Some of the samples used in Mineralogy Lab are museum specimens. Please do not destroy them. You can do just about anything you want to the grungy ones, but be nice to the pretty specimens as they are irreplaceable.

Name_______________________________

Properties of Minerals

Crystal Habits

Not all mineralogical samples form nicely shaped crystals but, when they do, the shape can be helpful in identifying the mineral. The **habit** of a crystal refers to its shape. (But, it refers only to the shape that the crystal forms as it grows, not as it breaks--see next section of cleavage and fracture.) For example, some minerals such as halite tend to be **cubic**, while others such as the micas are **foliated** and tend to form sheets or books. A large number of terms are used to describe habit; they are summarized in your mineralogy text (Table 3.2).

Some of the most commonly used terms that you should be familiar with are:

equant
bladed
blocky
tabular
columnar
foliated
micaceous
sheety
fibrous
dendritic
granular
massive
concentric
prismatic
cubic
hexagonal
octahedral
orthorhombic

Make up your own terms if you want to, just as long as they have a clear meaning (e.g., "grape-like").

Cleavage and Fracture in Minerals

Cleavage, parting and fracture refer to the ways a mineral breaks when an external force is applied. Since minerals have atomic structures that are not the same in all directions, there are some preferred directions and methods of breaking.

Cleavage is the tendency of minerals to break along one or more sets of parallel plains. In some minerals, such as micas, it is nearly perfect in one direction. In others, it may be poorly developed or nonexistent. When describing cleavage, both the orientation and the quality (excellent, fair, poor) should be mentioned. If there are more than one set of parallel plains along which it breaks, then you should note how many cleavages (sets of plains) there are. You would say there are 2-, 3- or 4-cleavages, etc.

Note that you don't have to smash a mineral to see how it breaks in most cases. Just look at the sample; cleavage is usually visible as sets of fine cracks or edges all running parallel. So, no smashing, please.

One often confusing thing is to be able to tell crystal faces (surfaces that form as the crystal originally grows) from surfaces caused by breaking (cleavage, parting or fracture). Sometimes they are directly related (i.e., the mineral breaks in directions parallel to crystal faces), but often not. Often a crystal has good cleavage parallel to crystal faces, and also in some other directions.

The distinction between crystal faces and cleavage surfaces can be confusing. Crystal faces often have fine growth lines on them--often somewhat concentric. Crystal faces may also sometimes appear to be less than perfectly flat. In contrast, cleavage surfaces are usually perfectly flat. In some minerals, crystal faces have fine grooves or lines called striations that run parallel to a crystal edge.

Cleavages can often be identified because there are lots of parallel cracks or layers in a crystal. Cleavage surface often are discontinuous, and may give the surface of the crystal a step-like appearance.

Figure caption:

a) cubic, b)octahedral, c)dodecahedral, d)rhombohedral, e)prismatic and pinacoidal, f)pinacoidal (basal). Adopted from Klein and Hurlbut (1977).

Parting is similar to cleavage, but refers to breaking along plains of structural weakness due to crystal defects. It is not very recognizable, except in a few special minerals.

Fracture refers to breakage that is not planar. It may be **conchoidal** (the way glass breaks, having curved surfaces and sharp edges). Other terms used to describe fracture are **fibrous**, **splintery**, **hackly** (having jagged sharp fractures) **uneven** or **irregular**. These terms are often subjective.

PLEASE DO NOT SCRATCH, SPINDLE, BREAK, FOLD, OR MUTILATE THE NICE SAMPLES!

A. Cleavage Exercise: There are 12 samples set out. For each of the 12 samples, describe the nature of its cleavage (or fracture). How many cleavage planes do you see and how good are they? Use terms like perfect, good, distinct, indistinct, or poor to describe the nature of the cleavage planes. Consult relevant parts of Chapter 3 of your mineralogy text.

muscovite-

biotite-

galena-

gypsum-

fluorite-

pyrophyllite-

calcite-

quartz-

arfvedsonite (hornblende)-

microcline-

kernite-

halite-

Hardness of Minerals

The resistance of a mineral to scratching is called its hardness. The easiest way to determine hardness is to scratch one mineral with another. The softer one will be damaged, the harder one will not. Some minerals, however, fall apart due to fracturing and are difficult to test this way. In a few rare minerals, hardness varies a bit depending on which surfaces are being scratched, and which direction.

Note that sometimes dust from the softer mineral will stay on the harder one and look like a scratch. Make sure to wipe or blow dust off to confirm which mineral is harder when you do a hardness test.

A series of 10 common minerals are used as a relative hardness scale. **Moh's "hardness" scale**, which you should *memorize*, is given in a Table 3.8 in the text book.

Field geologists - and students in lab - often just use a pocket knife (or a nail) to help separate hard minerals from soft ones.. They see how easily the knife/nail scratches the mineral, or how easily the mineral scratches the blade of the knife and can estimate the hardness quite accurately. Your fingernail, a glass plate, and a penny also help estimate hardness. Use them. Or use other minerals for comparison - minerals that you know the hardness of. See Table 3.8 in the text book.

