GEOL 333 - Lab 1 (Physical Properties of Minerals I) - Lab Exercise

Name:_____

Objectives (After completing this Lab, students will be able to:)
- Define chemical composition, crystal structure, hardness, Mohs Hardness Scale, cleavage, crystal, crystal shape, density, and specific gravity in the context of minerals.
- Define the relationships between crystal cleavage, hardness, crystal shape, and density to chemical composition and crystal structure.
- Determine the relative hardness of unknown minerals using scratch tests with known minerals or tools.
- Locate up to four different cleavage directions in any unknown mineral showing cleavage.
- Determine if cleavage directions are at 90 degrees or not at 90 degrees in any unknown mineral showing cleavage.
- Determine interfacial angle for crystal faces
- Determine any unknown mineral's density or specific gravity using a mass balance and a graduated cylinder filled with water.

Expected Prior Knowledge (Students should already be able to:)
If you are behind in the following areas, please let me know during or after class
- Practice safe laboratory conduct and follow laboratory instructions.
- Define the terms atom, electron, proton, neutron, atomic mass, atomic number, ion, isotope, covalent bond, ionic bond, and molecule.
- Have a basic understanding of chemistry.
- Read a periodic table of the elements.
- Find simple sources of error in their measurements and reflect that error in their data.

Overview
   Geology 333 (Earth Materials and the Environment) is a survey of Earth's geologic materials and their environmental applications and implications. For the first five weeks of Lab we will concentrate on Earth's minerals, which are the essential building blocks of nearly all geologic materials. We will learn about mineral properties and how and why geologists classify into distinct categories. This week and next week we will focus on the mineral properties themselves. Once we have become familiar with mineral properties we will spend the next two weeks identifying hand samples of unknown minerals. Then, we will identify minerals in thin section (thin slices) using the petrographic microscope. Learning about minerals is important because they are the most abundant earth material. We need to understand minerals to study rocks, the ingredients of Earth.
   Geologists normally identify a mineral by characterizing some of its physical properties. Today we will look at the following physical properties: **hardness**, **cleavage**, **crystal shape**, and **specific gravity** (or **density**).

Materials
- mineral samples labeled A through D, G through L, M, and Q through S
- penny
- glass plate
- streak plate
- hammer
- safety goggles; small plastic bags
- graduated cylinder
- water
- mass balance
- metal plate

GEOL 333 Lab Exercise #1

This exercise is adapted from: Peters, Kirsten E., Larry E. Davis. 2000. Geology from Experience. New York, NY: W. H. Freeman and Company. p. 34. Lab 3.2.

Hardness
1. At first glance, mineral samples A, B, C, and D may look similar because they are clear or translucent. Try rubbing a corner of one mineral against the face of another. What happens? What does a mineral's crystal structure and chemical composition have to do with what you just described?

2. List the four unknown minerals in order of decreasing hardness.

3. Now we have the hardness of all four minerals relative to each other. Using the table below of common items and their associated hardness value on Mohs Hardness Scale, give a range of hardness values for each mineral sample.

fingernail	~2.5	Hardness
US penny	~3	A: _____
glass plate	5.5	B: _____
streak plate	~7	C: _____
		D: _____

4. Diamond and graphite have the same chemical composition. They are both made of 100% Carbon. What common item is graphite used in? Is graphite relatively hard or soft? How hard is diamond? What causes this variation?

5. Why is the hardness of a mineral important to society? Hint: Think of a mineral used by society where hardness influences its use.

Cleavage
6. Sample G has already been broken with a rock hammer. Using a hand lens, examine 3 pieces of sample G with the greatest variation in shape. Sketch those three pieces below.

Cleavage (continued)

7. Find one small piece of each sample H through L. *Sketch* and label them below.

8. Using specific cleavage terms given in Class Notes for Lab #1 or in Fig. 3.13 - 3.17 on p. 49 and 50 of your Klein + Philpotts textbook, label all of your above sketches with the type of cleavage in the sample. Ask for help if you are not sure!

