EXERCISE 2: MINERAL IDENTIFICATION

PURPOSE: The most important purpose of this lab exercise is for you to learn the SYSTEMATIC PROCEDURE for mineral identification.

This procedure involves recognizing certain PHYSICAL PROPERTIES of the minerals.

Once you have learned to identify minerals and their physical properties, you should investigate the ECONOMIC SIGNIFICANCE of those minerals that we use in the manufacture of common objects (page 7).

DEFINITION:

A mineral is a naturally occurring substance with a uniform CHEMICAL COMPOSITION and a definite CRYSTALLINE STRUCTURE.

CLASSIFICATION:

The chemical composition and crystalline structure of a mineral determine its PHYSICAL PROPERTIES: how it reflects light, its color, hardness, shape, taste and feel.

Two different minerals will either have a different chemical composition or a different

I. Physical properties which depend on **CHEMICAL COMPOSITION**:

A. **LUSTER** - Luster is the way a mineral reflects light.

There are many different kinds of luster: dull or earthy, pearly, oily, glassy, waxy, steely, but you only need to distinguish between metallic and nonmetallic.

The basic types of luster are METALLIC and NONMETALLIC.

The determination of the luster of a mineral is simple. There is no test.
Decide whether the mineral looks metallic or nonmetallic.

If you are unsure about the luster of a mineral the following guidelines will be helpful. However, please realize that these are only generalizations.

METALLIC minerals are usually:

a. gold, silver, or black
b. shiny (unless tarnished)
c. opaque
d. irregularly shaped (lack cleavage)
e. less common
f. and always have a streak

NONMETALLIC minerals are usually:

a. not gold or silver
b. shiny to dull
c. transparent, translucent or opaque
d. geometric shapes (have cleavage)
e. more common
f. and only rarely have a

B. **STREAK** - Streak is the color of the mineral when it is powdered.

The metallic minerals tend to change color, or tarnish, when exposed to the air, so the color you see on the surface of the mineral may not be the gold, silver or black usually associated with it. However, the powdered mineral will remain the same color and is therefore more useful in identifying the mineral.

- Metallic minerals usually have a dark-colored streak different from the color of the mineral.
- A few nonmetallic minerals also have a
- A mineral with no streak or light-colored streak is probably non-metallic.

TEST FOR STREAK
a. Rub the mineral across the surface of a streak plate numerous times.
b. Brush the excess powder away.
c. The color of the remaining powder is the streak.

C. **COLOR** - should not be the only physical property used to identify a mineral.

1. The color of a metallic mineral is usually gold, silver, or black and can be used with luster and streak to identify the mineral.

2. The color of the nonmetallic minerals can be extremely variable and therefore should not be used for identification. Instead of using specific colors (green, blue, pink, white, etc.) for identification, we will use the distinction:

A. LIGHT-colored
or (although some minerals have
B. DARK-colored light and dark varieties)

NOTICE HOW QUARTZ VARIES IN COLOR:

D. **TASTE** - The mineral HALITE tastes salty. DO NOT TASTE SAMPLES. Ask lab instructor.

E. **REACTION TO ACID**

1. The mineral CALCITE will fizz rapidly when dilute hydrochloric acid (HCl) is applied to its surface.

2. The mineral DOLOMITE is similar to calcite, but it does not fizz with dilute HCl. (However, it will fizz when powdered)

NOTE: PLEASE USE A PAPER TOWEL TO WIPE ACID OFF SAMPLES AFTER TESTING. ALSO, DO NOT USE ACID ON MINERALS UNLESS OTHER TESTS SUGGEST IT IS CALCITE.

F. **MAGNETISM** - Some minerals (magnetite) are magnetic

G. **OPTICAL PROPERTIES** - If the mineral is:

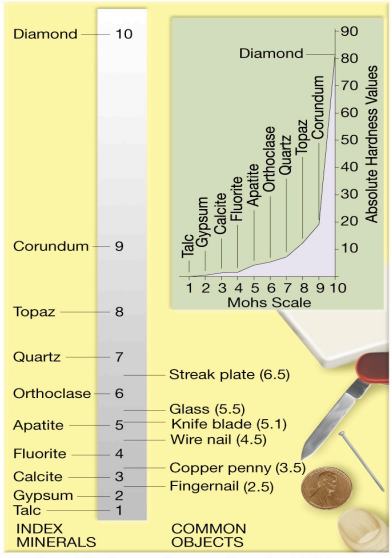
1. TRANSPARENT - light will pass through it and you can see through it

2. TRANSLUCENT - light will pass through it, but you can't see through it

3. OPAQUE - light will not pass through it

II. Physical Properties which depend on **CRYSTALLINE STRUCTURE**:

A. **HARDNESS** - The hardness of a mineral is its resistance to being scratched by or its ability to scratch other substances. A hard substance will scratch a soft substance.



