

Name:

Grade:

## Physical Geology 101 Lab #3 MINERALS – Properties, Classification and Identification

**INTRODUCTION:** The purpose of this lab is to learn the characteristics of minerals, and to identify minerals in hand samples from their physical properties. You will become familiar with a number of common rock forming minerals and several other minerals that are less common, but are important because they are the principle sources of economically important materials (such as iron and copper). The objective of this lab is for the student to be able to identify major rock-forming minerals hand specimens by determining their physical properties.

### PRELAB SECTION – To be completed before the lab meeting (First two pages)

#### I. MINERAL DEFINED

1. A mineral is defined by five attributes; a substance must possess these five attributes to be labeled a mineral. **Directions:** List the five attributes for a mineral as noted in your lab book. See page 47 in your lab book.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

2. Does coal or natural glass (obsidian) meet this definition of a mineral? Justify your answer.

**Coal** – Yes or No? Why? \_\_\_\_\_

**Natural glass** - Yes or No? Why? \_\_\_\_\_

**II. HARDNESS:** Some minerals are harder than others. Each mineral has a specific hardness (or at least a restricted range). You can test this for yourself because harder minerals will scratch softer minerals. Choose two mineral samples and try it yourself. A mineral's hardness sometimes determines its usefulness as an economic material. Cutting, grinding and polishing tools typically require abrasives with a specific hardness, depending on the material being worked on. Hard minerals, such as garnet, corundum, and diamond, are used as abrasives for working with hard stone or metals. Some hard minerals are also attractive as gemstones, due in part to their resistance to scratching. Soft minerals such as calcite are used as mild abrasives and polishes where the working material is more delicate.

1. **Question:** Why would a soft mineral be a poor choice for a gem, even if it were very attractive?

2. Soft minerals are sometimes used as mild abrasives if the working material is also soft.

**Question:** Can you think of a mineral that you probably use every day as a mild abrasive/polish?

**3. Questions:** Why does it have to be soft? What would happen if it were replaced with a hard abrasive?

**4.** A mineral hardness scale, called **MOHS HARDNESS SCALE**, uses 10 specific minerals - each with a unique and different hardness (1 to 10) - for comparison with other minerals. The 10 minerals are arranged in order of hardness and numbered from one to ten on the scale of hardness.

**Directions:** List the 10 Mohs Hardness minerals below. (Info found on page 53 in your lab book)

**Soft minerals:** 1) \_\_\_\_\_ 2) \_\_\_\_\_ 3) \_\_\_\_\_  
4) \_\_\_\_\_ 5) \_\_\_\_\_

**Hard minerals:** 6) \_\_\_\_\_ 7) \_\_\_\_\_ 8) \_\_\_\_\_  
9) \_\_\_\_\_ 10) \_\_\_\_\_

Note that the 9 specimens in your hardness kit box are the first 9 minerals of the Mohs scale.

**5. Question:** Guess why the #10 hardness mineral is missing from the hardness kit.

**Identifying Minerals by Hardness:** When geologists need to identify minerals in the field they frequently carry a mineral hardness kit to test field samples for mineral hardness. However, most of us do not walk around with a hardness kit for checking mineral hardness, so it is difficult to make a hardness comparison of minerals when out in the field. So, we can use **more common items** in place of the Mohs minerals.

**6.** What is hardness for these common items below? (You will find this on page 53 in your lab book)

**Streak plate = \_\_\_\_\_ Glass plate = \_\_\_\_\_ Knife blade = \_\_\_\_\_**

**Iron (carpentry) nail = \_\_\_\_\_ Copper penny = \_\_\_\_\_ Fingernail = \_\_\_\_\_**

Note that specimens **equal to or harder** than **feldspar (H = 6)** are considered "**HARD**". A "Hard" mineral will scratch **glass (H = 5.5)**. Specimens **softer** than **flourite (H = 4)** are considered "**SOFT**".

**Questions:**

**7.** Which of the above test item(s) appears to the BEST hardness testing tool for identifying the "HARD" minerals from the softer minerals?

Answer \_\_\_\_\_ .

**8.** Which Mohs minerals is the **hardest** that *you can scratch with your thumbnail*? \_\_\_\_\_

**10.** Which Mohs minerals is the **hardest** that *you can scratch with a carpenters nail*? \_\_\_\_\_

**12.** Which Mohs minerals is the **softest** mineral that will scratch a glass plate? \_\_\_\_\_

## IN-LAB SECTION –To be completed during lab

**III. LUSTER:** The luster of a material refers to the way it reflects light. Is it shiny like glass, metallic like metal, waxy like a candle, pearly like pearl, dull, etc? The various mineral lusters are listed and described in the lab book. Each mineral has a characteristic luster. A single mineral type may have several lusters, depending on the sample. The most preliminary criterion for identifying a mineral is whether a mineral has a **metallic** versus **nonmetallic** luster. Note that many metal-bearing ores have a metallic luster, whereas, all the silicate and carbonate minerals have a non-metallic luster.