    Cleavage planes often can be difficult to identify. Do not let this work against you. Keep asking questions until you feel confident identifying mineral cleavage. You should be able to recognize the following cleavages in unknown samples: 1, 2 at 90°, 2 not at 90°, 3 at 90°, 3 not at 90° and 4. Cleavage is caused by planes of weak bonds in a mineral's crystal structure. We will see some examples to explain this concept further and you need to become familiar with it.

Crystal Shape

9. Note the shape of sample M (quartz crystals). Although the particular shape of individual quartz crystals may vary, the crystal structure of quartz dictates that the same angle must occur between the crystal faces (called the Law of Constant Interfacial Angles or Steno's Law). Use the contact goniometer to measure the angle between adjacent faces of one of the quartz crystals (**use the faces along the long sides of a quartz crystal and not the faces at the ends**). Fig. 1.22 (on the last page of Class Notes for Lab #1) shows how to use the contact goniometer. There are 6 sides, so you'll need to make 6 measurements. Record your results below.

    Contact Angle #1 _____
    Contact Angle #2 _____
    Contact Angle #3 _____
    Contact Angle #4 _____
    Contact Angle #5 _____
    Contact Angle #6 _____

    Are your 6 measurements of the contact angle between the long faces of a quartz crystal identical? If not, then discuss possible error in your measurement.

Specific Gravity/Density

10. Select ONE sample among the mineral samples Q, R, and S. Weigh your selected sample on the balance using weight units of grams (gm). Record your data in the table below. Using the water fountain in the hallway, half-fill a graduated cylinder with water (no need to be exact) and record the volume of the water in milliliters (ml). Tipping the cylinder to the side, gently slide the first sample into the cylinder so that it moves to the bottom of the cylinder. Tap out any large air bubbles trapped on the sample. Record the new volume in the cylinder. Subtract the first volume (water only) from the new volume (sample and water) to get the sample volume and record your data in the table below. Pour out the water and the sample. Finally, divide the sample weight by its volume to calculate its density (in grams/cm^3). Remember that 1 ml is equal to 1 cm^3. The other student groups will determine the density of the other two samples and your Lab Instructor will make those results available to the entire class.

Sample	Weight (gm)	Volume (ml)	Density (gm/cm^3) = Specific Gravity (unitless)
Q			
R			
S			

11. In question #10 above, you've also just calculated specific gravity (ratio of a mineral mass to the mass of an equal volume of water) because 1 ml of water weighs ~1 gram at standard temperatures and pressures. Therefore, any measurement of a mineral's density in units of grams/ cm^3 equals the mineral's specific gravity, which is unitless. Specific gravity can also be considered a ratio of the density of a mineral compared to the density of water, which is 1. For example, if the specific gravity of a mineral is 5, then that mineral is 5 times denser than water. Your Lab Instructor will give you the standardized specific gravities for sample Q, R, and S after everyone finishes their density/G determination. Compare your results to the average result of hundreds of scientists. Why are the results not identical? Describe a few sources of error in your measurements.

12. How does knowing a mineral's density give insight about the chemical composition or crystal structure of that mineral?

Reading for Next Week

Chap. 4 in Study of Minerals software by Dyar et al. (NOTE: This program is available on any computer in an ICS Computer Lab; there are 6 ICS Computer Labs; specific locations of ICS Computer Labs are given in the Class Web site and the syllabus); the procedure to access this program is on the Class Web site in 'Course Information' link and in syllabus, which will be distributed in the first Lecture class.

Chapter 3 and p. 15 - 24 in Klein + Philpotts (2012) Earth Materials (if you didn't already do this reading for the first Lab)

Remember that at the beginning of next week's Lab there will be a quiz, which is based on key concepts from this week's Lab and the assigned reading for next week!