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The hardness of each mineral is indicated by a number from 1 to 10. Diamond has a hardness of 10 and is the hardest mineral known. Talc, which is used to make talcum powder, has a hardness of 1.

We will not be concerned with specific hardnesses, but will distinguish whether a mineral is harder or softer than glass, which has a hardness of 5.5, a penny (3.0-3.5), or your fingernail (2.5).

TEST FOR HARDNESS

a. Place a glass plate on a hard, flat, dark surface.
<u>NEVER HOLD GLASS PLATE IN YOUR HAND</u>**
b. Grasp mineral firmly using as much pressure as possible, drag mineral across the middle of the glass.
c. Brush away any powder on glass.
d. If a scratch remains, the mineral is harder than glass (H > 5.5).
e. If no scratch remains, the mineral is either softer than glass (H< 5.5), or not enough pressure was used
f. Repeat the procedure using a different part of the mineral.
g. If the mineral is softer than glass, test to see if it also softer than your fingernail (H = 2.5) or a penny (H = 3.5)

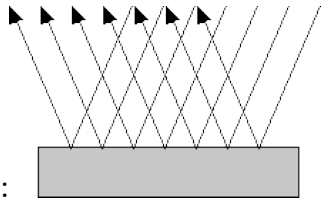
B. **CLEAVAGE** - Cleavage is the way a mineral tends to break, in a regular fashion along planes of weakness in the atomic bonds. Not all minerals have cleavage.

Cleavage is described by:

1. QUALITY - good, poor, none

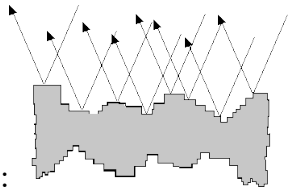
a. GOOD cleavage results in:
(1) simple geometric shapes
(2) flat, parallel surfaces that reflect light as a single plane.

Light rays:



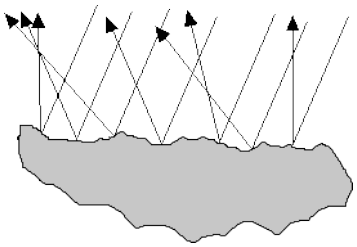
b. POOR cleavage results in:
(1) simple geometric shapes
(2) "stairstep" surfaces that reflect light as if they were single planes.

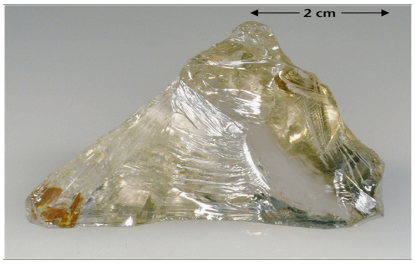
Light rays:



c. NO cleavage results in:
(1) irregular shapes

(2) surfaces that reflect light as curves or points.





2. QUANTITY

# of good Cleavage Directions	# of possible Flat surfaces
1	2
2	4
3	6
4	8

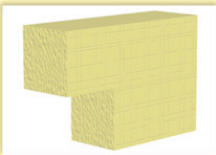
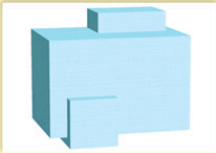
3. ANGLES between cleavage directions

a. 90º (right angle, perpendicular)
b. not 90º

A mineral with good cleavage has the same shape in each specimen.

ONE DIRECTION of CLEAVAGE = flat sheets
TWO DIRECTIONS of CLEAVAGE at 90º = rectangle
TWO DIRECTIONS of CLEAVAGE not at 90º = parallelogram
THREE DIRECTIONS of CLEAVAGE at 90º = cube or rectangle
THREE DIRECTIONS of CLEAVAGE not at 90º = rhombohedron
FOUR DIRECTIONS of CLEAVAGE not at 90º = octohedron
NO DIRECTIONS OF CLEAVAGE = irregular shapes

The Table below shows examples of types of cleavage:

Number of Cleavage Directions	Shape	Sketch	Directions of Cleavage	Sample
1	Flat sheets			Muscovite
2 at 90°	Elongated form with rectangle cross section (prism)			Feldspar
2 not at 90°	Elongated form with parallelogram cross section (prism)			Hornblende
3 at 90°	Cube			Halite
3 not at 90°	Rhombohedron			Calcite
4	Octahedron			Fluorite

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C. **CRYSTAL FORM** - All minerals have a crystalline structure and will form perfect crystals if allowed to grow in an unrestricted area.

Crystal faces resemble cleavage faces because they are flat, parallel and reflect light as a single plane, but they are DIFFERENT FROM CLEAVAGE because:

1. Crystals have complex geometric shapes.
2. Crystals often have more that 6 surfaces.
3. The surfaces of a crystal are not reproduced when the crystal is broken.

