Student Name: _____ **College:** _____ **Grade:**_____

Physical Geology 101 Laboratory
MINERALS I – 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**".

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*? _____

9. Which Mohs minerals is the **hardest** that *you can scratch with a carpenters nail*? _____

10. 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 28 mineral samples in the box collection according to their luster: List the sample numbers in the correct category.

Metallic Luster Samples #'s _____

Nonmetallic Luster Sample #'s _____

IV. COLOR and CLARITY: The color of a mineral is usually helpful in determining it 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 according to *color shading*: **light-colored** versus **dark-colored**. The secondary use of color for mineral identification is *color hue*, such as white, red, orange, yellow, green, blue, violet, gray, black, and all the tonal variations.

Directions: Classify (divide) the 28 minerals according to whether they are light- or dark-colored:

Samples# _____ are **light-colored**.

Samples# _____ are **dark-colored**

V. 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 uniquely-oriented 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. Note that some minerals completely lack cleavage.

Directions: Carefully examine the following mineral samples. **1)** Determine each listed mineral's unique cleavage. **2)** Check your determination with the cleavage listed for that mineral in the mineral database in your lab book (pages 66 to 70). **3)** Match each mineral(s) below to their correct type of cleavage character (use the Capital Letter assigned to cleavage type). Note: Two groups below have same type of cleavage.

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

VI. 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 six-sided 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. Which type of fracture does your Quartz sample(s) show? _____

5. Which type of fracture does your Feldspar 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 SiO_2. Quartz and chalcedony are minerals; jasper and chert are rock names.

VII. CARBONATE MINERALS: The minerals **Calcite** ($CaCO_3$), and **Dolomite** $(Mg,Ca)2CO_3$ 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; 2) cleavage; and 3) reaction to dilute HCl acid (the acid test)

1. What is the hardness of the carbonate minerals? _____

2. What is the cleavage of the carbonate minerals? _____

3. The carbonate minerals are light or dark colored? _____

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 carbonate mineral like **Calcite** ($CaCO_3$), and **Dolomite** $(Mg,Ca)2CO_3$.

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

4. Describe the result of the acid test. What do you think is happening?

5. Chalk consists of very tiny shells made of calcite. Do the acid test on a piece of chalk. Results?

6. Kaolinite looks a lot like chalk but is actually clay. Give it the acid test. Is Kaolinite a carbonate?

VIII. EXAMINATION OF THE 20 MOST COMMON ROCK-FORMING MINERALS

Directions: Carefully examine each of the following common minerals samples for their physical properties. A physical property that is **exceptionally helpful in identifying a specific mineral has an "X"** . Record only for those properties of each mineral that has a marked "X". Note **luster** (M or NM); **color shade** (light or dark), **hardness** (soft, medium or hard), **cleavage** characteristics (0, 1, 2@90, 2not@90, 3@90, or 3not@90), acid test (+ or -), magnetic (yes or no), other (taste or touch). Then check the mineral glossary in your lab manual for the established physical property values and compare them to those that you determined.

	luster	color	hardness	cleavage	streak	acid	magnet	other
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_____	____	____	____	X____

IX. UNKOWN MINERAL SAMPLE IDENTIFICATION:

Directions: Determine the luster, color, hardness, cleavage, streak, and other characterizing physical properties of the following unknown mineral samples. Carefully read the steps listed below:

1) Note luster as either *metallic "M"* or *nonmetallic "NM"*.
2) Note color as either "*Light*" , "*Dark" or if characteristic, note actual hue, like "green" for olivine.*
3) Note hardness as either "*Hard"* (6 and up); "Medium" (between 3 and 6); or "*Soft" (3 down).*
4) Note number of sets of cleavage (0 through 4). Also note the angle between two or more sets.
5) Note the streak color ONLY for metallic minerals. If test not needed, then mark with a dash (-----).
6) Mark either "Yes" or "No" for doing the acid test. If test not needed, then mark with a dash (-----).
7) Mark either "Yes" or "No" for the magnet test. If test not needed, then mark with a dash (-----).
6) Finally, using your mineral ID chart, name the mineral that best fits your listed properties.

Samp#	luster	color	hardness	cleavage	streak	acid	magnet	Name the Mineral
A.	_____	_____	_____	_____	_____	_____	_____	_____
B.	_____	_____	_____	_____	_____	_____	_____	_____
C.	_____	_____	_____	_____	_____	_____	_____	_____
D.	_____	_____	_____	_____	_____	_____	_____	_____
E.	_____	_____	_____	_____	_____	_____	_____	_____
F.	_____	_____	_____	_____	_____	_____	_____	_____
G.	_____	_____	_____	_____	_____	_____	_____	_____
H.	_____	_____	_____	_____	_____	_____	_____	_____
I.	_____	_____	_____	_____	_____	_____	_____	_____
J.	_____	_____	_____	_____	_____	_____	_____	_____
K.	_____	_____	_____	_____	_____	_____	_____	_____
L.	_____	_____	_____	_____	_____	_____	_____	_____
M.	_____	_____	_____	_____	_____	_____	_____	_____
N.	_____	_____	_____	_____	_____	_____	_____	_____

X. - Written Laboratory Reflection

Directions: Write a 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 (fill in all the lines for full credit.)

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

_____

_____

_____

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_____

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.*

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