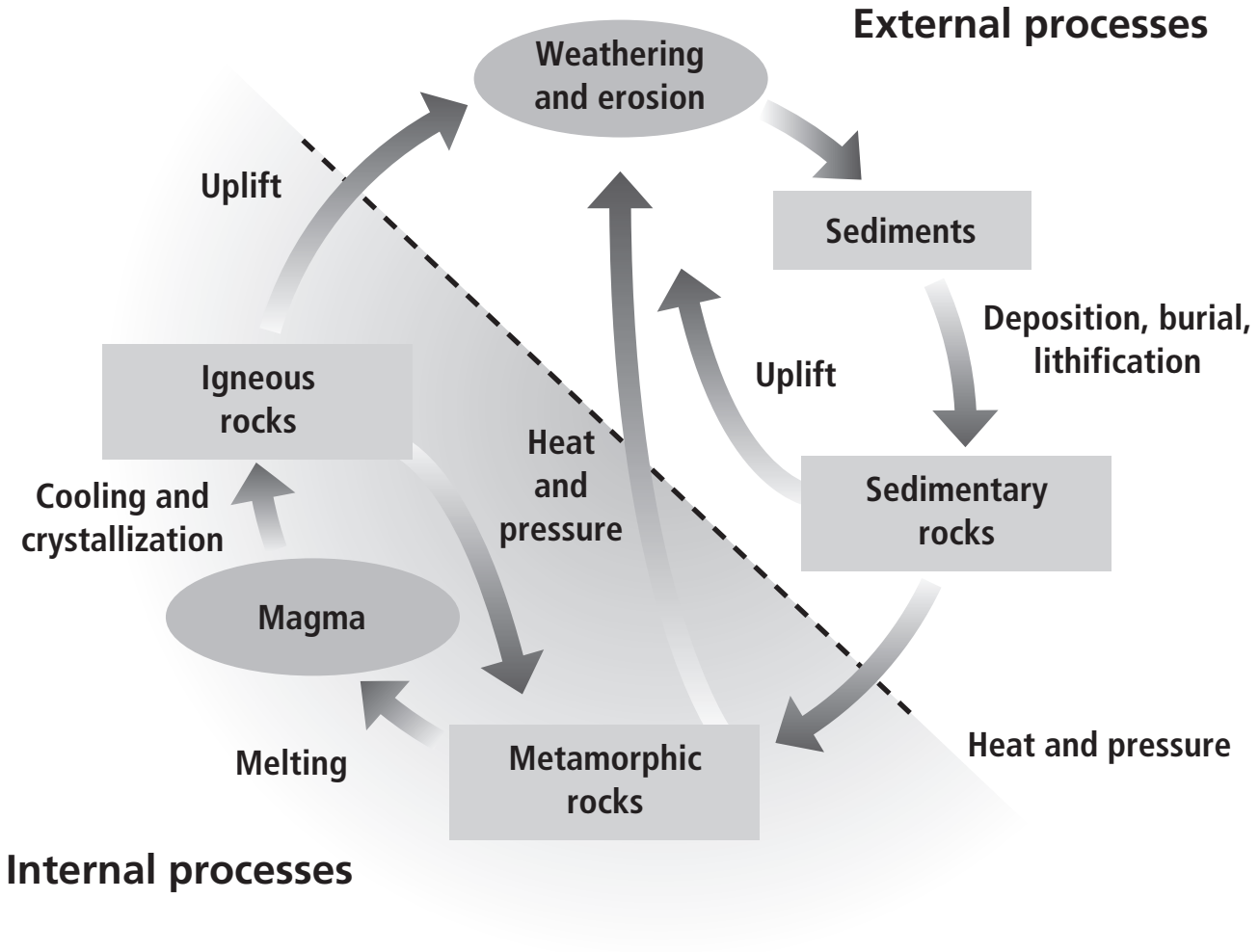
6. Name three common evaporite minerals.

7. How do organic sedimentary rocks form?

8. Name two organic sedimentary rocks.

Use with Chapter 6
Section 6.3

The Rock Cycle



Name Class Date

WORKSHEET 15 TEACHING TRANSPARENCY

Use with Chapter 6
Section 6.3

The Rock Cycle

1. What is the rock cycle?

2. What three processes transform metamorphic and sedimentary rocks into sediments?

3. What two processes transform sedimentary rocks into metamorphic rocks?

4. What causes all types of rocks to be exposed to weathering and erosion?

5. How can a metamorphic rock become an igneous rock?

6. Describe two different paths an igneous rock can take to become another igneous rock.

7. Name two internal processes.

8. Name two external processes.

Name Class Date

CHAPTER 6 STUDY GUIDE

Sedimentary and Metamorphic Rocks

SECTION 6.1 *Formation of Sedimentary Rocks*

In your textbook, read about the processes that form sedimentary rocks.
Use each of the terms below to complete the following statements.

cementation	**chemical weathering**	**clastic sediments**	**deposition**
lithification	**physical weathering**	**sedimentary rock**	**sorted deposits**
sediment	**unsorted deposits**		