Below are some examples of common crystal shapes for some common minerals:

Garnet

Halite

Quartz

Topaz

Pyrite

Fluorite

D. **STRIATIONS** - Striations appear to be long, straight grooves on the cleavage faces of some minerals. Many minerals have striations including calcite and plagioclase feldspar. We will use the presence of striations to distinguish PLAGIOCLASE FELDSPAR from ORTHOCLASE FELDSPAR.

1. PLAGIOCLASE FELDSPARS have STRIATIONS (Fig. A) and color bands. STRIATIONS are:
    a. Straight lines or grooves
    b. Parallel to one another
    c. On one cleavage direction
    d. Parallel to second cleavage direction

2. ORTHOCLASE FELDSPARS have COLOR BANDS and NO STRIATIONS(Fig. B). COLOR BANDS are:
    a. not straight
    b. Not parallel to one another
    c. On all cleavage faces and sometimes on non-cleavage faces
    d. not parallel to any cleavage direction.

Figure A. Plagioclase Feldspar with striations

Figure B. Orthoclase Feldspar with color bands

ECONOMIC SIGNIFICANCE OF SOME COMMON MINERALS

QUARTZ -used in making lenses and prisms for optical equipment.
(SiO_2) -major constituent of sand used in making glass, mortar, concrete, and sandpaper.
-minor importance as a gemstone: amethyst, tiger's eye, agate, onyx

FELDSPAR -major use in manufacture of porcelain and ceramics.
($KAlSi_3O_8$) -minor use as gemstone called amazonstone, moonstone, or sunstone
($CaAl_2Si_2O_8$)-($NaAlSi_3O_8$)

MUSCOVITE -used in sheets as an insulating material in electric appliances
[$KAl_2(AlSii_3O_{10})(OH)_2$] -ground in wallpaper and paint to give a shiny luster

CALCITE -used as fertilizer, soil conditioner, and in Portland cement.
($CaCO_3$) -minor use as ornamental stone in forms called travertine and onyx.

HALITE -used as table salt, rock salt, road salt.
(NaCl) -old salt mines are being considered as storage sites for toxic or nuclear wastes

GYPSUM -major use in manufacture of plaster of Paris.
($CaSO_4.2H_2O$) -some use as ornamental stone in form called alabaster

AMPHIBOLE -some forms used as asbestos because of their fibrous nature.
(Na,Ca,Mg,Fe,Al,silicate)

OLIVINE -gem variety, called peridot, is August birthstone.
$(Mg,Fe)_2SiO_4$

PYRITE -mined as an ore of sulfur and often mined for associated gold or copper.
(FeS_2) -Also known as Fool's Gold.

HEMATITE -major ore of iron; minor use as a pigment.
(Fe_2O_3) Cave paintings were often done with hematite, but this is not a major use now

LIMONITE -ore of iron; minor use as a pigment
($Fe_2O_3.2H_2O$)

GALENA -ore of lead
(PbS)

GRAPHITE -dry lubricant, pencil "lead"
(C)

FLUORITE -used as a flux in making steel, and in making hydrofluoric acid
(CaF_2)

PYROXENE -some forms used as gemstone called Jade
(Mg,Fe,SiO_3)

PROCEDURE FOR MINERAL IDENTIFICATION

Step 1. Obtain a box of minerals, glass plate, streak plate, penny, magnet, acid and paper towel.
2. Separate mineral by LUSTER: NONMETALLIC or METALLIC
3. Separate NONMETALLIC minerals by SHADE OF COLOR: LIGHT OR DARK.

***Have your work checked before you move on.**

4. List the PHYSICAL PROPERTIES on the attached table for each mineral in the following order USING THE FOLLOWING TERMS:

PROPERTY	TERM
LUSTER	NON METALLIC OR METALLIC
COLOR	Note color
HARDNESS	-HARDER THAN GLASS -SOFTER THAN GLASS, HARDER THAN A PENNY -SOFTER THAN A PENNY, HARDER THAN A FINGERNAIL -SOFTER THAN FINGERNAIL
CLEAVAGE	-ABSENT OR PRESENT If present please list also: -NUMBER OF DIRECTIONS: 1,2,3, or 4 If 2 or more directs list also: -ANGLES: @90º OR not 90º
STREAK	NONE OR ACTUAL COLOR
OTHERS	REACTION TO ACID, TASTE, MAGNETISM, COLOR, as they apply

5. Use the classification charts on pages 12-14 to determine the mineral name.

6. Place the specimen on top of the description.

7. Have lab instructor check your identifications.

8. Do at least one other set. Note the similarities and differences between different specimens of the same mineral.

9. Study the demonstration specimens provided.

10. For more practice and understanding try the CD-ROM in the lab or visit the websites listed below.

11. Come back to the lab and do the minerals again until you can identify the properties and names without your lab manual.

