

Your Name \_\_\_\_\_

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Minutes \_\_\_\_\_

Standard 4  
Key Idea 3

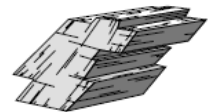
Performance Indicator 3.1

Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.

**Major Understanding:**

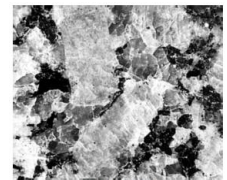
3.1a Minerals have physical properties determined by their chemical composition and crystal structure.

- Minerals can be identified by well-defined physical and chemical properties, such as cleavage, fracture, color, density, hardness, streak, luster, crystal shape, and reaction with acid.
- Chemical composition and physical properties determine how minerals are used by humans.



3.1b Minerals are formed inorganically by the process of crystallization as a result of specific environmental conditions. These include:

- cooling and solidification of magma
- precipitation from water caused by such processes as evaporation, chemical reactions, and temperature changes
- rearrangement of atoms in existing minerals subjected to conditions of high temperature and pressure.



3.1c Rocks are usually composed of one or more minerals.

- Rocks are classified by their origin, mineral content, and texture.
- Conditions that existed when a rock formed can be inferred from the rock's mineral content and texture.
- The properties of rocks determine how they are used and also influence land usage by humans.



2.1w Sediments of inorganic and organic origin often accumulate in depositional environments. Sedimentary rocks form when sediments are compacted and/or cemented after burial or as the result of chemical precipitation from seawater.



## Mini Lesson 1: Minerals

Five characteristics of a mineral are that it is naturally occurring, found in nature as a solid, is inorganic, has a definite chemical composition and has a regular atomic structure (is crystalline). Minerals formed by the cooling and solidification of magma, precipitation from water caused by evaporation, chemical reactions and temperature changes or the rearrangement of atoms due to extreme heat and pressure.

The identification of a mineral is based on its physical and chemical properties. The way in which the atoms are arranged determines which physical properties a mineral has. Minerals are grouped according to their chemical compositions. Silicates are the most common minerals and contain silicon and oxygen. Of the thousands of known minerals, only a few are found almost everywhere. If you can identify about a dozen minerals, you will be able to identify the minerals found in most rocks. Chemical composition and physical properties determine how we use minerals.

### Need to know:

1. List 5 characteristics of a mineral.

- (a) \_\_\_\_\_
- (b) \_\_\_\_\_
- (c) \_\_\_\_\_
- (d) \_\_\_\_\_
- (e) \_\_\_\_\_

2. List three ways minerals are formed

- (a) \_\_\_\_\_
- (b) \_\_\_\_\_
- (c) \_\_\_\_\_

3. What is the identification of minerals based on? \_\_\_\_\_

4. What determines the physical properties of a mineral? \_\_\_\_\_

5. How are minerals grouped? \_\_\_\_\_

6. What type of minerals are the most common? \_\_\_\_\_

7. What two elements are present in silicate minerals? \_\_\_\_\_ & \_\_\_\_\_

8. How many different minerals are there? \_\_\_\_\_

9. About how many minerals are found in most rocks? \_\_\_\_\_

10. What determines how minerals are used? \_\_\_\_\_

**"Properties of Common Minerals: Earth Science Reference Tables Page 16"**

1. Fill in the missing information in the chart below.

Luster	Hardness	Composition	Color	Mineral Name
Nonmetallic	6		white to pink	
	2	S		
	4		colorless/variable	
Metallic	2.5		metallic silver	
		$Mg_3Si_4O_{10}(OH)_2$		Talc
	1-6.5	$Fe_2O_3$		
Nonmetallic	2	$CaSO_4 \cdot 2H_2O$	white to pink	
			brassy yellow	
		$Fe_3Al_2Si_3O_{12}$	dark red	
Nonmetallic	3		colorless/variable	
Metallic	5.5-6.5		black to silver	

2. The physical properties of a mineral depend on its internal arrangement of atoms. For example, both diamonds and graphite are composed of 100% carbon yet have completely different characteristics. Fill in the chart below to see the differences. Diamond is already done for you.

Mineral	Diamond	Graphite
Luster	Non-metallic	
Hardness	10	
Cleavage	Perfect in four directions	
Fracture	No	
Distinguishing characteristics	White streak	
Uses	Jewelry, cutting tools	
Composition	Carbon (C)	

3. Refer to the column labeled "Composition" on the "Properties of Common Minerals". Highlight every composition that has both silicon (Si) and oxygen (O) as part of its composition. List the minerals that are silicates.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

4. Name the mineral that has the following characteristic:

<b>Mineral Characteristics</b>	<b>Mineral Name</b>
Bubbles with acid when <i>powdered</i>	
Cleaves at 56° and 124°	
Food additive and melts ice	
Easily scratched by a fingernail	
Red-brown streak	
Feels greasy, used in paper	
Used in glass, jewelry and electronics	
Polarizing prism and used in cement	
Light green color and granular	
Fool's gold	
Cleaves in 4 directions	
Used in batteries	
Used for sulfuric acid	
Hardness 1-2, has cleavage, pencil lead	
Striations visible	
NYS gem stone	
Attracted to a magnet	
Black to dark green, mineral collections	
Hardness of 6, commonly orthoclase	

**Introduction:**

Minerals are identified based on their physical and chemical properties. Below is a list of these properties, description and information on how to test for them.

**Materials**

- ✓ Mineral ID sheet
- ✓ Mineral kit

**Objective:**

- To identify a selection on minerals using the physical properties listed below

Property		Description	Test
1)	Color	Easiest to recognize but not very reliable because several minerals are the same color and some minerals are found in several colors	Simply look at the sample
2)	Streak	Color of a mineral's powder	Rub the mineral across an unglazed porcelain plate to determine the color of the mineral's powder.
3)	Luster	The way a mineral reflects light (can be metallic, non-metallic, dull, waxy, glassy, etc.)	Metallic - looks like shiny metal Non-metallic - does not look like metal
4)	Hardness	A mineral's ability to scratch or be scratched  Moh's hardness scale lists 10 common minerals placed in order of hardness.  Talc = softest Diamond = hardest  <i>5.5 - approximate hardness of a glass plate</i>	Find a sharp edge on your mineral. Firmly press the mineral and attempt to scratch the glass plate.  <u>Moh's hardness scale:</u> (1) Talc (2) Gypsum (3) Calcite (4) Fluorite (5) Apatite (6) Feldspar (7) Quartz (8) Topaz (9) Corundum (10) Diamond
5)	Cleavage	The tendency of a mineral to split along smooth, flat surfaces	Look carefully at a mineral. Turn it and look for shiny surfaces. Many flat surfaces reflect light making them easier to see.
6)	Fracture	When a mineral breaks and has rough or irregular surfaces.	It looks like a clump with no flat surfaces.
7)	Specific gravity	The ratio between the weight of a substance and the weight of an equal volume of water	It is tested by determining the weight of a mineral in water. It is the same as a mineral's density.
8)	Special properties	Unique properties a mineral may have	Salty taste, attraction to magnets, double refraction, effervesces (bubbles) with HCl

### Mineral Identification Chart

Luster	Hardness	Cleavage Fracture	Streak	Special characteristics	Mineral name
Metallic	Not as hard as glass	Fracture	Black	Greasy feel	Graphite
		Cleavage	Black	Cubic cleavage	Galena
	Harder than glass	Fracture	Black	Magnetic	Magnetite
		Fracture	Black	Fool's gold	Pyrite
Non-metallic	Not as hard as glass	Fracture	White	Can be scratched w/fingernail	Alabaster
		Fracture	Yellow	Yellow color	Sulfur
		Fracture	Dark red	Usually ruby red	Cuprite
		Cleavage	White	Tastes salty	Halite
		Cleavage	White	Bubbles with acid	Calcite
		Cleavage	White	Cleaves in 4 directions	Fluorite
	Harder than glass	Cleavage	None	Red, pink, brown colors	Pyroxene
		Cleavage	Dark green	Black to green color	Hornblende
		Cleavage	None	Salmon in color	Feldspar
		Fracture	None	Light green color	Olivine
		Fracture	None	Glassy luster	Quartz
		Fracture	None	Usually dark red in color	Garnet