1. _____ consists of solid material that has been deposited on Earth's surface by wind, water, ice, gravity, or chemical precipitation.
2. Glaciers and landslides tend to create _____ in which sediments of different sizes are mixed together.
3. During _____, the minerals in a rock are dissolved or otherwise chemically changed.
4. The process by which mineral growth binds sediment grains together into solid rock is _____.
5. Weathering produces _____, which are rock and mineral fragments.
6. When sediments become cemented together, they form _____.
7. As a result of _____, sediments are laid down on the ground or on the bottom of bodies of water.
8. The physical and chemical process called _____ transforms sediments into sedimentary rocks.
9. During _____, minerals remain chemically unchanged, and rock fragments simply break off of the solid rock along fractures or grain boundaries.
10. Sediments tend to form _____ when transported by water and wind.

SECTION 6.1 *Formation of Sedimentary Rocks, continued*

In your textbook, read about lithification.
For each statement below, write *true* or *false*.

_____ **11.** Lithification begins with erosion.

_____ **12.** Muds may contain up to 60 percent water and shrink as excess water is squeezed out.

_____ **13.** Sands are usually poorly compacted during deposition, and they tend to compact a great deal during burial.

_____ **14.** Groundwater, oil, and natural gas are commonly found within pore spaces in sedimentary rocks.

_____ **15.** The temperature in Earth's crust decreases with depth.

_____ **16.** Physical weathering changes the composition of mineral fragments.

_____ **17.** In one type of cementation, a new mineral grows between sediment grains.

_____ **18.** Mud compacts more than sand.

In your textbook, read about the features of sedimentary rocks.
Use each of the terms below to complete the passage.

cross-bedding	**fossils**	**graded bedding**	**lithification**
ripple marks	**sand dunes**	**transport**	**bedding**

The primary feature of sedimentary rocks is **(19)** _____, or horizontal layering. The type of bedding that occurs depends upon the sediment's method of **(20)** _____. Bedding is called **(21)** _____ when the heaviest and coarsest material is on the bottom. A second type of bedding called **(22)** _____ forms as inclined layers of sediment migrate forward across a horizontal surface. Large-scale cross-bedding can be formed by migrating **(23)** _____. When sediment is moved into small ridges by wind or wave action, **(24)** _____ can form. Many sedimentary rocks contain **(25)** _____, the preserved remains, impressions, or any other evidence of once-living organisms. During **(26)** _____, parts of an organism can be replaced by minerals and turned into rock.

SECTION 6.2 *Types of Sedimentary Rocks*

In your textbook, read about the about different types of sedimentary rocks.
Complete the table by filling in the type of sedimentary rock described: *clastic*, *biochemical*, or *chemical*.

Description	Type of Sedimentary Rock
1. Breccias and conglomerates are examples.	
2. Classified by particle size	
3. Coal is an example.	
4. Formed from the remains of once-living things	
5. Formed from deposits of loose sediments	
6. Often contains calcite, halite, or gypsum	
7. Forms evaporites	
8. Sandstone is a medium-grained example.	
9. Formed from precipitation and growth of mineral crystals	
10. Formed from the shells of sea organisms	

In your textbook, read about how sedimentary rocks form and their importance to humans.
Answer the following questions.

11. How does fossil-containing limestone form?

12. What information can fossils provide?

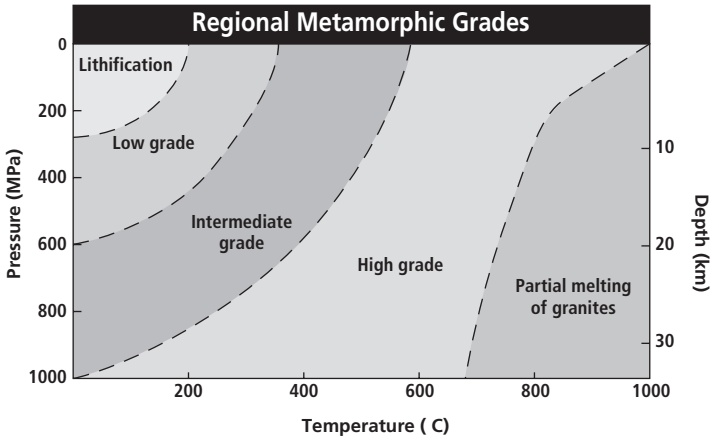
13. What do some of the features of sedimentary rocks indicate about ancient bodies of water?

SECTION 6.3 *Metamorphic Rocks*

In your textbook, read about metamorphic rocks.
For each item in Column A, write the letter of the matching item in Column B.

Column A	Column B
_____ **1.** Occurs when rocks come into contact with molten rock	**a.** contact metamorphism
_____ **2.** Rock whose texture, mineralogy, or chemical composition has been altered without melting it	**b.** foliated metamorphic rock
_____ **3.** Metamorphism resulting from high temperature and pressure that affects a large region	**c.** nonfoliated metamorphic rock
_____ **4.** Large crystals of new metamorphic minerals	**d.** metamorphic rock
_____ **5.** Occurs when very hot water reacts with rock	**e.** hydrothermal metamorphism
_____ **6.** Characterized by wavy layers and bands of light and dark minerals	**f.** porphyroblasts
_____ **7.** Composed mainly of minerals with blocky crystal shapes	**g.** regional metamorphism

In your textbook, read about types of metamorphism.
Use the diagram to answer the following questions.



