The Purpose of this lab is to practice identifying minerals by systematically observing their physical properties. We will emphasize your ability to observe and test for these properties over your ability to merely name the mineral, although that is the overall goal. In test situations, your ability to observe and describe mineral properties will be weighed more heavily than only naming the minerals.

Bring to class your textbook descriptions of the mineral properties used to identify minerals.

Logistics: The lab is done in three parts, which you will have two weeks to complete:

Part I Move around the room to various stations at which you will observe excellent examples of all of the physical properties. Each of the mineral samples exemplify one or more of the key physical properties.

Part II See examples of all the required minerals along with descriptions of their distinctive physical properties. A list of required minerals is on page 4.

Part III Determine the names of ten unknown minerals by observing their physical properties and the identification key provided. This is the only part of the lab on which I will grade you.

Part I. Examples of physical properties.

The numbers refer to observation stations containing examples of minerals positioned around the room. The observations stations should stay where they are; students move around the room. Along the way, several important minerals will be pointed out. Learn these minerals.

1. Crystal Form. Minerals form crystal faces when given room to grow without space restrictions. The large feldspar crystals we saw in the local granite on our last field trip last week are a good example. The examples here include quartz, pyrite, and halite.

   Cubes: Pyrite and halite are examples; look for the 90° angles between all of the surfaces in these minerals. Note that galena, which you see elsewhere in this lab, also has a cubic crystal form. In all these examples, crystal form can be the same, but other physical properties, including luster and density can differ greatly. Halite and galena share similar atomic structures. Even the form of their chemical formulas are similar: NaCl (halite) vs PbS (galena).

   Prismatic: Quartz has a six-sided prismatic crystal form. The faces usually form a point at one end of the prism but not the other.

   Blocky: Looks like a building block. The feldspars are good examples.

   Equant: All sides are equal, or very similar, but it is not a cube or rectangle.

2. Luster and Density. These two properties are not related, but the two minerals shown here, fluorite and galena, illustrate their properties very well.

   Luster: Galena has metallic luster: it shines like metal. Fluorite illustrates vitreous luster: it looks like glass. These are the two most common lusters and serve to discriminate between the two main classes of minerals: metallic and nonmetallic (see tables below).
**Density:** Note that the galena is much heavier than the fluorite, even though the samples are about the same size. Thus, the density of galena is much greater than that of fluorite. The reason is that galena contains lead, one of the heaviest elements. The chemical formula for galena is lead sulfide (PbS). Fluorite, on the other hand, contains calcium and fluoride (CaF₂), both of which are much lighter than lead.

3. **Color.** Except for some minerals, color is the most notoriously worst way to distinguish minerals from each other. These examples of garnet and fluorite show that each of these minerals can have several different colors. Other minerals--chalcopyrite, for example--are almost always the same color and is the main distinguishing characteristic.

4. **Streak.** Streak is a valuable tool for identifying the metallic or submetallic minerals. Sometimes the color and even luster or a mineral will change (see the hematite examples) whereas the streak will remain exactly the same color no matter what the color and luster are doing.

   The combination of streak and color are the best distinguishing characteristics of chalcopyrite.
   
   What is the streak of chalcopyrite? *Gray*
   Does it match its color? *No*
   
   Same two questions for hematite: what is its streak and does it match its color?
   
   *Brick Red. Sometimes the color of hematite is brick is also brick red, in which case the color of the streak does match the color of the mineral. Other times, however, the color of hematite is dark gray or silvery, in which case the color of the streak does not match the color of the mineral.*

   Does the streak change for these minerals change from sample to sample, as do some of the physical properties with some of these minerals? *No, the streak is always the same.*

5. **Hardness.** Compare the hardness of these three minerals: corundum, quartz, and gypsum. Corundum is the hardest of the common minerals (9 on the Mohr hardness scale). Diamond is one of the only naturally occurring substances that is harder.

   Does corundum scratch quartz? *Yes, it should.*
   
   The hardness of quartz is 7. Does glass or steel scratch quartz? *No, qtz scratches glass.*

   Gypsum is very soft with a hardness of 2. Is the gypsum harder or softer than your fingernail? *Softer; fingernails can scratch gypsum.*

6. **Cleavage.** The key here is to establish the number of directions of cleavage and to estimate the quality of the cleavage. It is sometimes difficult to distinguish between crystal faces and cleavage faces. Generally, cleavage faces can be repetitive and can appear in a step like pattern, whereas there is often only one crystal face. Often, the Crystal and cleavage faces are in the same direction, making it even more difficult to tell the difference.

   Muscovite and biotite are members of the mica group of minerals; they have one direction of perfect cleavage.