#### Procedure

1. Pick up a mineral kit from your instructor. Remove and inspect Sample 1 from the mineral kit.
2. Carefully observe the way the mineral reflects light. If it looks like metal (shiny chrome / iron skillet), place an "X" under the "Metallic" column. If it does not look like metal, place an "X" under the "Non-metallic" column. [Hint: if you can't tell or are unsure, perform the streak test in Procedure 5 below. If the streak is dark, the mineral is metallic. If it is light, white, or no streak, it is non-metallic.]
3. Test for hardness by placing the glass plate on your desk and then pressing and sliding the mineral firmly across it (look for a sharp edge on the sample). DO NOT hold the plate in your hand - it might break if you press too hard! If the mineral does scratch the glass, place an "X" under the "Harder than glass" column.
4. Determine if the mineral has cleavage or fracture. Pick up the mineral and look very carefully for "flat" shiny surfaces. If there are flat surfaces place an "X" in the Cleavage column, otherwise place an "X" in the column labeled Fracture.
5. Rub the mineral on the white porcelain streak plate (DO NOT hold the plate in your hand!). If the mineral leaves a colored powder, place an "X" under the "Colored" column. If the mineral leaves a white powder (or no powder at all), place an "X" under the "None or White" column.

6. Write down any visible characteristics that may help identify the mineral (look in the special characteristics column on the Mineral ID sheet).
7. Using the Mineral Identification Chart on page 6, determine the name of the mineral and write the name in the chart below.
8. Repeat steps 2 - 8 for each of the other minerals in the kit.
9. Have your teacher check and sign your work in the box to the right.



Sample Number	Luster		Hardness		Cleavage	Fracture	Streak		Special Characteristics  (magnetic, smells bad, double refraction, effervesces in an acid, etc.)	Mineral Name
	Metallic	Non - metallic	Not as hard as glass	Harder than glass			Colored	None or White		
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

✓ **Check Point**

- |  |             |
|--|-------------|
| _____1. When a mineral breaks and has rough or irregular surfaces.     | A. Cleavage |
| _____2. Easiest to recognize but not very reliable                     | B. Color    |
| _____3. Color of a mineral's powder                                    | C. Fracture |
| _____4. The way a mineral reflects light                               | D. Hardness |
| _____5. A mineral's ability to scratch or be scratched                 | E. Luster   |
| _____6. The tendency of a mineral to split along smooth, flat surfaces | F. Streak   |

**Regents Questions:**

- \_\_\_\_1. Which mineral is the major component of drywall?  
 (1) talc (2) calcite (3) muscovite mica (4) selenite gypsum

- \_\_\_\_2. The table below shows some properties of four different minerals. The minerals listed in the table are varieties of which mineral?

- (1) garnet  
 (2) magnetite  
 (3) quartz  
 (4) olivine

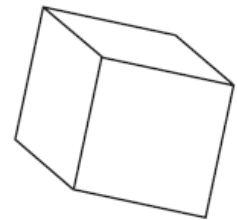
Mineral Variety	Color	Hardness	Luster	Composition
Flint	Black	7	nonmetallic	SiO <sub>4</sub>
Chert	Gray, brown, or yellow	7	nonmetallic	SiO <sub>4</sub>
Jasper	Red	7	nonmetallic	SiO <sub>4</sub>
Chalcedony	White or light color	7	nonmetallic	SiO <sub>4</sub>

Use the diagrams of the crystal shapes of two minerals below to answer question 3.

- \_\_\_\_3. Quartz and halite have different crystal shapes primarily because  
 (1) light reflects from crystal surfaces  
 (2) energy is released during crystallization  
 (3) of impurities that produce surface variations  
 (4) of the internal arrangement of the atoms



Quartz



Halite

- \_\_\_\_4. The mineral graphite is often used as  
 (1) a lubricant (3) a source of iron  
 (2) an abrasive (4) a cementing material

Base your answers to questions 5 and 6 on Moh's mineral hardness scale and the chart below showing the approximate hardness of some common objects.

- \_\_\_\_5. Which statement is best supported by this scale?  
 (1) A fingernail will scratch calcite, but not quartz.  
 (2) A fingernail will scratch quartz, but not calcite.  
 (3) A piece of glass can be scratched by quartz, but not by calcite.  
 (4) A piece of glass can be scratched by calcite, but not by quartz

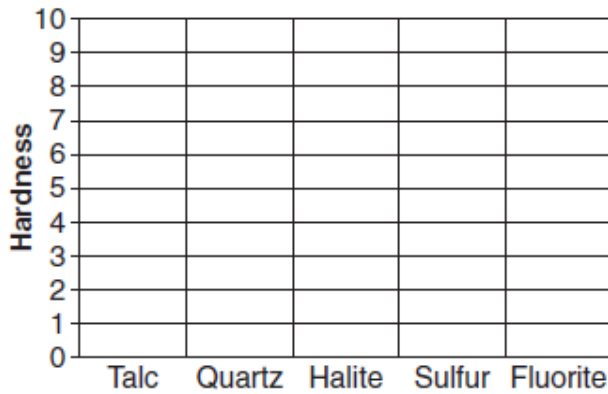
- \_\_\_\_6. The hardness of these minerals is most closely related to the  
 (1) mineral's color  
 (2) mineral's abundance in nature  
 (3) amount of iron the mineral contains  
 (4) internal arrangement of the mineral's atoms

Moh's hardness scale:

	<u>Approximate Hardness of Common Objects</u>
(1) Talc	
(2) Gypsum	
(3) Calcite	
(4) Fluorite	Fingernail (2.5)
(5) Apatite	Copper Penny (3.5)
(6) Feldspar	Iron nail (4.5)
(7) Quartz	Glass (5.5)
(8) Topaz	Steel file (6.5)
(9) Corundum	Streak plate (7.0)
(10) Diamond	



7. Silicate minerals contain the elements silicon and oxygen. Which list contains only silicate minerals
- (1) graphite, talc, and selenite gypsum                      (3) calcite, dolomite, and pyroxene  
 (2) potassium feldspar, quartz, and amphibole              (4) biotite mica, fluorite, and garnet
8. On the grid *below* construct a bar graph to represent the hardness of these minerals.



9. Which mineral shown on the grid to the left would be the best abrasive?

State *one* reason for your choice.

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Use the passage below as a reference in answering questions 10 - 13.

#### Asbestos

Asbestos is a general name given to the fibrous varieties of six naturally occurring minerals used in commercial products. Most asbestos minerals are no longer mined due to the discovery during the 1970s that long-term exposure to high concentrations of their long, stiff fibers leads to health problems. Workers who produce or handle asbestos products are most at risk, since inhaling high concentrations of airborne fibers allows the asbestos particles to become trapped in the workers' lungs. Chrysotile is a variety of asbestos that is still mined because it has short, soft, flexible fibers that do not pose the same health threat.

10. State *one* reason for the decline in global asbestos use after 1980.

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11. Chrysotile is found with other minerals in New York State mines located near 44° 30' N, 74°W. Name the mountain that is closest to this location.

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12. What determines the physical properties of minerals, such as the long, stiff fibers of some varieties of asbestos?

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13. The chemical formula for chrysotile is  $Mg_3Si_2O_5(OH)_4$ . State the name of the mineral found on the *Earth Science Reference Tables* that is most similar in chemical composition.

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## Mini Lesson 2: Rock Cycle

Rocks are classified based on how they were formed (their origin), mineral content and texture. By observing a rock's mineral content and texture we can infer its environment of formation. Rocks continually undergo changes due to processes above and below the surface of Earth. At the surface weathering and erosion break rocks into sediments that may eventually become sedimentary rocks. Beneath the surface heat and pressure can alter the rocks (recrystallization) and if temperatures are hot enough the rock can melt. These processes are described in the Rock Cycle Chart.

Rocks are identified based on composition, structure and texture. Although there are some exceptions, most rocks are composed of one or more minerals. Some exceptions include coal, which comes from decayed plants and limestone that is composed of biological remains and chemical precipitates. The properties of rocks determine how they are used and influence land usage.