<u>B. Moh's Exercise:</u> There are 12 samples set out for hardness tests. Determine the Moh's number for each, as best you can. We won't tell you what minerals they are; you should identify those you think you recognize, but don't worry too much if there are some you don't know:

Mineral #	**Moh's # (between 1 and 10)**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Tenacity of Minerals

Tenacity refers to the manner in which a mineral breaks or ruptures when stressed. Make up your own terms (e.g., "bendy"), as long as they have a clear meaning. Common terms used to describe tenacity given in the text.

Note that when you conduct a hardness test (or streak test--see section below) you usually will get a pretty good *idea of a mineral's tenacity.*

Specific Gravity of Minerals

Specific gravity refers to the weight of the mineral compared to a comparable amount of water. It is a ratio that has no units, but has about the same value as **density** (which is given in units such as grams per cubic centimeter = gm/cc) . The actual definition of specific gravity is given in Chapter 3 of your text.

C. Heft (Specific Gravity) Exercise: For identifying minerals in lab, or in the field, it is really only necessary to recognize whether the mineral is light, medium, or heavy (i.e., low specific gravity, average specific gravity, high specific gravity). This is sometimes referred to as **heft**. Arrange the five samples according to heft from least dense (top) to most dense (bottom) in the table below. Then look up values in the book and compare to your answers. *No cheating - you order them first, then look up answers.* Discuss any inconsistencies in the space below.

Sample #	**Specific gravity**	s.g. value from book
	lowest s.g	
	highest s.g.	

If you are writing a specialized paper describing the properties of a mineral, precise measurements of specific gravity must be made. In that case, it would be necessary to use a specific gravity balance (or a similar apparatus) to determine specific gravity.

We will use a low-end alternative - the Deluxe Hanneman Direct Reading Specific Gravity Balance (by Mineralab) - to determine specific gravity. Operation of this balance is outlined below.

1) First, weigh your sample using the electric scale (not the Hanneman Balance) and record the value.
2) Add 100 ml of water to the beaker.
3) Make sure the beam is roughly horizontal with no counterweight holders on it (on right side- but leave the beam leveler attached on the left side).
4) Using the tweezers, place the small mineral sample on the upper weighing pan.
5) Hang the counterweight holder in the groove at the right end of the beam making sure that the little red bucket is facing you. *(NOTE: if sample weighs less than 1 gram use small holder. If sample weighs more than 1 gram and less than 30 grams, use large holder. If sample weighs more than 30 grams, do not use this scale.)*
6) Hang counterweights from the lowest point on the counterweight holders (back side) until the pointer comes to rest on the zero line. Add salt to the bucket for very precise adjustments. The counterweights are arranged on the base as shown on the next page. After beam is at rest, carefully remove your sample and place on the lower weighing pan (with no air bubbles). The right end will now drop since the stone weighs less under water.
7) Now, carefully lift and slide the counterbalance assembly (with the attached weights) to the left until the beam once again comes to rest at the zero line. Then, read the specific gravity from the scale on the beam.
8) You are now done.

Note: 1 carat = 0.2 grams

D. Specific Gravity Measurements: Here's what you do today: For this lab, use the balance as described above to determine s.g. of any 4 of the 8 samples provided. Put answers in the table in the next section, below. BE SURE TO START WITH DRY SAMPLES!

Luster of Minerals

Luster refers to the general appearance or sheen that a sample has. That is, how well and in what way does it reflect light?

There are two major types of luster: **metallic** and **nonmetallic.** Minerals between are said to be **submetallic**. Terms often used for nonmetallic minerals, that you should know, include:

vitreous **silky** **greasy**
resinous **adamantine**

Diaphaneity refers to a mineral's ability to transmit light. Metallic minerals are usually **opaque** to light (they don't transmit any light, no matter how thin a piece you have.) Non-metallic minerals may be **translucent** (transmit some light) or **transparent** (you can see right through them).

D and E - Specific Gravity and Luster Exercise: Put your measured s.g. values in the table below. Also, for each mineral, note its luster and diapheneity.

mineral name	spec. grav. (measured)	luster	diapheneity

Color in Minerals

Color is the most often used, and one of the least reliable, properties when identifying minerals. Almost all the mechanisms that produce color are the result of interaction of light waves with electrons. The interactions may be due to several different things:

"idiochromatic" minerals have a major element essential to the mineral composition

"allochromatic" minerals have an element as a minor impurity that gives the color

structural factors: defects in the crystal, twinning, exsolution, etc.

Certain elements, especially transition metals, are **chromophoric**. This means that they may absorb or emphasize certain colors. Most elements will not. Of the chromophoric elements, Fe is the most abundant in the Earth's crust, and thus is a dominant color contributor in minerals. However, the color given to a mineral by Fe may not always be the same (although there are some consistencies) because the nature of the crystal structure and the overall chemical composition often change the color properties.

F. Questions re. Color (answer the following questions):

Examine all the garnets in the box.