8. What grades of regional metamorphism are shown on the graph?

_____

9. Which grades represent the highest pressure conditions?

_____

10. Which grade generally occurs between 0 and 20 km below Earth's surface?

_____

SECTION 6.3 *Metamorphic Rocks, continued*

In your textbook, read about causes and types of metamorphism.
Circle the letter of the choice that best completes the statement.

11. The pressure required for metamorphism can be generated by
- **a.** pressure from weight of overlying rock.
- **b.** heat from magma bodies in contact with surrounding rock.
- **c.** cementation and lithification.
- **d.** hydrothermal solutions.

12. A regional metamorphic belt is divided into zones based upon
- **a.** the number of volcanoes in the area.
- **b.** mineral groups found in the rocks.
- **c.** types of fossils found in the rocks.
- **d.** current underground temperatures.

13. Contact metamorphism occurs under conditions of
- **a.** high temperature and high pressure.
- **b.** high temperature and moderate-to-low pressure.
- **c.** low temperature and very high pressure.
- **d.** low temperature and moderate-to-low pressure.

14. Minerals that crystallize at higher temperatures as a result of contact metamorphism tend to be found near
- **a.** coal deposits.
- **b.** bodies of water.
- **c.** coral reefs.
- **d.** igneous intrusions.

15. The type of metamorphism that occurs when very hot water reacts with and alters the mineralogy of rock is
- **a.** contact.
- **b.** regional.
- **c.** hydrothermal.
- **d.** local.

16. Metamorphic rocks in which the long axes of their minerals are perpendicular to the pressure that altered them are described as
- **a.** marble-like.
- **b.** quartzite-like.
- **c.** foliated.
- **d.** nonfoliated.

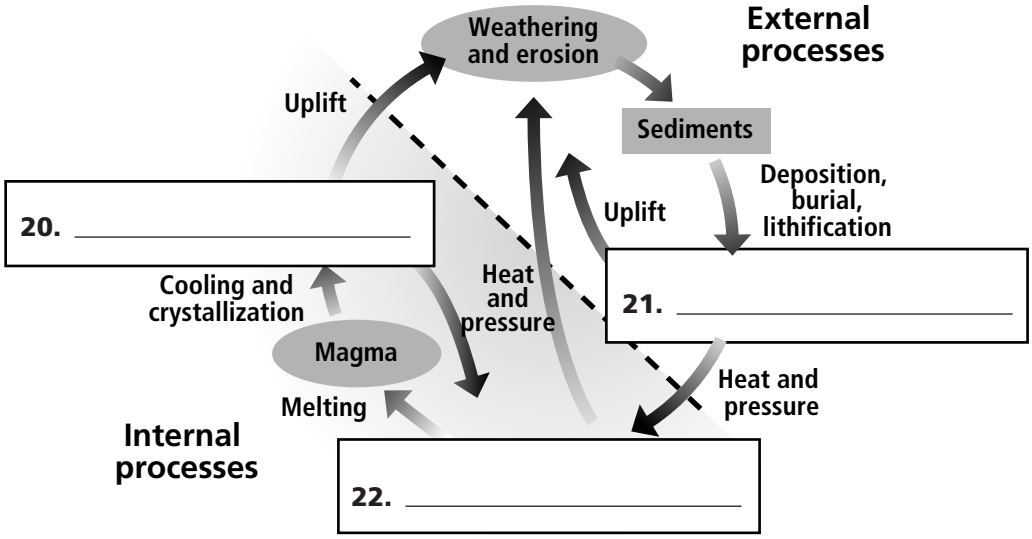
17. Metamorphic rocks that lack mineral grains with long axes oriented in one direction are described as
- **a.** marble-like.
- **b.** quartzite-like.
- **c.** foliated.
- **d.** nonfoliated.

18. Porphyroblasts differ from the minerals surrounding them in terms of
- **a.** size.
- **b.** color.
- **c.** axis of orientation.
- **d.** shape.

19. Hot fluids migrating into and out of a rock during metamorphism can change the rock's
- **a.** chemistry.
- **b.** energy.
- **c.** grade.
- **d.** fossil content.

SECTION 6.3 *Metamorphic Rocks, continued*

In your textbook, read about the rock cycle.
Label each blank below as *igneous rocks*, *sedimentary rocks*, or *metamorphic rocks*.



Answer the following questions.

23. How are igneous rocks formed?

_____

24. What happens to igneous rocks that undergo weathering and erosion?

_____

25. How do sediments become sedimentary rock?

_____

_____

26. What forces cause sedimentary rocks to be transformed into metamorphic rocks?

_____

27. How can metamorphic rock be transformed into igneous rock?

_____

_____

28. How can sandstone be transformed into sediment without becoming metamorphic or igneous rock first?

_____