### Need to know:

1. How are rocks classified? \_\_\_\_\_  
\_\_\_\_\_
2. What happens to rocks at the surface? \_\_\_\_\_  
\_\_\_\_\_
3. What two things change rocks beneath the surface? \_\_\_\_\_ & \_\_\_\_\_
4. How are rocks identified? \_\_\_\_\_
5. What are most rocks composed of? \_\_\_\_\_
6. Give two examples of rocks that are not composed of minerals and their composition.
  - (a) \_\_\_\_\_ , \_\_\_\_\_
  - (b) \_\_\_\_\_ , \_\_\_\_\_

## Rock Cycle Diagram: Earth Science Reference Tables Page 6

### Materials

- ✓ ESRT's
- ✓ Highlighter
- ✓ Color pencils

1. Open your Earth Science Reference Tables to page 6. Refer to the "Rock Cycle in Earth's Crust" diagram.
2. Highlight **ONLY** the names of each rock type located in the rectangle boxes (Sedimentary Rock, Igneous Rock and, Metamorphic Rock).
3. Using a red colored pencil, color in the oval labeled "Magma".
4. Find the arrow that is going from the magma oval to the "Igneous Rock" box.
5. Trace the arrow in red. Trace the **outline** of the "Igneous Rock" box in red as well.
6. If you follow the arrow backwards it will tell you how an Igneous rock forms:  
"Igneous rocks form from the \_\_\_\_\_ of magma"
7. Each "rock" box has an arrow labeled "Melting" going from the box. Trace the arrows in red.
8. Using a brown colored pencil, lightly color in the oval labeled "Sediments".
9. Find the arrow that is going from the sediments oval to the "Sedimentary Rock" box.
10. Trace the arrow in brown. Trace the **outline** of the "Sedimentary Rock" box in brown as well.
11. If you follow the arrow backwards it will tell you how a Sedimentary rock forms:  
"Sedimentary rocks form from the \_\_\_\_\_ and Burial,  
\_\_\_\_\_ and/or \_\_\_\_\_ of sediments."
12. Each "Rock" box has an arrow labeled "Weathering & Erosion (uplift)" going from the box. Trace these arrows in brown. There is an arrow going from the "Sediments" oval. Trace this brown.
13. Trace the "Metamorphic Rock" box blue.
14. Look at the two arrows that are going into the "Metamorphic Rock" box and trace them in blue. Include the third arrow to the left of the "Metamorphic Rock" box.
15. If you follow the arrow backwards it will tell you how a Metamorphic rock forms:  
"Metamorphic rocks form due to \_\_\_\_\_ and/or \_\_\_\_\_ (Metamorphism)."
16. Each "Rock" box has an arrow labeled "Heat and/or Pressure" going from the box. Trace these arrows in blue.

### ✓ **Check Point**

1. Look at any "Rock" box. There are three arrows going from it. They describe three things that can happen to any rock. List these three things below:

(a) \_\_\_\_\_

(b) \_\_\_\_\_

(c) \_\_\_\_\_

2. Describe how each of the following rocks form.

a) Sedimentary \_\_\_\_\_

b) Igneous \_\_\_\_\_

c) Metamorphic \_\_\_\_\_

3. Name the rock type comes directly from other rocks. \_\_\_\_\_

4. Name the rock type that forms from magma. \_\_\_\_\_

5. Name the rock type that forms from sediments. \_\_\_\_\_

### Regents Questions

\_\_\_\_1. A sample of conglomerate consists mostly of fragments of granite and sandstone. The best inference that can be made from the sample is that this conglomerate

- (1) Contains fossils
- (2) Resulted from solidification
- (3) Formed from other rocks
- (4) Formed during the Cambrian Period

\_\_\_\_2. Metamorphic rock could be the direct result of the

- (1) melting and solidification of sedimentary rock
- (2) weathering and erosion of igneous rock
- (3) compaction and heating of metamorphic rock
- (4) erosion and deposition of sediments

\_\_\_\_3. The recrystallization of unmelted material under high temperature and pressure results in

- (1) metamorphic rock
- (2) igneous rock
- (3) sedimentary rock
- (4) volcanic rock

\_\_\_\_4. Which characteristics would give the best evidence about the conditions under which a rock was formed?

- (1) The rock's density and size
- (2) The rock's structure and texture
- (3) The rock's mineral and color
- (4) The rock's shape and phase

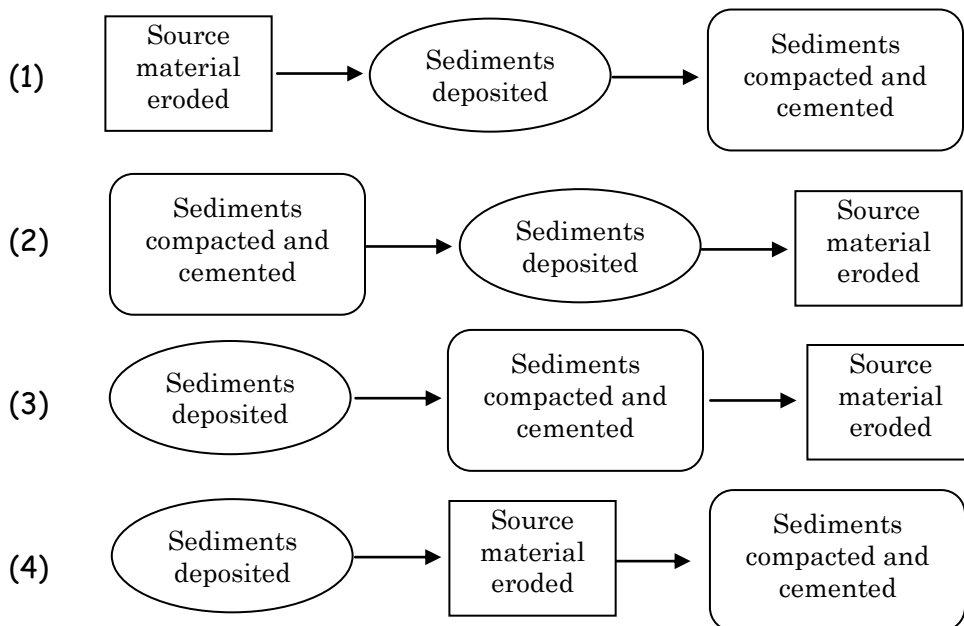
\_\_\_\_5. Metamorphic rocks are formed by

- (1) compaction and cementation
- (2) melting and solidification
- (3) heating and pressure
- (4) erosion and deposition

\_\_\_\_6. Which processes have all igneous rocks undergone?

- (1) deposition and burial
- (2) solidification from a melt
- (3) volcanic eruption
- (4) weathering and erosion

- \_\_\_7. Which type of rock can be the source of deposited sediments?  
 (1) Igneous and metamorphic rocks, only  
 (2) Metamorphic and sedimentary rocks, only  
 (3) Sedimentary rocks, only  
 (4) Igneous, metamorphic and sedimentary rocks
- \_\_\_8. Some sedimentary rocks form as the direct result of the  
 (1) solidification of molten magma (3) melting of minerals  
 (2) recrystallization of material (4) cementation of rock fragments
- \_\_\_9. Most igneous rocks form by which processes?  
 (1) melting and solidification (3) erosion and deposition  
 (2) heat and pressure (4) compaction and cementation
- \_\_\_10. Which statement is supported by the Rock Cycle diagram?  
 (1) Metamorphic rock results directly from melting and crystallization  
 (2) Sedimentary rock can only be formed from igneous rock.  
 (3) Igneous rock always results from melting and solidification.  
 (4) All sediments turn directly into sedimentary rock.
- \_\_\_11. What is the main difference between metamorphic rocks and most other rocks?  
 (1) Many metamorphic rocks contain only one mineral.  
 (2) Many metamorphic rocks have an organic composition.  
 (3) Many metamorphic rocks exhibit banding and distortion of structure.  
 (4) Many metamorphic rocks contain a high amount of oxygen-silicon tetrahedra.
- \_\_\_12. Which sequence of events occurs in the formation of a sedimentary rock?



