Laboratory Manual for Physical Geology

Mineral Identification

OVERVIEW

Why study minerals? The physical properties and chemical composition of some mineral grains retain hints of their origins despite many generations of rock recycling. These clues about mineral formation lead to a better understanding of Earth's history, structure, and processes.

Investigating the composition and properties of minerals is the main focus of this lab. You will see why minerals have unique physical properties and how you can use these properties to identify mineral specimens.

MATERIALS NEEDED

- Printouts from lab manual
  - Mineral Decision Tree
  - Mineral Charts A–F
  - Demonstration Mineral Data Sheet
  - Mineral Data Sheet
- Items from lab kit
  - Mineral specimens #1–21
  - Glass plate
  - Streak plate
  - Nail
  - Penny
  - Magnet
  - Hand lens
  - White vinegar in dropper bottle
- Metal spoon
- Pencil and eraser

SCIENTIFIC DEFINITION OF MINERALS

Somewhat different than the common perception of the word “mineral,” the scientific definition states that a mineral is a naturally occurring, homogeneous, inorganic solid which has both a regular crystal structure and a definite composition.

Naturally Occurring

A mineral forms by natural Earth processes. Man has created many solid, homogeneous, crystalline materials that do not exist in nature, such as silicon chips and cement. Although made from minerals, these resulting materials are not classified as minerals because they are man-made. Man has also created synthetic diamonds, sapphires, and quartz crystals, which are in most ways identical to natural gemstones, but these are not considered to be minerals either.

Homogeneous

A homogeneous material is a single substance that cannot be physically separated into simpler substances. No matter how large the mineral grain, or how small it is divided, its composition and structure are the same.

Solid

Although water (H_2O) is not a mineral, glacial ice, with the same chemical formula, is considered a mineral. Elemental mercury, which occurs in nature, is not considered a mineral because it is a liquid at normal room temperature.

Inorganic

Traditionally, minerals are not biological in origin. Organic compounds are products of biologic activity and contain carbon, hydrogen, oxygen, and nitrogen. Some organic compounds, such as sugar, can occur naturally as crystalline, homogeneous solids, but they are not minerals. Coal and amber (fossilized tree remains) are also not minerals; both are non-crystalline, organic compounds.

However, some materials made by animals and plants are considered minerals. For example, animals build bones and teeth from phosphate minerals and external shells from dissolved carbonate minerals. Many types of algae also create external “shells” from dissolved carbonate minerals. Micro-organisms can cause the precipitation of calcite in sea water outside of their cell walls by altering the water chemistry, and bacteria are responsible for the formation of pyrite in organic-rich mud. These materials, although formed by organisms, are not organic compounds; they are identical to minerals not formed by biologic activity, so they are included with minerals.

Regular Crystal Structure

The atoms in minerals are arranged in a regular, orderly, three-dimensional pattern called a crystalline structure. The pattern is formed by small building blocks, called unit cells, which are stacked together repetitively like Lego blocks to form the larger structure. The unit cell contains all the elements that comprise the mineral, held together by chemical bonds. Each mineral has its own unit cell, with unique dimensions and angles. The regular external shape of a crystal reflects the orderly stacking of these unit cells, although many different external crystal shapes can be made by the same unit cell (just as square Lego blocks can be stacked to make a pyramid shape).

Definite Chemical Composition

A mineral has a well-defined chemical composition that can be expressed as a chemical formula. Many minerals such as quartz (SiO_2) or halite (NaCl) have very specific compositions. Small amounts of other elements, called trace elements, can be incorporated into these minerals without altering the crystal structure and physical properties, although these impurities can cause the mineral to have different colors.

Other minerals have a range of compositions. In olivine, iron can substitute for magnesium in the crystal lattice. The formula for olivine in general is given as $(Mg,Fe)_2(SiO_4)$, with substitution indicated by the magnesium and iron symbols surrounded by parentheses and separated by a comma. In the case of olivine, iron and magnesium can substitute for each other completely, so that olivine can vary from pure $Mg_2(SiO_4)$, called forsterite, to $Fe_2(SiO_4)$, called fayalite. The crystal structure is the same, but the density of olivine increases with increasing iron content.

Other minerals allow only limited substitution. For example, sphalerite is usually shown with a formula of ZnS, but iron can substitute for up to 50% of the zinc. The crystal structure and most of the physical properties are the same, so all varieties are called sphalerite, but zinc-rich specimens tend to be lighter in color with a resinous luster, while iron-rich specimens are darker, even black, with a submetallic luster.

Some minerals allow much more complex substitution, such as augite, $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$. In this complex silicate, sodium and calcium can substitute for each other; magnesium, iron, and aluminum can substitute for each other; and a limited amount of aluminum can also substitute for silicon.

Some minerals contain only one element. Examples of these minerals, called **native elements**, include sulfur (S), graphite (C), diamond (C), gold (Au), and copper (Cu). Notice that graphite, commonly seen in pencil lead, and diamonds have the same chemical formula. Minerals with the same chemical formula but different crystal structures are called **polymorphs**. These minerals have different types of chemical bonds and, thus, different crystal forms.

If a substance fails any part of this definition, it is not a mineral. For example, table sugar, an organic compound formed by biological plant activity, fits all facets of the definition except the inorganic part.

Some naturally occurring, homogenous solids do not have a crystal structure and are called **mineraloids.** One example is opal, which has a chemical composition of SiO_2, but it does not have a crystalline structure. Amber and jet (hard, black fossil wood) are other examples of these "almost minerals."