**Directions:** Classify all 30 mineral samples in the box collection according to their luster:

### Metallic Luster

1. **Samples #'s** \_\_\_\_\_ have a **metallic** luster.

### Nonmetallic Lusters

2. **Sample #'s** \_\_\_\_\_ have a **nonmetallic** luster.

**IV. COLOR and CLARITY:** The color of a mineral is usually helpful in determining its identity. However, quite a few minerals have a variety of color, depending on the type of chemical impurities. One useful way to use color for mineral identification is to divide minerals into two color types: **light-colored** versus **dark-colored**. The secondary use of color is then to define the actual hue, such as white, red, orange, yellow, green, blue, violet, gray, black, and all the tonal variations.

**Directions:** Classify (divide) the 30 minerals according to whether they are light- or dark-colored:

**Samples#** \_\_\_\_\_ are **light-colored**.

**Samples#** \_\_\_\_\_ are **dark-colored**.

**V. FRACTURE:** Minerals that break along curved or rough, uneven surfaces are said to fracture rather than cleave. Many minerals fracture in some directions and cleave in others. For example: Examine Orthoclase Feldspar. It cleaves in two directions, but fractures in the third. Examine Muscovite Mica. It cleaves in one plane, but fractures in any other direction. In contrast, Quartz only has fracture surfaces, with no observable cleavage. Note: do not confuse the six-sided crystal-form faces of quartz for cleavage faces.

1. Name another mineral that cleaves in two directions, but fractures in the third. \_\_\_\_\_

2. Name another mineral that cleaves in one direction, but fractures in others. \_\_\_\_\_

3. Name another mineral that has no cleavage - only fracture \_\_\_\_\_

Look at your quartz sample. If it has been broken you will see that it did not break along a crystal face. Do not confuse the smooth, flat, six-sided form in which a crystal grows with a cleavage face. Quartz grows with no cleavage. Minerals that break leaving a rough surface are said to have an **IRREGULAR FRACTURE**. Minerals that fracture in a smooth, curved surface rather than a rough, uneven, blocky surface are said to exhibit **CONCHOIDAL FRACTURE**.

4. What kind of fracture does your Quartz sample(s) show? \_\_\_\_\_

**Quartz, Chalcedony, Jasper, and Chert** are all forms of pure silica with similar physical properties. Silica is the name for the chemical compound  $\text{SiO}_2$ . Quartz and chalcedony are minerals; jasper and chert are rock names.

**VI. CLEAVAGE:** Some minerals break along smooth, flat, parallel surfaces called CLEAVAGE PLANES. These smooth, flat, shiny surfaces are planes of weakness in the mineral crystal. When a mineral "cleaves" or breaks into an easily recognized shape it will help us to recognize the mineral. Cleavage of a mineral is described in terms of, the number of cleavage planes, the quality (perfect, good, poor), and the angles between the cleavage planes. For example the cleavage of the mica minerals, like biotite and muscovite, have one single perfect cleavage plane, as you can cleave the mineral into thin flat "plates" or "sheets". Check for mineral cleavage by turning the sample back and forth, as you look for patches of bright reflected light emitted from mineral cleavage surfaces. If cleavage is present, then determine how many co-planar sets of cleavage are present.

**Directions:** Carefully examine the following mineral samples. Determine each mineral's unique cleavage. Check your determination with the cleavage listed for that mineral in the mineral database in your lab book (pages 66 to 70). **Match each mineral(s) to their correct type of cleavage character (use the Capital Letter assigned to cleavage type).** **Note:** Two groups have same type.

<u>Mineral</u>	<u>Type of Cleavage</u>
1. Feldspar and Pyroxene _____	<b>A</b> = no cleavage/ only fracture
2. Magnetite and Pyrite - _____	<b>B</b> = 1 direction - perfect
3. Galena and Halite _____	<b>C</b> = 2 directions @ 90 - good;
4. Calcite and Dolomite - _____	<b>D</b> = 2 directions @ 56/124 - good
5. Gypsum – _____	<b>E</b> = 3 directions @ 90–(1-good; 2-poor)
6. Biotite and Muscovite – _____	<b>F</b> = 3 directions @ 90 - perfect
7. Quartz and Olivine - _____	<b>G</b> = 3 directions @ 60/120 - perfect
8. Fluorite - _____	<b>H</b> = 4 directions – perfect
9. Amphibole – _____	

**VII. CARBONATE MINERALS:** The minerals **Calcite** ( $\text{CaCO}_3$ ), and **Dolomite** ( $\text{Mg,Ca}2\text{CO}_3$ ) are very common in sedimentary and metamorphic rocks like limestone and marble, respectively. Three physical properties help set these minerals apart from others that might "look" like them: 1) hardness of three; 2) three sets of cleavage at 60/120 degrees; and 3) reaction to dilute HCl acid (the acid test) **THE ACID TEST:** The expression "The Acid Test" has become a figure of speech in the English language. It indicates certainty. This expression comes from the test geologists use for the mineral **Calcite** ( $\text{CaCO}_3$ ), and Dolomite ( $\text{Mg,Ca}2\text{CO}_3$ ).