## Mini Lesson 3: Igneous Rocks

Igneous rocks are formed by the solidification of molten material (magma). These rocks have two general environments of formation. Intrusive rocks (plutonic) form deep under Earth's surface. Due to the high temperatures within Earth, it takes millions of years for the magma to cool and solidify, giving mineral crystals time to form. The texture of intrusive igneous rocks can be coarse or very coarse. The word "coarse" refers to the size of the minerals NOT the roughness of the rock. Extrusive igneous rocks form at or near Earth's surface. Temperatures at the surface of Earth are much cooler and cause molten material (lava) to cool and solidify much faster. This does not leave enough time for the formation of mineral crystals so the texture of extrusive rocks can range from glassy to fine.

### Need to know:

1. How do igneous rocks form? \_\_\_\_\_
2. What page of the Earth Science Reference Tables describes how Igneous rocks form? \_\_\_\_\_
3. Where do intrusive igneous rocks form? \_\_\_\_\_
4. How many years does it take magma to cool and solidify for an intrusive rock to form? \_\_\_\_\_
5. What two textures can an intrusive rock have? \_\_\_\_\_ , \_\_\_\_\_
6. What does the word "coarse" refer to? \_\_\_\_\_
7. Where do extrusive igneous rocks form? \_\_\_\_\_
8. Why do extrusive rocks cool faster? \_\_\_\_\_
9. What two textures can an extrusive rock have? \_\_\_\_\_ , \_\_\_\_\_
10. Why is the texture so small in an extrusive rock? \_\_\_\_\_

### "Igneous Rock Chart" Earth Science Reference Tables Page 6

1. Open your Earth Science Reference to page 6.
2. Highlight the title "Scheme for Igneous Rock Identification".
3. Highlight the label on the left of the chart "Igneous Rocks".
4. Highlight just the names of the igneous rocks in the chart located in the center section in the table. DO NOT highlight the entire box.
5. How many different rocks are listed in the chart? \_\_\_\_\_
6. Looking to the left of the table, highlight the two environments of formation listed.

#### Materials

- ✓ ESRT's
- ✓ Highlighter
- ✓ Color pencils

7. List the two environments you just highlighted. \_\_\_\_\_ & \_\_\_\_\_
8. Which environment is far beneath Earth's surface? \_\_\_\_\_
9. Which environment is at or near Earth's surface? \_\_\_\_\_
10. With a gray color pencil, trace over and darken the line that separates intrusive and extrusive rocks.
11. Using a green color pencil, lightly shade in the first row, starting with **obsidian** and going all the way to the right of the row through the word "**Non-vesicular**".
- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the two igneous rocks you colored over in green. \_\_\_\_\_  
\_\_\_\_\_
- c) What is the crystal size of these two rocks? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_
12. Using an orange color pencil, lightly shade in the next row, starting with **pumice** and going all the way to the right of the row through the word "**vesicular**".
- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the two igneous rocks you colored over in orange. \_\_\_\_\_  
\_\_\_\_\_
- c) What is the crystal size of these two rocks? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_
- e) What does a vesicular rock have in it? \_\_\_\_\_
13. Using a blue color pencil, lightly shade in the next row, starting with **Vesicular Rhyolite** and going all the way to the right of the row through the word "**vesicular**".
- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the three igneous rocks you colored over in blue. \_\_\_\_\_  
\_\_\_\_\_ , \_\_\_\_\_
- c) What is the crystal size of these three rocks? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_

14. Using a pink color pencil, lightly shade in the next row, starting with **Rhyolite** and going all the way to the right of the row through the word "**non-vesicular**". *Only shade in the top half for Diabase.*

- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the four igneous rocks you colored over in pink. \_\_\_\_\_  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ (1/2 pink)
- c) What is the crystal size of these four rocks? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_

15. Using a light green color pencil, lightly shade in the next row, starting with **Granite** and going all the way to the right of the row through the word "**non-vesicular**". *Only shade in the bottom half for Diabase.*

- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the six igneous rocks you colored over in light green. \_\_\_\_\_  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_ (1/2 green)
- c) What is the crystal size of these six rocks? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_

16. Using a purple color pencil, lightly shade in the next row, starting with **Pegmatite** and going all the way to the right of the row through the word "**non-vesicular**".

- a) Are these rocks intrusive or extrusive? \_\_\_\_\_
- b) Name the igneous rock you colored over in purple. \_\_\_\_\_
- c) What is the crystal size of this rock? \_\_\_\_\_
- d) What are the two classifications for texture given for these rocks?  
\_\_\_\_\_ & \_\_\_\_\_

17. Using a yellow highlighter, highlight the word "characteristics" on the left side of the table.

18. Using a yellow highlighter trace over the word "Lighter" through the entire line and the word "Color". Continue through the word "Darker". This line indicates the general color of the rocks.

- a. Is the word "Lighter" located on the left or right side of the chart? \_\_\_\_\_
- b. Look at the list of the igneous rocks located on the left side of the chart. Are these rocks lighter or darker in color?  
\_\_\_\_\_



c. Which rock on this side of the chart is the exception? \_\_\_\_\_

Explain your reasoning. \_\_\_\_\_

d. List the other five rocks that are lighter in color. \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

e. Is the word "Darker" located on the left or right side of the chart? \_\_\_\_\_

f. Look at the list of the igneous rocks located on the right side of the chart. Are these rocks lighter or darker in color? \_\_\_\_\_

g. List the eight rocks that are darker in color.

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

19. Using a highlighter trace over the word "Lower" through the entire line and the word "Density" until you reach the end. Highlight the word "Higher". This line indicates the relative densities of the rocks.

a. Is the word "Lower" located on the left or right side of the chart? \_\_\_\_\_

b. List the names of the six igneous rocks that are lower in density.

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

c. Is the word "Higher" located on the left or right side of the chart? \_\_\_\_\_

d. List the names of the eight igneous rocks that are higher in density.

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

\_\_\_\_\_ & \_\_\_\_\_

20. Using a highlighter trace over the word "Felsic" through the entire line and the word "Composition" until you reach the end. Highlight the word "Mafic". This line indicates the relative composition of the rocks.

a. Is the word "Felsic" located on the left or right side of the chart? \_\_\_\_\_

b. What two elements are Felsic rocks "rich in"? \_\_\_\_\_ and \_\_\_\_\_

c. List the names of the six igneous rocks that are felsic in composition.

\_\_\_\_\_ & \_\_\_\_\_  
\_\_\_\_\_ & \_\_\_\_\_  
\_\_\_\_\_ & \_\_\_\_\_

d. Is the word "Mafic" located on the left or right side of the chart? \_\_\_\_\_

e. What two elements are Mafic rocks "rich in"? \_\_\_\_\_ and \_\_\_\_\_

f. List the names of the eight igneous rocks that are higher in density.

\_\_\_\_\_ & \_\_\_\_\_  
\_\_\_\_\_ & \_\_\_\_\_  
\_\_\_\_\_ & \_\_\_\_\_  
\_\_\_\_\_ & \_\_\_\_\_

21. Rocks on the left side of the chart have all of the following in common:

\_\_\_\_\_ in color, \_\_\_\_\_ in density and \_\_\_\_\_ composition

22. Rocks on the right side of the chart have all of the following in common:

\_\_\_\_\_ in color, \_\_\_\_\_ in density and \_\_\_\_\_ composition

23. The reason the color, density and composition are the same for rocks on the same side of the chart is that the minerals those rocks contain are also the same. Go to the last section at the bottom of the chart. This section lists the mineral composition of the igneous rocks above. Highlight "Mineral Composition" on the left side of the bottom chart.

a. Using a pencil, darken in the line between Vesicular Rhyolite and Vesicular Andesite. Go all the way through the mineral composition portion of the chart.

b. List the 5 minerals found in Granite and Rhyolite (and all other rocks on the left of the chart)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

c. Using a pencil, darken in the line between Obsidian and Basalt Glass. Go all the way through the mineral composition portion of the chart.

d. List the 5 possible minerals found in Vesicular Andesite, Andesite, and Diorite

\_\_\_\_\_

\_\_\_\_\_

e. Using a pencil, darken in the line between Diabase and Peridotite. Go all the way through the mineral composition portion of the chart.

f. List the 5 possible minerals found in Basaltic Glass, Scoria, Basalt, Diabase and Gabbro.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

g. Using a pencil, darken in the line between Peridotite and Dunite. Go all the way through the mineral composition portion of the chart.

h. List the 2 minerals found in Peridotite

\_\_\_\_\_

i. List the only mineral found in Dunite \_\_\_\_\_

24. In the table below, list the seven minerals listed in the Mineral Composition section of the Igneous rock chart. Refer to the Earth Science Reference Tables, "Properties of Common Minerals" and place an "X" in the box to indicate the elements that are present in each mineral. All of the elements for each of the minerals are not listed, mark the ones that are.