   Can you see the outline of the crystal faces on any of the mica samples? *Yes, you should be able to.*

   What is the distinguishing characteristic between muscovite and biotite? *Color: biotite is dark--almost black--, and muscovite is light and translucent.*
Hornblende contains two directions of cleavage at 60° and 120° degrees from each other. Find the small brownish hornblende crystal. Can you find both crystal faces and cleavage directions on this crystal? Yes, this particular sample shows the relationship between cleavage and crystal faces very well. See image to right.

7. Fracture. When quartz breaks, it breaks along conchoidal fractures, which looks like glass breaking. Can you identify the conchoidal fracture on any of the samples shown here? Yes, there are beautiful examples. See image to the left.

8. Other Properties.

8a. Distinctive Feels are the distinguishing characteristics for graphite and serpentine. Graphite, like a lot of other minerals, is always metallic gray. What does graphite feel like? to me, and authors of some textbooks, it feels greasy.

Serpentine forms in many colors, usually encompassing all of the greens between white and black. Cleavage or crystal form are rarely visible. Serpentine is the California State rock and represents metamorphosed ultramafic rock from the mantle. It is often found in fault zones. What does serpentine feel like? smooth, soapy, “distinctive”.

8b. HCl Reaction. Calcite reacts (fizzes) when dilute HCl is applied. Drop a few drops of the HCl on the calcite. See what happens. Don’t get it in your eyes! How do the various examples of calcite differ from one another? Can you see the rhombahedral cleavage in all of them? you should be able to see the rhombahedral cleavage in most of the samples. All of the samples should also fizz with HCl.

8c. Striations and exsolution lamellae. Striations are very straight lines visible on some of the cleavage faces of certain minerals. It is the best way to distinguish plagioclase feldspar from potassium feldspar (K-spar). Can you find striations on the plagioclase crystal? They are straight lines like looking at pages on a book. What are the other physical characteristics of plagioclase? Vitreous luster, blocky crystal form, various colors but often whitish for plag and/or pinkish for k-spar.

Calcite sometimes contains striations that bisect the acute angle of the rhombahedral cleavage. Can you find the striations on this sample? Yes, they’re there.
The little squiggly lines in the potassium feldspar (K-spar) are called exsolution lamellae. They are the distinguishing characteristic of this mineral. This is the same mineral we saw in the local granite on our last field trip.

Draw a picture of the exsolution lamellae.

8d. 

Magnetic. Magnetite, as the name implies, is magnetic. It is the distinguishing characteristic of this mineral. What are the other characteristics of magnetite?

(sub)metallic luster, high density, lack of visible cleavage or crystal form, grey streak.

Part II. The Geology 2 Mineral List and Distinctive Physical Properties

The following list shows the 17 minerals considered important for the purposes of Geology 2. You will need to be able to identify each of these minerals. The minerals are listed in the form of a key designed to use the physical properties to determine the identity of the minerals. Metallic and non-metallic minerals are arranged by their hardness and streak or cleavage.

Each mineral has one to three “distinctive properties” that are the best physical properties to use to identify that particular mineral. These distinctive properties are shown in bold on the mineral list on the next page. In this section, you will see an example of each mineral along with an explanation of their distinctive physical properties as displayed by the minerals.

Walk around the room and look at the minerals at the numbered stations as described on the list on the next page.

Distinctive Physical Properties of Geology 2 Minerals

1. 

Pyrite has a distinctive gold color and most often forms in little cubes. The little cubes often have striations on them. Pyrite is found mostly in metamorphic rocks and in ore deposits. Name the precious metal that pyrite most resembles.

2. 

Magnetite is magnetic, by far its most diagnostic property. It is also submetallic and gray. What element do you think is a principle component of magnetite?

3. 

Hematite always has a reddish brown streak. It can occur in a dull reddish earthy color, or as a very metallic gray mineral, but its streak is always reddish brown. How would you tell hematite from magnetite?

4. 

Chalcopyrite has a distinctive gold tinsel color. It occurs in ore settings. How would you distinguish chalcopyrite from pyrite?

5. 

Galena is dense, gray and very metallic. Galena is our major ore mineral for Pb. Have you ever lifted any material that is more dense than galena? If yes, what was it?

6. 

Graphite is soft and has a greasy feel. This mineral is used for pencil lead. It is composed entirely of Carbon, however. How does the density of graphite compare to the density of galena?
7. **Quartz** is translucent to transparent and produces conchoidal fractures. It is one of the most common minerals occurring in all of the three major rock types. Because it is very hard and is resistant to weathering, it is also a common component of beach sand and other clastic sediments. Name a place that you have seen quartz before.

8. **Garnet** most often occurs as small, sub-vitreous, equant crystals. It is usually a dark color, often red, but also greens and yellows. Garnet is very common in metamorphic rocks.

9. **Plagioclase Feldspar** is blocky and often contains striations, but not exsolution lamellae. Plagioclase is common in granitic rocks. What is the best way to tell plagioclase from quartz?