1. What colors do you see?

2. Some of the more common varieties are almandine, grossular, pyrope (not available for this lab), and spessartine. What are the chemical differences between these four varieties?

3. What are the colors of the samples of each variety in the box? Which color is which variety? Are there any ambiguities, or does color work for distinguishing the different varieties apart?

4. What are the normal colors of the varieties (according to your text)?

There are six samples of quartz displayed in box # 7b. Purple quartz (amethyst) is said to get its color from minor Fe^{+3} impurities. Smokey and black quartz is often formed by radiation damage--it can be made artificially using medical X-ray machines. Milky quartz is usually due to small fluid inclusions. Rose quartz gets its color from small amounts of Ti^{4+} in the structure. Citrine is a light yellow or brown variety of quartz, containing Fe^{+2}. Other things cause other colors.

5. What colors are these samples; what (varietal) names would you give them?

6. What do you think about using color for identifying quartz?

There are 10 pinkish minerals set out: The pink color is due to the presence of particular idiochromatic chromophoric transition metals, except in the cases of chabazite, clinozoisite, grossular, quartz and rubellite where the color is due to an allochromatic impurity.

7. For each of the 10 samples, look up the chemical formula and write it on the next page in the appropriate place. What element is probably responsible for its color? You may have to do some digging to find the answer for the allochromatic ones (i.e., use an additional reference book or something).

quartz

zoisite (thulite)

grossular

chabazite

rhodochrosite

cinnabar

zincite

rhodonite

crocoite

rubellite (tourmaline)

There are five varieties of microcline for you to examine.

8. What is microcline?

9. What colors are the five samples?

10. Why do you suppose the different varieties have different colors?

11. What do you think about using color for identifying microcline?

Streak of Minerals

One problem with using mineral color to identify a mineral is that it is often highly variable for a given mineral. Impurities, crystallinity, and lots of factors may have major effects. The color of a finely powdered mineral, known as its **streak**, however, does not vary much.

To determine streak, we rub the mineral on a **streak plate**. The streak plate has a hardness of about 7 and can't be used for harder minerals. The streak of many nonmetallic minerals is light-colored or colorless, but for some of them streak is very noticeable. Metallic minerals often have very dark streak colors.

Streak is an especially useful property for identifying dark colored, high specific gravity minerals. Many of them look pretty much the same but yield a different streak color.

G. Streak Exercise: There are 8 samples set out. For each, rub the mineral on the white streak plate and record its color in the table below. Also, using your text, try to identify each mineral.

Sample #	Streak color	Mineral ID
1		
2		
3		
4		
5		
6		
7		
8		

Other Properties of Minerals

There are many other properties of minerals that deal with the way a mineral interacts with light. Some we will see this semester include **opalescence, tarnish, and pleochroism.**

Magnetic, electrical and thermal properties of minerals also vary greatly. For our purposes, we will simply identify those few minerals that react to a magnet. They are **ferromagnetic**--we won't worry about the other types of magnetism.

Most **chemical properties** will be discussed at a later time. The only one we should note now is the **reaction to acid** when dilute hydrochloric acid is applied to a mineral. Calcite and aragonite both effervesce strongly. Dolomite effervesces weakly--it may need to be pulverized to see any reaction. Most other minerals show no reaction whatsoever.

<u>8. Other Properties Exercise:</u> For each of the 6 samples set out, check all properties in the table given below.

Sample #	**magnetic**	**readily reacts w/acid**	**reacts w/acid if pulverized** ?	**name the mineral**
1				
2				
3				
4				
5				
6				

Notes for TA

Samples and other things needed at each station:

1. Cleavage station: A box with the following samples (labeled with names): muscovite, biotite, galena, gypsum, fluorite, pyrophyllite, calcite, quartz, hornblende, microcline, kernite, halite

2. Moh's station: 12 "unknown" samples of various harness. Also, several Moh's hardness kits for comparison (without diamond).

3. Heft - Specific gravity exercise: 5 samples (labeled with names) of varying heft.

4 and 5. Specific gravity measurements, luster, etc. 8 different minerals. If possible, large hand specimens of each, and also smaller pieces for s.g. measurements. I think (maybe) smaller pieces of about 740 mg are about right for s.g. measurements, but am not sure - so see what you think works best.

6. Color
A. A box containing a number of different garnet species having a number of different colors.
B. A box containing 6-10 samples of quartz of different color, including amethyst, smokey, black, milky, rose and citrine.
C. A box containing 10 "pinkish" or purple minerals. You can go through the drawers and find them, but the ones we have used before are: quartz, zoisite, grossular, chabazite, rhodochrosite, cinnabar, zincite, rhodonite, crocoite, rubellite. If you use different ones, adjust the lab handout above.
D. A box containing 5 different colored microclines.

7. Streak: 10 samples for streak tests. These should be numbered, NOT labeled with mineral names. Use magnetite, brown hematite, black hematite, sulfur, hornblende, pyroxene, graphite, galena, limonite, pyrite if you can.

8. Other properties: samples of magnetite, calcite, dolomite, galena, pyrite, magnesite. These should not be labeled with mineral names.