Mineral Name	Silicon (Si)	Oxygen (O)	Magnesium (Mg)	Potassium (K)	Aluminum (Al)	Iron (Fe)
Potassium Feldspar	X	X	X	X	X	

25. Turn to the back cover of your Earth Science Reference Tables. Highlight the mineral name if it is found in the Igneous Rock chart. There are 7 total.

26. What two elements do each of the above minerals contain?

\_\_\_\_\_ & \_\_\_\_\_

**Introduction:**

Igneous rocks are formed from the solidification of molten material. When they form deep under Earth's surface they have a coarse texture because minerals had a long time to form as the magma cooled. These rocks are called intrusive. If they formed at or near the surface, they cooled quickly and have no visible minerals. They have a glassy or fine texture and are extrusive.

**Materials**

- ✓ Pencil
- ✓ Rock Kit
- ✓ ESRT's

**Objective:**

- To identify 6 igneous rocks using texture, color and other visible features

**Procedure**

1. Pick up an Igneous Rock Kit from your teacher.
2. Empty the box of rocks onto the table.
3. Look at the table below and describe the properties of each rock. Refer to your ESRT.
4. Find the rock and write the rock number in the column to the right. Place the rock back in the Rock Box.
5. Have your teacher check and sign your work in the box to the right.



Rock Name	Texture (glassy, fine, coarse)	Vesicular (or) Non- vesicular	Color (light, dark, both)	Rock number
Granite				
Diorite				
Obsidian				
Rhyolite				
Scoria				
Basalt				

✓ **Check Point**

1. How are igneous rocks formed? \_\_\_\_\_
2. How can you determine if an igneous rock is intrusive or extrusive? \_\_\_\_\_
3. How is the size of the mineral in an igneous rock related to the rate at which the molten rock material cools? \_\_\_\_\_
4. Which environment of formation would lead to a coarse textured igneous rock?  
\_\_\_\_\_

5. Compare the density of light colored igneous rocks to the density of dark colored igneous rocks. \_\_\_\_\_
6. What is magma called when it reaches Earth's surface? \_\_\_\_\_
7. What does vesicular mean? \_\_\_\_\_
8. What is the texture of the rock if its crystal size is between 1mm to 10mm? \_\_\_\_\_
9. How large is the crystal size of a rock that is very coarse? \_\_\_\_\_
10. Name the igneous rock that is felsic but appears black. \_\_\_\_\_
11. Name four things that Rhyolite and Granite have in common.  
 \_\_\_\_\_  
 \_\_\_\_\_
12. Name three things that are different between Rhyolite and Granite.  
 \_\_\_\_\_  
 \_\_\_\_\_
13. What is the main difference between Basalt and Vesicular Basalt? \_\_\_\_\_
14. Compare the density of Gabbro with the density of Granite. \_\_\_\_\_
15. Name the igneous rock that is composed 100% of Olivine. \_\_\_\_\_
16. Name the igneous rock that is low in density, non-vesicular and has a fine texture.  
 \_\_\_\_\_
17. Name a rock that may be intrusive or extrusive. \_\_\_\_\_
18. What is another name for intrusive? \_\_\_\_\_
19. Name the igneous rock that has a fine, non-vesicular texture and contains approximately 60% plagioclase feldspar, 15% biotite and 25% amphibole. \_\_\_\_\_
20. Describe the density, color and composition of a rock that is composed of primarily pyroxene and olivine.

Density: \_\_\_\_\_

Color: \_\_\_\_\_

Composition: \_\_\_\_\_

**Regents Questions:**

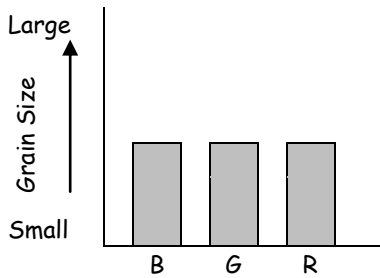
- \_\_\_\_1. Which is usually a characteristic of igneous rocks with a high density?  
 (1) They are light in color (3) They have a high aluminum content.  
 (2) They are felsic. (4) They contain iron.
- \_\_\_\_2. As the percentage of mafic minerals in an igneous rock increases, the rocks color becomes  
 (1) lighter and its grain size decreases (3) darker and its density decreases  
 (2) lighter and its grain size increases (4) darker and its density increases
- \_\_\_\_3. Which rock is of felsic composition, low in density, light in color, and coarse grained?  
 (1) Rhyolite (2) Basalt (3) Granite (4) Gabbro
- \_\_\_\_4. Which statement is true of granite and gabbro?  
 (1) they are both intrusive (3) they have different grain sizes  
 (2) they both contain potassium feldspar (4) they are both extrusive
- \_\_\_\_5. Which characteristic of an igneous rock would provide the most information about the environment in which the rock solidified?  
 (1) color (2) texture (3) hardness (4) streak
- \_\_\_\_6. Which graph best represents the comparison of the average grain sizes in basalt, granite, and rhyolite?

Key to Graph Abbreviations:

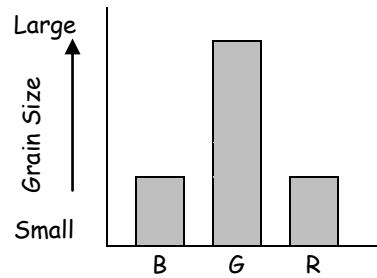
**B - Basalt**

**G - Granite**

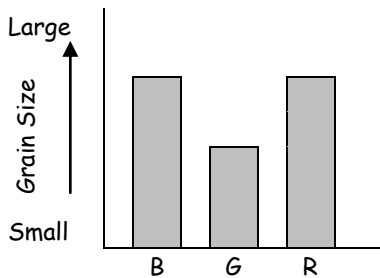
**R - Rhyolite**



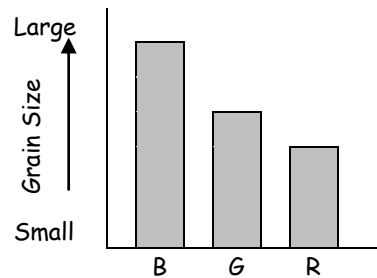
(1)



(3)



(2)



(4)

- \_\_\_7. Larger crystal size in one of two igneous rocks of similar composition usually indicates that the rock with the larger crystals cooled for
- (1) a shorter period of time than the other rock
  - (2) a longer period of time than the other rock
  - (3) the same amount of time as the other rock
- \_\_\_8. Large crystals in an igneous rock most likely form as a result of the
- (1) mineral composition of the magma
  - (2) fossil content of the rock
  - (3) cooling rate of the magma
  - (4) color of the rock
- \_\_\_9. Which property is common to most light-colored igneous rocks?
- (1) coarse grained texture
  - (2) intrusive formation
  - (3) abundant felsic minerals
  - (4) high density
- \_\_\_10. Which property is common to most dark-colored igneous rocks?
- (1) coarse grained texture
  - (2) intrusive formation
  - (3) abundant felsic minerals
  - (4) high density
- \_\_\_11. Compared to basalt, granite is
- (1) lighter in color
  - (2) greater in density
  - (3) more mafic in composition
  - (4) more fine grained in texture
- \_\_\_12. Rhyolite and granite are alike in that they both are
- (1) fine grained
  - (2) dark colored
  - (3) mafic
  - (4) felsic
- \_\_\_13. Which relative concentrations of elements are found in a felsic rock
- (1) A high concentration of aluminum and a low concentration of iron
  - (2) A high concentration of iron and a low concentration of aluminum
  - (3) A high concentration of magnesium and a low concentration of iron
  - (4) A high concentration of magnesium and a low concentration of aluminum
- \_\_\_14. A mafic igneous rock is most likely to be relatively
- (1) high in density and dark in color
  - (2) high in density and light in color
  - (3) low in density and dark in color
  - (4) low in density and light in color
- \_\_\_15. The best evidence for determining the cooling rate of an igneous rock during its solidification is provided by
- (1) index fossils
  - (2) faults in the rock
  - (3) the crystal size of its minerals
  - (4) the disintegration of radioactive substances
- \_\_\_16. As the hot molten rock material (magma) cools, the size of the crystals in the igneous rock formed depends chiefly on the
- (1) amount of iron present
  - (2) dissolved gases present in the magma
  - (3) amount of silicate present
  - (4) rate at which the magma cools

## Mini Lesson 4: Sedimentary Rocks

Sedimentary rocks form from the deposition, burial, compaction and cementation of sediments. Clastic sedimentary rocks form from pieces and fragments of other rocks. Crystalline sedimentary rocks form from chemical precipitates and evaporites. Bioclastic sedimentary rocks form from something that was once living.