10. **Potassium Feldspar** is blocky and often has exsolution lamellae, but not striations. Potassium feldspar (K-spar) is common in granite. What is the best way to tell K-spar from plagioclase?

11. **Olivine** is always a distinctive shade of vitreous green and is the distinguishing mineral for basaltic rock. It also a very abundant mineral in the mantle. It is made of Mg, Fe, and Si. How would you tell olivine from garnet?

12. **Amphibole** is prismatic, black, and vitreous. Often the dark mineral in igneous and metamorphic rocks. Amphibole is actually a family of minerals. The most common amphibole that we will see is hornblende.

13. **Serpentine** has a soapy or greasy feel and is some shade of green between black and white. Add water to rock from the mantle and you get serpentine. Serpentinite is California’s State rock. How would you tell serpentine from graphite?

14. **Fluorite** is vitreous and colorful. Looks like colored glass, but is softer than quartz and does not react with HCl like Calcite. Forms nice crystals. Besides hardness, how would you tell fluorite from quartz and calcite?

15. **Calcite** will always react with HCl to form fizzing or bubbles; also called effervescing. Calcite is Calcium Carbonate (CaCO₃), the most common carbonate. Calcite is the main constituent in a rock called limestone, which most commonly forms in warm shallow seas. Limestone metamorphoses to form marble. How do you distinguish calcite from quartz?

16. **Biotite** is platy and dark. It is in the mica family. Biotite is also a common dark mineral in igneous rocks. How can you tell biotite from amphibole?

17. **Muscovite** is platy and light. It is also in the mica family. How might you distinguish muscovite from calcite?

18. **Gypsum** is usually white and can be scratched by your fingernail. It is the only common mineral (in this class) that can be scratched by your fingernail. How might you tell gypsum from muscovite?
Minerals common to the three major rock groups

<table>
<thead>
<tr>
<th>Igneous</th>
<th>Sedimentary</th>
<th>Metamorphic</th>
<th>Ore minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olivine</td>
<td>Calcite</td>
<td>Garnet</td>
<td>Galena</td>
</tr>
<tr>
<td>Amphibole</td>
<td>Gypsum</td>
<td>Biotite</td>
<td>Magnetite</td>
</tr>
<tr>
<td>Biotite</td>
<td>Quartz</td>
<td>Muscovite</td>
<td>Chalcopyrite</td>
</tr>
<tr>
<td>Plagioclase Feldspar</td>
<td>Feldspar (both)</td>
<td>Feldspar (both)</td>
<td>Hematite</td>
</tr>
<tr>
<td>Potassium Feldspar</td>
<td></td>
<td>Quartz</td>
<td>Graphite</td>
</tr>
<tr>
<td>Quartz</td>
<td></td>
<td>Serpentine</td>
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</tbody>
</table>

Part III . Identification of Unknowns. Check out the suite of unknowns from the instructor. You will have to turn back in a complete set at the end of the lab. There are not quite enough for everybody, so you may have to share. Use the worksheets provided on the following pages to record the physical properties and then use the mineral list to key out or identify the names of the minerals. You should know the names and physical properties of all the minerals in the key. I will ask you to identify them on the mineral test. In test situations, more weight will be given to knowing the physical property than remembering the mineral name.

Please note, not every mineral will have every characteristic. Focus on the “distinctive properties” shown in bold on the table included here. In test situations, you must identify a physical property that is actually present on the sample given in the test.

Please note: the table of minerals and their physical properties was omitted in this key to save space.
**Mineral Identification worksheet**  
*Identifies key characteristic*

**Mineral A = Potassium Feldspar**

Luster  *vitreous* metallic submetallic vitreous other

Hardness >glass glass penny fingernail

Cleavage *two perfect* number of directions 2; quality perfect good perfect

Streak N/A gray reddish brown none

Crystal form *blocky* cubes prismatic blocky equant

fracture N/A conchoical

Specific gravity medium heavy medium light

HCl reaction no yes no

Distinctive feels none soapy greasy other

Striations no yes no

exsolution lamellae yes no

**Mineral Identification worksheet**

**Mineral B = Quartz**

Luster *vitreous* metallic submetallic vitreous other

Hardness >glass glass penny fingernail

Cleavage *none* number of directions; quality good perfect

Streak N/A gray reddish brown none

Crystal form *prismatic* cubes prismatic blocky equant

fracture *conchoidal* conchoidal

Specific gravity medium heavy medium light

HCl reaction no yes no

Distinctive feels none soapy greasy other

Striations yes yes no; exsolution lamellae no yes no
Mineral Identification worksheet  *Identifies key characteristic*

