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. Note that physical properties are one of the five attributes. 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. PHYSICAL PROPERTIES of MINERALS

1. A mineral has multiple physical properties that are used to both, classify a mineral and help in identifying an unknown mineral specimen. **Directions**: **List five physical properties of a mineral as noted in your lab book. Use your lab manual.**

1. _____
2. _____
3. _____
4. _____
5. _____

II. HARDNESS: Hardness is one of the best physical properties to use for identifying a mineral. Some minerals are harder than others. Each mineral has a specific hardness. 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: What is the general procedure for testing for mineral hardness?

2. Question: If you are using a mineral abrasive material to polish a surface of an object (like a car or your teeth), what value of abrasive hardness (relative to the surface material would you select to polish the surface needing polishing? Why that hardness?

3. Gemstones are valuable minerals prized for their color, beauty, sparkle, and rarity.
Question: Why do the vast majority of gemstones have high hardness values? Why not soft?

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 in your lab manual)

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 in your lab manual)

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**. Note that all metallic luster minerals are classified as 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 in your reference box for cleavage. **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 manual. **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	
1. Feldspar and Pyroxene	_____
2. Magnetite and Hematite	_____
3. Galena and Halite	_____
4. Calcite and Dolomite	_____
5. Gypsum	_____
6. Biotite and Muscovite	_____
7. Quartz and Olivine	_____
8. Amphibole	_____
9. Garnet and Tourmaline	_____

Type of Cleavage

A = no cleavage/ only fracture
B = 1 direction - perfect
C = 2 directions @ 90 - good;
D = 2 directions @ 56/124 - good
E = 3 directions @ 90–(1-good; 2-poor)
F = 3 directions @ 90 - perfect
G = 3 directions @ 60/120 - perfect

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 in any/all directions. Note: do not confuse the six-sided crystal-form faces of quartz for cleavage faces; this is true for other minerals like garnet and tourmaline, which frequently display flat, symmetrical crystal-form 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 general hardness value of the carbonate minerals? _____

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

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

VIII. 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 minerals like **Calcite** ($CaCO_3$), and **Dolomite** $(Mg,Ca)2CO_3$ – both soft minerals.
Directions: Place a drop of dilute hydrochloric acid (HCl) on several different chosen mineral and rock samples below and observe the results. Note: please use the acid sparingly, and wipe off acid residue with a paper towel when done.

4. Acid test your calcite sample. Describe the results of the acid test. What do you think is happening?

5. Chalk (used to make chalkboard chalk) consists of very tiny shells made of calcite. Do the acid test on a piece of chalk. Results?

6. Limestone consists mostly of calcite. Do the acid test on the limestone sample in your box. Results?

7. Marble consists mostly of calcite or dolomite. Do the acid test on the marble sample in your box. Results?

8. Kaolinite looks a lot like chalk but is actually clay – a silicate mineral. Give it the acid test. Results?

9. Question: Why is it a waste of good acid to perform the acid test on a hard mineral specimen?

IX. EXAMINATION OF THE 16 MOST COMMON ROCK-FORMING MINERALS

Directions: Carefully examine and check/test each of the following common rock-forming mineral samples in your reference box for their physical properties. A physical property that should be checked **for that 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 < 4; medium 4-5; or hard >5), **Cleavage** characteristics (0, 1, 2@90, 2not@90, 3@90, or 3not@90), **Acid test** (+ or -), **Magnetic** (yes or no), and **Other** (taste or touch). Check the mineral glossary in your lab manual for the physical property values and compare them to your observations.

	luster	color	hardness	cleavage	streak	acid	magnet	other
Quartz	____	X ____	X____	X _____	____	____	____	____
Plagioclase Feldspar	____	X ____	X____	X _____	____	____	____	____
Potassium Feldspar	____	X ____	X____	X _____	____	____	____	____
Muscovite (mica)	____	X____	X____	X_____	____	____	____	____
Biotite (mica)	____	X____	X____	X_____	____	____	____	____
Hornblende (amphibole)	____	X ____	X____	X _____	____	____	____	____
Augite (pyroxene)	____	X ____	X____	X _____	____	____	____	____
Olivine	____	X____	X____	X_____	____	____	____	____
Tourmaline	____	X____	X____	X_____	____	____	____	____
Garnet	____	X ____	X____	X _____	____	____	____	____
Kaolinite (clay)	____	X____	X ____	_____	____	X____	____	X____
Magnetite	X____	X ____	X ____	_____	X____	____	X____	____
Hematite	X____	X____	X ____	_____	X____	____	X____	____
Calcite	____	X ____	X____	X _____	____	X____	____	____
Gypsum	____	X ____	X____	X _____	____	____	____	____
Halite	____	X ____	X____	X _____	____	X____	____	X____

X. UNKNOWN COMMON ROCK-FORMING MINERAL SAMPLE IDENTIFICATION:

Directions: Determine the color, hardness, cleavage, and other characterizing physical properties of the following unknown mineral samples. Finally name the unknown mineral based on the determined properties. Follow the steps listed below. **Note that each of the 15 unknown mineral samples will be one of the above 16 minerals listed in part IX.**

1) Note luster as either *metallic "M"* or *nonmetallic "NM"*.
2) Note color as either "*Light"* or "*Dark"; AND note actual hue, like "white", "gray", "black", "brown", "green", or "violet".*
3) Note hardness as either "*Hard"* (5 1/2 and harder); or "*Soft" (5 or softer).*
4) Note number of sets of cleavage (0, 1, 2 or 3). Also note the angle between two or more sets (at/near 90° or not at 90°).
5) Mark as "Pos" or "Neg" reaction if you did test. If test not needed/not done, then mark as "ND"
6) Mark either "M" (magnetic) or "NM" (nonmagnetic) if you did magnet test. If test not needed/done, then mark "ND".
7) Finally, using your mineral ID chart, List the name of the mineral that best fits your listed physical properties.

Sam#	Luster	Color	Hardness	Cleavage	Acid test	Magnetic	Mineral Name
1.	_____	____ / _____	_____	_____	_____	____	_____
2.	_____	____ / _____	_____	_____	_____	____	_____
3.	_____	____ / _____	_____	_____	_____	____	_____
4.	_____	____ / _____	_____	_____	_____	____	_____
5.	_____	____ / _____	_____	_____	_____	____	_____
6.	_____	____ / _____	_____	_____	_____	____	_____
7.	_____	____ / _____	_____	_____	_____	____	_____
8.	_____	____ / _____	_____	_____	_____	____	_____
9.	_____	____ / _____	_____	_____	_____	____	_____
10.	_____	____ / _____	_____	_____	_____	____	_____
11.	_____	____ / _____	_____	_____	_____	____	_____
12.	_____	____ / _____	_____	_____	_____	____	_____
13.	_____	____ / _____	_____	_____	_____	____	_____
14.	_____	____ / _____	_____	_____	_____	____	_____
15.	_____	____ / _____	_____	_____	_____	____	_____

XI. - 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.

1) *What was 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?*

_____

_____