Sedimentary rocks are formed at or near Earth's surface because that is where all of the weathering and erosion (breakdown and movement) of rocks occur. They are usually deposited in horizontal layers by water. Fossils provide evidence of past environments and are almost exclusively found in sedimentary rocks because the magma that forms igneous rock would melt the fossils, and the heat and pressure that forms metamorphic rocks would deform them.

### Need to know:

1. How do sedimentary rocks form? \_\_\_\_\_  
\_\_\_\_\_
2. What page of the Earth Science Reference Tables describe how Sedimentary rocks form?
3. What do clastic rocks form from? \_\_\_\_\_
4. What do crystalline rocks form from? \_\_\_\_\_  
\_\_\_\_\_
5. What do bioclastic rocks form from? \_\_\_\_\_
6. Where do sedimentary rocks form? \_\_\_\_\_
7. Why do sedimentary rocks form where they do? \_\_\_\_\_  
\_\_\_\_\_
8. What do fossils provide evidence of? \_\_\_\_\_  
\_\_\_\_\_
9. Why are fossils found almost exclusively found in sedimentary rocks? \_\_\_\_\_  
\_\_\_\_\_
10. The formation of which rock type would melt the fossils? \_\_\_\_\_
11. The formation of which rock type would alter or deform fossils? \_\_\_\_\_



**"Sedimentary Rock Chart" Earth Science Reference Tables Page 7**

1. Open your Earth Science Reference to page 7.
2. Highlight the title "Scheme for Sedimentary Rock Identification".
3. This table is divided into two basic sections (they are shaded gray). Name the two main categories for sedimentary rocks.

**Materials**

- ✓ ESRT's
- ✓ Highlighter
- ✓ Color pencils

- (a) \_\_\_\_\_
- (b) \_\_\_\_\_
4. Looking at the top section, what is the texture listed? \_\_\_\_\_
5. These sedimentary rocks are formed primarily from pieces and parts (fragments) of other rocks. Find and highlight the rock names.
6. Very carefully study this section of the table by looking at each column and the information beneath. What is the one major difference between each of these rocks? In other words, what makes shale different from siltstone and sandstone? \_\_\_\_\_
7. Using a purple colored pencil, color in the column for "grain size" on the top section **ONLY**.
8. The way in which clastic sedimentary rocks are classified is by \_\_\_\_\_
9. What is the name of the smallest fragment listed on this chart? \_\_\_\_\_
  - a) What is the size of the fragment? \_\_\_\_\_
  - b) What is the name of the rock that forms from this size fragment? \_\_\_\_\_

10. Fill in the chart below. **Clastic Sedimentary Rocks:**

Rock name	Grain size (name)	Grain size (cm)	Comments
Conglomerate	Mixed	Variable	Rounded fragments
Breccia			
Sandstone			
Siltstone			
Shale			

11. Turn to page 6 of the Earth Science Reference Tables. Refer to the graph labeled "Relationship of Transported Particle Size to Water Velocity".
12. Using a highlighter trace over each of the dotted lines that run across the graph that have numbers listed on them to the right. These lines separate the different particle sizes.

13. List the names and sizes of the particles in the table below from the largest to the smallest. Boulders is already done.

Particle Name	Particle size
Boulders	Greater than 25.6 cm
	to _____ cm
	to _____ cm
	to _____ cm
	to _____ cm
	Less than _____ cm

14. Fill in the following chart using the Earth Science Reference Tables page 6: *Relationship of Transported Particle Size to Water Velocity* and the *Scheme for Sedimentary Rock Identification* table on page 7.

Grain size (cm)	Name of the Grain	Rock name
0.00001	Clay	Shale
0.1		
0.002		
0.007		
0.9 (round)		
0.5 (angular)		
0.00004		
0.005		

15. The bottom section of the *Scheme for Sedimentary Rock Identification* table on page 7 has three different textures listed. What are they?

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

16. Very carefully study this section of the table by looking at each column and the information beneath. What is the one major difference between each of these rocks? In other words, what makes halite different from gypsum and dolomite?

\_\_\_\_\_

17. Color in the column for "composition" purple on the bottom section **ONLY**.

18. Clastic rocks are formed from other rocks, what do crystalline sediment rocks form from?

Look under "comments" \_\_\_\_\_

19. Name the three crystalline sedimentary rocks.

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

20. What does limestone usually form from? \_\_\_\_\_

21. What bioclastic material forms Bituminous Coal? \_\_\_\_\_

22. Crystalline & Bioclastic Sedimentary rocks: Fill in the chart below.

Rock Name	Composition	Crystalline (or) Bioclastic?	Grain size
Rock Salt			
Rock Gypsum			
Dolostone			
Limestone			
Coal			

23. While looking at the bottom section of the Sedimentary Rock Chart, write down each mineral listed under composition. Carbon is NOT a mineral.

\_\_\_\_\_

24. Go to the "Properties of Common Minerals" table and highlight the minerals you listed above.

✓ **Check Point**

1. What is another name for Clastic rocks? \_\_\_\_\_
2. How are Clastic sedimentary rocks classified? \_\_\_\_\_
3. By what process did Clastic rocks form? \_\_\_\_\_  
\_\_\_\_\_
4. How are Crystalline and Bioclastic sedimentary rocks classified? \_\_\_\_\_
5. By what process do crystalline rocks form? \_\_\_\_\_  
\_\_\_\_\_
6. Where does coal come from? \_\_\_\_\_
7. What is limestone sometimes made up of? \_\_\_\_\_
8. Name the rock composed of calcite. \_\_\_\_\_
9. Name the sedimentary rock that bubbles if HCl is placed on it. \_\_\_\_\_  
Explain why \_\_\_\_\_
10. Name the rock that is the product of decayed plants \_\_\_\_\_
11. Name the rock that is composed of halite. \_\_\_\_\_
12. Name the rock that contains angular fragments (mixed silt to boulders). \_\_\_\_\_

13. Name the rock that has a grain sizes of 0.0004 to 0.006cm. \_\_\_\_\_
14. What is the size of the grains in a piece of shale? \_\_\_\_\_
15. Sandstone is made up of \_\_\_\_\_ size particles with a grain size of \_\_\_\_\_ cm.
16. Name three rocks that may form from the evaporation of sea water.  
\_\_\_\_\_

### Laboratory Activity 3.3

### Sedimentary Rock Identification [40]

#### Introduction

Sedimentary rocks are identified on the basis of texture, grain size and composition. Some rocks are obvious and others not so much. Find the rocks that you can see pebbles or angular fragments first. Then feel the rocks. Determine which rock feels like sand paper, looks like mud or has layers in it. You then may need to test for calcite to determine which rock is limestone.

**Materials**

- ✓ Pencil
- ✓ Rock Kit
- ✓ HCl
- ✓ ESRT's

#### Objective:

- To identify 6 sedimentary rock samples

#### Procedure

1. Pick up a Sedimentary Rock Kit from your teacher.
2. Empty the box of rocks on to the table
3. Look at the table below and describe the properties of each rock. Then find the rock and place the rock number in the column to the right.