**Mineral C = Biotite**

Luster ____ vitreous ____ metallic submetallic vitreous other

Hardness __<penny, >fingernail__ glass penny fingernail

Cleavage *one perfect* number of directions__; quality______ good  perfect

Streak____ none _______ gray  reddish brown  none

Crystal form __*platy___ cubes prismatic blocky equant

fracture____ none _______ conchoical

Specific gravity __medium__ heavy medium  light

HCl reaction____ no______ yes  no

Distinctive feels none soapy  greasy other

Striations___ no________ yes  no; exsolution lamellae __no__ yes  no

**Mineral Identification worksheet**

**Mineral D = Calcite**

Luster ____ vitreous____ metallic submetallic vitreous other

Hardness __<penny, >fingernail__ glass penny fingernail

Cleavage *3 perfect* number of directions__; quality______ good  perfect

Streak____ none _______ gray  reddish brown  none

Crystal form __*blocky; cleavages form rhombahedral forms___ cubes prismatic blocky

fracture____ none _______ conchoical

Specific gravity __medium__ heavy medium  light

HCl reaction___ *yes_______ yes  no

Distinctive feels none soapy  greasy other

Striations____ often____ yes  no; exsolution lamellae __no__ yes  no
Mineral Identification worksheet *Identifies key characteristic

Mineral E = Gypsum

Luster___ vitrious___ metallic submetallic vitreous other

Hardness__<*fingernail________glass penny fingernail

Cleavage 1 perfect; 2 poor number of directions__; quality_____ good perfect

Streak___none_______ gray reddish brown none

Crystal form ___blocky/platy__ cubes prismatic blocky equant

fracture___none________ conchoical

Specific gravity__light_______ heavy medium light

HCl reaction___no________ yes no

Distinctive feels ___none_______ soapy greasy other

Striations___no________ yes no; exsolution lamellae___no______yes no

Mineral Identification worksheet

Mineral F = Galena

Luster__metallic________ metallic submetallic vitreous other

Hardness__>fingernail, <penny___ glass penny fingernail

Cleavage__*cubic________ number of directions_; quality perfect good perfect

Streak__gray________ gray reddish brown none

Crystal form__*cubes__ cubes prismatic blocky equant

fracture___none________ conchoical

Specific gravity__*heavy____ heavy medium light

HCl reaction___produces hydrogen sulphide smell____ yes no

Distinctive feels___no_______ soapy greasy other

Striations___no________ yes no; exsolution lamellae___no______yes no
Mineral Identification worksheet  *Identifies key characteristic

Mineral G = Magnetite

Luster _sub-metallic_ metallic submetallic vitreous other

Hardness _>glass_ glass penny fingernail

Cleavage _not obvious_ number of directions_; quality______ good perfect

Streak ____ gray gray reddish brown none

Crystal form _not obvious_ cubes prismatic blocky equant

fracture _not obvious_ conchoical

Specific gravity _heavy_ heavy medium light

HCl reaction _no_ yes no _Best physical property: *Magnetic!_

Distinctive feels _none_ soapy greasy other

Striations _no_ yes no; exsolution lamellae _no_ yes no

Mineral Identification worksheet

Mineral H = Pyrite (Fools Gold)

Luster _metallic_ metallic submetallic vitreous other

Hardness _>glass_ glass penny fingernail

Cleavage _none_ number of directions_; quality______ good perfect

Streak _gray_ gray reddish brown none

Crystal form _cubes_ cubes prismatic blocky equant

fracture _conchoidal (but often hard to see with small crystals)_ conchoical

Specific gravity _heavy_ heavy medium light

HCl reaction _no_ yes no; Gold color is excellent physical property

Distinctive feels _none_ soapy greasy other

Striations _yes_ yes no; exsolution lamellae _no_ yes no
Mineral Identification worksheet *Identifies key characteristic

Mineral I = Fluorite

Luster ___ vitreous _____ metallic submetallic vitreous other

Hardness __<glass, >penny____ glass penny fingernail

Cleavage *four________ number of directions__; quality perfect good perfect

Streak ___ N/A ___________ gray reddish brown none

Crystal form ___cubes_______ cubes prismatic blocky equant

fracture ___no_________ conchoical

Specific gravity medium_______ heavy medium light

HCl reaction ___no________ yes no

Distinctive feels ___no____ soapy greasy other

Striations ___no________ yes no; exsolution lamellae ___no___ yes no

Mineral Identification worksheet

Mineral J = Hornblende (a kind of amphibole)

Luster ___ vitreous____ metallic submetallic vitreous other

Hardness __<glass, >penny____ glass penny fingernail

Cleavage *two at 60 and 120 degrees number of directions__; quality perfect good

Streak ___ N/A ___________ gray reddish brown none

Crystal form *prismatic________ cubes prismatic blocky equant

fracture ___none______ conchoical

Specific gravity med-heavy_______ heavy medium light

HCl reaction ___no________ yes no

Distinctive feels ___none______ soapy greasy other

Striations ___no________ yes no; exsolution lamellae ___no___ yes no