REMEMBER:

You may work in groups, but you will be on your own during the exam.

Being able to describe the PHYSICAL PROPERTIES of a mineral is more important than knowing the name.

Helpful or interesting links:

http://academic.brooklyn.cuny.edu/geology/leveson/core/linksa/mineral_invest_intro.html
http://geology.csupomona.edu/alert/mineral/minerals.htm
http://www.minsocam.org/MSA/K12/K_12.html
http://mineral.galleries.com/default.htm
http://www.minsocam.org/msa/collectors_corner/id/mineral_id_keyq1.htm

METALLIC LUSTER

Streak	Description	Name
gray to black	Silver gray color H = 2.5 3 cleavages @ 90º	GALENA PbS
gray to black	Black to dark gray color H = 5-6 Magnetic	MAGNETITE Fe_3O_4
gray to black	Steel gray color H = 1 Marks paper easily greasy feel	GRAPHITE C (pencil "lead")
black to green black	Golden yellow May tarnish purple H = 4	CHALCOPYRITE $CuFeS_2$
black to green black	Brass yellow May tarnish green H = 6-6.5	PYRITE FeS_2
reddish brown	Silver to gray May tarnish reddish brown H = 5-6.5	HEMATITE Fe_2O_3
yellow brown	black to silver gray May tarnish yellow-brown H = 5.5	LIMONITE $Fe_2O_3 \cdot H_2O$

NONMETALLIC LUSTER - DARK COLOR

Hardness	Cleavage	Description	Name
Harder than glass	2 @ 90º	blue-gray to blue black H = 6 STRIATIONS	PLAGIOCLASE FELDSPAR $CaAl_2Si_2O_8$
	2 @ 90º	dark green to black H = 6 may look splintery no striations	PYROXENE Ca, Mg, Fe, Na, silicate
	2 not @ 90º (120º and 60º)	dark green to black H = 5.5-6 may look splintery or fibrous, not striations	AMPHIBOLE Na, Ca, Hg. Fe silicate
	none	olive green to black H = 6.5-7 no streak may occur in masses of small glassy grains	OLIVINE $(Fe, Mg)_2SiO_4$
	none	gray to black H = 7 transparent to translucent no streak	QUARTZ SiO_2
	none	red, with hint of silver H = 1.5-5.5 RED-BROWN STREAK opaque	HEMATITE Fe_2O_3
	none	yellow to black H = 1.5-5.5 YELLOW-BROWN STREAK, opaque	LIMONITE $Fe_2O_3 \cdot H_2O$
SOFTER THAN GLASS	1	brown to greenish black, H = 2.5-3 thin, transparent, elastic sheets	BIOTITE $K(Mg,Fe)_3AlSi_3O_{10}(H)_2$
	none	red, with hint of silver H = 1.5-5.5 RED-BROWN STREAK opaque	HEMATITE Fe_2O_3
	none	yellow to black H = 1.5-5.5 YELLOW-BROWN STREAK, opaque	LIMONITE $Fe_2O_3 \cdot H_2O$

NONMETALLIC LUSTER - LIGHT COLOR

Hardness	Cleavage	Description	Name
HARDER THAN GLASS	2 @ 90º	pink, white or green H = 6 may have color bands no striations	ORTHOCLASE FELDSPAR $KAlSi_3O_8$
	2 @ 90º	white to blue gray H = 6 STRIATIONS	PLAGIOCLASE FELDSPAR $NaAlSi_3O_8$
	none	white, gray, pink, clear, violet, translucent H = 7	QUARTZ SiO_2
	none	olive green to black H = 6.5-7 no streak may occur in masses of small glassy grains	OLIVINE $(Fe, Mg)_2SiO_4$
SOFTER THAN GLASS	3 @ 90º	colorless - white, clear H = 2.5 SALTY TASTE soluble in water	HALITE NaCl
	3, 1 good @ 90º, 2 poor not @ 90º	colorless to white H = 2 (EASILY SCRATCHED WITH FINGERNAIL) transparent to translucent NONELASTIC sheets	GYPSUM $CaSO_4$
	3 not @ 90º	colorless to white, yellow, blue, pink H = 3 transparent to opaque REACTS TO ACID	CALCITE $CaCO_3$
	4 not @ 90º	colorless, purple, yellow, blue, green H = 4 transparent to translucent	FLUORITE CaF_2
	1	colorless to light green H = 2.5-3 transparent to translucent thin elastic sheets	MUSCOVITE $KAl_2(AlSi_3O_{10})(OH)$