Rock Name	Grain size	Comments	Rock number
Conglomerate			
Breccia			
Sandstone			
Siltstone			
Shale			
Limestone			

#### ✓ Check Point

1. Name the rock made of clay particles. \_\_\_\_\_
2. Name two rocks that may be formed from organic remains.  
\_\_\_\_\_
3. Name the rock made of sand grains cemented together. \_\_\_\_\_
4. Name the rock made of the mineral gypsum. \_\_\_\_\_

5. Name the rock made of the mineral dolomite. \_\_\_\_\_
6. Is conglomerate organic or inorganic? \_\_\_\_\_
7. Is gypsum crystalline or bioclastic? \_\_\_\_\_
8. Sedimentary rocks form at or near the \_\_\_\_\_ of Earth.  
Explain why? \_\_\_\_\_
- 
9. Looking at the *Generalized Bedrock Geology of New York State* in the Earth Science Reference Tables (page 3), what rock type is MOST abundant? \_\_\_\_\_
10. Why are fossils found almost exclusively in sedimentary rocks? \_\_\_\_\_
- 

**Regents Questions:**

- \_\_\_\_1. Which rock is formed when rock fragments are deposited and cemented together  
(1) dolostone                      (2) sandstone                      (3) rhyolite                      (4) gabbro
- \_\_\_\_2. Which rock type most likely would contain fossils?  
(1) intrusive igneous rock                      (3) sedimentary rock  
(2) extrusive igneous rock                      (4) metamorphic rock
- \_\_\_\_3. Some sedimentary rocks are composed of rock fragments that had different origins. Which statement best explains why this could occur?  
(1) Fossils are often found in sedimentary rocks.  
(2) Sedimentary rocks form from the weathered products of any type of rock.  
(3) When molten lava solidifies to form sedimentary rock it often contains foreign particles.  
(4) Under high heat and pressure, recrystallization results in the formation of many minerals.
- \_\_\_\_4. Which rocks form relatively thin layers, compared to the thickness of the continent, over large areas of the continents?  
(1) granite and gabbro                      (3) metamorphic rocks  
(2) sandstone and shale                      (4) intrusive igneous rocks
- \_\_\_\_5. One similarity between a sand pile and sandstone is that they  
(1) contain a cementing agent                      (3) have a crystalline structure  
(2) always contain fossils                      (4) are composed of sediments
- \_\_\_\_6. Which kind of bedrock would most likely contain fossils?  
(1) A mass of granite in the core of a mountain  
(2) A series of alternating layers of shale and sandstone  
(3) A basalt lava flow from an ancient volcano  
(4) A high-grade metamorphic rock layer made from mixed igneous and sedimentary layers

- \_\_\_\_7. Which sedimentary rock is land derived?  
 (1) limestone                      (2) gypsum                      (3) siltstone                      (4) salt
- \_\_\_\_8. Which statement correctly describes the distribution of sedimentary rocks on the Earth?  
 (1) Sedimentary rock layers are the thickest in the middle of the oceans.  
 (2) Sedimentary rocks extend down into the earth's crust as far as the inner core.  
 (3) Sedimentary rocks are usually located in volcanic regions.  
 (4) Sedimentary rocks usually form a thin layer over large areas of the continents.
- \_\_\_\_9. The thick sedimentary rocks of central and western New York State, which were formed from shallow water deposits, were most probably produced by  
 (1) glaciations    (3) deposition  
 (2) the uplift of this region    (4) volcanic eruption
- \_\_\_\_10. Compaction and cementation of pebble-size particles would form which sedimentary rock?  
 (1) shale                      (2) conglomerate                      (3) sandstone                      (4) siltstone
- \_\_\_\_11. A sediment contains particles that range in diameter from 2 to 4 centimeters. Which sedimentary rock would be formed when this sediment is compressed and cemented together?  
 (1) shale                      (2) siltstone                      (3) sandstone                      (4) conglomerate
- \_\_\_\_12. Which property is used to classify the land-derived sedimentary rocks listed in the Earth Science Reference Tables?  
 (1) particle size    (3) color  
 (2) fossil content    (4) mineral composition
- \_\_\_\_13. Sedimentary rocks formed by compaction and cementation of land-derived sediments are classified on the basis of  
 (1) composition                      (2) particle size                      (3) type of cement                      (4) rate of formation
- \_\_\_\_14. Which sedimentary rock most likely formed as an evaporite?  
 (1) siltstone                      (2) conglomerate                      (3) gypsum                      (4) shale
- \_\_\_\_15. Which sedimentary rock is composed of fragmented skeletons and shells of sea organisms compacted and cemented together?  
 (1) shale                      (2) sandstone                      (3) gypsum                      (4) limestone
- \_\_\_\_16. Dolostone, gypsum, and salt are rocks formed by the process of  
 (1) melting and solidification    (3) erosion and deposition  
 (2) evaporation and precipitation    (4) weathering and metamorphism
- \_\_\_\_17. Which rock could be formed either by deposition of animal shells and skeletons or by precipitation from evaporating seawater?  
 (1) limestone                      (2) conglomerate                      (3) shale                      (4) rock salt

## Mini Lesson 5: Metamorphic Rocks

Metamorphic rocks form directly from other rocks that are exposed to extreme heat and pressure. Rocks that become metamorphic never melt, however, sometimes minerals may realign and foliation occurs. When heat and pressure are great enough recrystallization occurs and alternating bands of minerals become visible. This is called banding. In addition, metamorphic rocks are more dense than their parent rocks due to the extreme pressure that changed them. The parent rock is the rock that the metamorphic rock formed from.



### Need to know:

1. How do metamorphic rocks form? \_\_\_\_\_  
\_\_\_\_\_
2. What page of the Earth Science Reference Tables describe how Metamorphic rocks form? \_\_\_\_\_
3. What is the realignment of minerals called? \_\_\_\_\_
4. What is banding? \_\_\_\_\_
5. Compare the density of metamorphic rocks with the density of the parent rocks. \_\_\_\_\_  
\_\_\_\_\_
6. What is the parent rock? \_\_\_\_\_  
\_\_\_\_\_



Mineral Arrangement  
Before Metamorphism



Rock Showing Banding  
After Metamorphism

**"Metamorphic Rock Chart" Earth Science Reference Page 7**

1. Turn to page 7 in the Earth Science Reference Tables.
2. Highlight the title "Scheme for Metamorphic Rock Identification" at the bottom of the page.
3. This table is divided into two basic sections. Name the two **main** categories for metamorphic rocks (listed under texture).

- Materials**
- ✓ ESRT's
  - ✓ Highlighter
  - ✓ Color pencils

(a) \_\_\_\_\_

(b) \_\_\_\_\_

4. The foliated section is broken up into two additional categories, what are they?

\_\_\_\_\_ and \_\_\_\_\_

5. Using a blue color pencil draw a line under the word fine, all the way to the end of the table, past slate and under the map symbol. Lightly shade in blue the area above the line you just drew.

6. What is the name of the mineral that is present in slate?

7. Using a light green colored pencil, lightly draw a line from left to right, sectioning off the rock Phyllite, going through the map symbol area again. Lightly shade the area in light green above the line.

8. What five minerals are in the rock Phyllite?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

9. Using a purple colored pencil, lightly draw a line from left to right, sectioning off the rock Schist, going through the map symbol area again. Lightly shade the area in purple above the line.