**Directions:** Put a drop of dilute hydrochloric acid (HCl) on your calcite sample; observe the results:

1. Describe the result of the acid test. What do you think is happening?
2. Chalk consists of very tiny shells made of calcite. Do the acid test on a piece of chalk. Results?
3. Kaolinite looks like chalk but is actually clay. Give it the acid test. Is Kaolinite a carbonate? \_\_\_\_\_

**VIII. The SILICATE MINERAL GROUP:** Silicates make up the vast majority of rock-forming minerals (by volume) in the Earth's crust and mantle.: Silicates are among our most important rock forming minerals. They all contain silica and oxygen, but can also contain various metal ions. Quartz and other forms of pure silica consist only of silica tetrahedron covalently bonded together in a three dimensional framework. However, in most silicates some of the silica covalent bonds are replaced by ionic bonds to metals, such as aluminum, iron, magnesium, sodium, potassium, and calcium. These bonds may create planes of weakness and a noticeable cleavage. You need to become familiar with each of these mineral's **luster, color, hardness, and cleavage** to be good at identifying hand samples of these minerals. The following are the most common silicate minerals:

Directions: Look up these minerals in the mineral glossary

	<u>Luster</u>	<u>Color</u>	<u>Hardness</u>	<u>Cleavage</u>
1. Olivine	_____	_____	_____	_____
2. Augite (pyroxene)	_____	_____	_____	_____
3. Hornblende (amphibole)	_____	_____	_____	_____
4. Biotite (mica)	_____	_____	_____	_____
5. Garnet	_____	_____	_____	_____
6. Tourmaline	_____	_____	_____	_____
7. Quartz	_____	_____	_____	_____
8. Orthoclase Feldspar	_____	_____	_____	_____
9. Plagioclase Feldspar	_____	_____	_____	_____
10. Muscovite (mica)	_____	_____	_____	_____

**NOTES:**

**IV. FOCUS ON THE 20 MAJOR ROCK-FORMING MINERALS:** Directions: Carefully examine each of the following common minerals. A physical property that is **exceptionally helpful in identifying a specific mineral has an "X"**. Check only for those properties of each mineral that has an "X" .

	<u>luster</u>	<u>color</u>	<u>hardness</u>	<u>cleavage</u>	<u>streak</u>	<u>acid</u>	<u>magnet</u>	<u>other</u>
1. Quartz	___	___	X___	X___	___	___	___	___
2. Plagioclase Feldspar	___	___	X___	X___	___	___	___	___
3. Orthoclase Feldspar	___	___	X___	X___	___	___	___	___
4. Muscovite (mica)	___	X___	___	X___	___	___	___	___
5. Biotite (mica)	___	X___	___	X___	___	___	___	___
6. Hornblende (amphibole)	___	___	X___	X___	___	___	___	___
7. Augite (pyroxene)	___	___	X___	X___	___	___	___	___
8. Olivine	___	X___	X___	X___	___	___	___	___
9. Tourmaline	___	X___	X___	X___	___	___	___	___
10. Garnet	___	___	X___	X___	___	___	___	___
11. Chlorite (mica)	___	X___	___	X___	___	___	___	___
12. Kaolinite (clay)	___	___	X___	___	___	X___	___	X___
13. Magnetite	X___	X___	___	___	X___	___	X___	___
14. Hematite	___	X___	___	___	X___	___	X___	___
15. Pyrite	X___	X___	___	___	X___	___	___	___
16. Chalcopyrite	X___	X___	___	___	X___	___	___	___
17. Galena	X___	X___	___	___	X___	___	___	___
18. Calcite	___	___	X___	X___	___	X___	___	___
19. Gypsum	___	___	X___	X___	___	___	___	___
20. Halite	___	___	___	X___	___	___	___	X___



## **XI. - Written Laboratory Reflection**

**Directions:** Write a 120 word minimum reflection of the lab activity, explaining its purpose, the methods used, the results obtained, and a brief personal reflection of what you enjoyed and learned about doing this lab (*3 points possible*). Answer the following 3-point question reflection set on a separate sheet of paper:

**1) *The purpose of this lab? What did you actually discover and learn during this lab?***

**2) *What did you enjoy most about this lab? Also, what was challenging or thought-provoking?***

**3) *What are your constructive comments about the design and execution of this lab? What's good? What's bad? Offer suggestions for making the lab better.***