10. What five minerals are always in the rock Schist?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

11. What mineral may appear in Schist?

\_\_\_\_\_

12. Using a pink colored pencil, lightly draw a line from left to right, sectioning off the rock Gneiss, going through the map symbol area again. Lightly shade the area in pink above the line

13. What six minerals are in the rock Gneiss?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

14. What type of metamorphism do these foliated rocks go through?

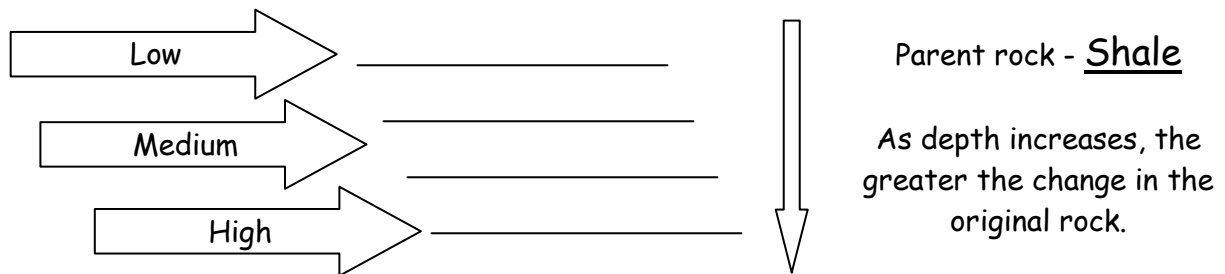
\_\_\_\_\_

15. Looking at the comments, as heat and pressure increases what happens to the "grade" of metamorphism?

\_\_\_\_\_



16. Referring to the comment section again, name the rock that is formed from "Low-grade metamorphism" of Shale. \_\_\_\_\_ This rock is considered the "parent" rock for Slate.
17. The deeper underground, the more heat and pressure and the greater the change. There are four rocks listed on the top section of the Metamorphic Rock Chart. Place the rock names in order in the blanks below. This illustrates the amount change that occurred to the original (parent) rock Shale as depth within Earth increased.



18. Highlight the word "NONFOLIATED" under texture at the bottom of the Metamorphic Chart.
19. What is the composition of Anthracite coal? \_\_\_\_\_
20. Name the parent rock of Anthracite coal. \_\_\_\_\_
21. What is the composition of Quartzite? \_\_\_\_\_
22. What is the parent rock for Quartzite? \_\_\_\_\_
23. What is the composition of Marble? \_\_\_\_\_ and/or \_\_\_\_\_
24. What is the parent rock of Marble? \_\_\_\_\_ or \_\_\_\_\_
25. Name the mineral in marble that bubbles in acid. \_\_\_\_\_
26. Name the mineral in marble that bubbles in acid when powdered. \_\_\_\_\_
27. What is the composition of Metaconglomerate? \_\_\_\_\_
28. What is the parent rock of a Metaconglomerate? \_\_\_\_\_
29. Name the Metamorphic rock that is formed only by contact metamorphism.
30. While looking Metamorphic Rock Chart, write down each mineral listed under composition. Carbon is not a mineral.

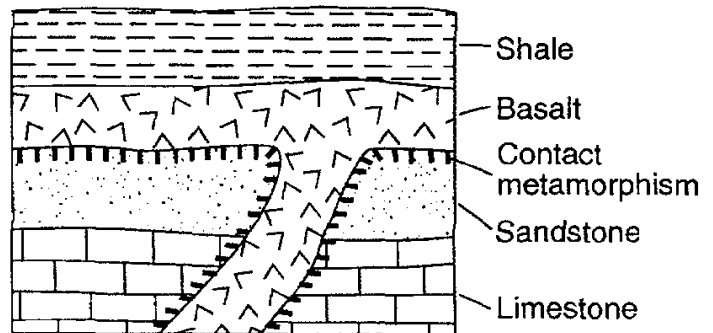
_____	_____
_____	_____
_____	_____
_____	_____

31. Go to the "Properties of Common Minerals" table and highlight the minerals you listed above. If any minerals are already highlighted place an "X" to the right of the mineral's name.

There are two types of metamorphism. The first type is regional metamorphism that occurs when large areas of rock are under intense heat and pressure. This is associated with **mountain building**. The second type is contact metamorphism. This occurs when molten rock comes in contact with surrounding rock. Heat alters the rock it comes in contact with (but does not melt it). Contact metamorphism is usually found between **Igneous and Sedimentary Rocks**.

32. The diagram below illustrates where contact metamorphism takes place. Color the Basalt red to show that it came from solidification of magma.
33. Highlight the "hasher" marks that indicate the contact metamorphism.

- Limestone and sandstone were formed
- Magma came up through a crack or fissure
- Heat melted some rocks and they solidified and became igneous rock
- The extreme heat did not melt all the rock.
- Some of the rock the magma touched changed due to the extreme heat and these became metamorphic rock.



34. What type of rock is Basalt? \_\_\_\_\_
35. What type of rock is Shale, Sandstone and Limestone? \_\_\_\_\_
36. Between which two rock types is the contact metamorphism located?  
 \_\_\_\_\_ and \_\_\_\_\_
37. List the regional metamorphic rocks listed in the reference tables.  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
38. List the metamorphic rocks that can be formed either regionally or by contact.  
 \_\_\_\_\_  
 \_\_\_\_\_
39. Which rock is formed by contact metamorphism only. \_\_\_\_\_

**Introduction**

Metamorphic rocks have undergone a change due to great heat and pressure. These rocks are more dense than their parent rocks and are usually more shiny. Look under the descriptions of each rock and match them with the rock's appearance.

**Materials**

- ✓ Metamorphic Rock Kit
- ✓ ESRTs

**Objective**

- To identify 6 metamorphic rocks based on their texture and composition

**Procedure**

1. Pick up Metamorphic Rock Kit from your teacher.
2. Empty the box of rocks on to the table
3. Look at the table below and describe the properties of each rock. Then find the rock and place the rock number in the column to the right.


Rock Name	Texture / Composition	Comments	Rock number
Gneiss			
Schist			
Phyllite			
Slate			
Quartzite			
Marble			

✓ **Check Point**

1. When does contact metamorphism occur? \_\_\_\_\_  
\_\_\_\_\_
2. What is regional metamorphism associated with? \_\_\_\_\_
3. Why do you seldom find fossils in metamorphic rocks? \_\_\_\_\_
4. Name the parent rock for each of the following metamorphic rocks:
 

Slate _____	Quartzite _____
Phyllite _____	Marble _____
Schist _____	Metaconglomerate _____
5. What two rock types are found on either side of contact metamorphism ?  
\_\_\_\_\_ and \_\_\_\_\_

## Regents Questions

- \_\_\_\_ 1. Which metamorphic rock will have visible mica crystals and a foliated texture?  
(1) marble                      (2) quartzite                      (3) schist                      (4) slate
- \_\_\_\_ 2. Which characteristic of rocks tends to increase as the rocks are metamorphosed?  
(1) number of fossils present                      (3) density  
(2) permeability                      (4) volume
- \_\_\_\_ 3. The diagram to the right shows a rock with deformed structure and intergrown crystals. The rock was probably formed by  
(1) sediments that were deposited on the ocean floor  
(2) heat and pressure that changed a preexisting rock  
(3) volcanic lava that cooled on Earth's surface  
(4) a meteor impact on Earth's surface
- 
- \_\_\_\_ 4. Metamorphic rocks result from the  
(1) erosion of rocks                      (3) cooling and solidification of molten magma  
(2) recrystallization of rocks                      (4) compression and cementation of soil particles
- \_\_\_\_ 5. Which metamorphic rock is foliated, contains pyroxene and has platy mica crystals?  
(1) gneiss                      (2) schist                      (3) marble                      (4) slate
- \_\_\_\_ 6. Which characteristics would indicate that a rock has undergone metamorphic change?  
(1) The rock shows signs of being heavily weathered and forms the floor of a large valley.  
(2) The rock becomes less porous when exposed at the surface and is finely layered.  
(3) The rock contains a mixture of different sized, rounded grains of both felsic and mafic silicate minerals.  
(4) The rock is composed of intergrown mineral crystals and shows signs deformed fossils and structure.
- \_\_\_\_ 7. Which characteristics are most useful for identifying the conditions under which a metamorphic rock was formed?  
(1) color and luster                      (3) hardness and size  
(2) shape and mass                      (4) composition and structure
- \_\_\_\_ 8. Which rock most probably formed in a contact metamorphic zone within a shale rock unit?  
(1) marble                      (2) basalt                      (3) quartzite                      (4) hornfels
- \_\_\_\_ 9. How do the metamorphic rocks schist and quartzite differ?  
(1) Quartzite contains the mineral quartz and schist does not.  
(2) Quartzite forms from regional metamorphism and schist does not.  
(3) Schist is organically formed and quartzite is not.  
(4) Schist is foliated and quartzite is not.
- \_\_\_\_ 10. Which metamorphic rock will bubble with acid?  
(1) quartzite                      (2) marble                      (3) slate                      (4) hornfels