PHYSICAL PROPERTIES OF MINERALS

The mineral identification process begins with learning about mineral characteristics: which ones to look for, what their definitions are, and which ones are most useful in the identification process.

Consistency in chemistry and crystal structure causes a mineral to have consistent physical properties. Physical properties observed from minerals are:

- Color
- Luster
- Hardness
- Cleavage/fracture
- Streak
- Specific gravity
- Miscellaneous properties

Color

Although probably the most obvious feature, color is the least diagnostic physical property of most minerals. Color should be recorded, but it should never be used until the end of the identification process. Even then, for most minerals, it is not as important as other properties. For example, although green is a very common color of chlorite specimens, all green specimens are NOT chlorite. Other minerals that can be green include quartz, calcite, augite (pyroxene), hornblende (amphibole), olivine, talc, serpentine, epidote, apatite, and garnet. There are even green feldspars! So record colors that you see, but reserve judgment until you gather all the data and work through the analysis.

Luster

Luster is a much more important characteristic than color. Luster describes how light is absorbed or reflected by a mineral surface, which affects the mineral's appearance.

The two major categories of luster are metallic and nonmetallic. Simply stated, metallic luster is the appearance of a metal, such as steel, chrome, aluminum, or gold. Nonmetallic luster has several varieties—glassy (also called vitreous), waxy, resinous, dull, or earthy. Metals are opaque and highly reflective and can be either shiny or dull. Having good light as you make these observations is essential.

In addition to describing how a mineral surface reflects light, some mineral charts include terms that describe transparency, the amount of light that passes through a mineral. Transparency is not usually diagnostic of a mineral's identity, but it can help eliminate possibilities. Transparent minerals allow most light to pass through; translucent minerals partially allow light to pass through; and opaque minerals do not let any light through. A mineral type can exhibit more than one level of transparency; most transparent minerals also occur in translucent forms.

Hardness

Hardness, the resistance of a smooth surface of a mineral to scratching, is a particularly useful physical property in mineral identification. Mohs hardness scale assigns a numerical value of one to ten for ten common minerals. The hardness of an unknown mineral is determined by testing its hardness against known minerals.

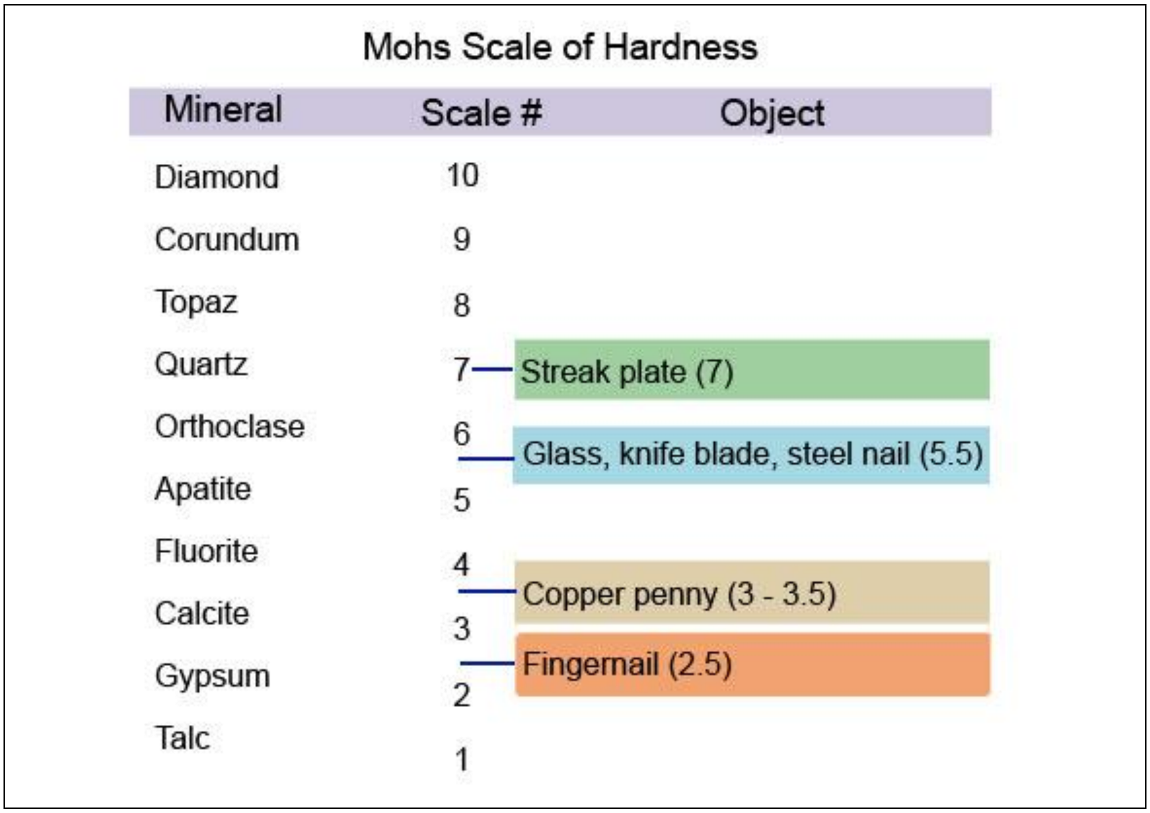


Table 3.1 Mohs Scale

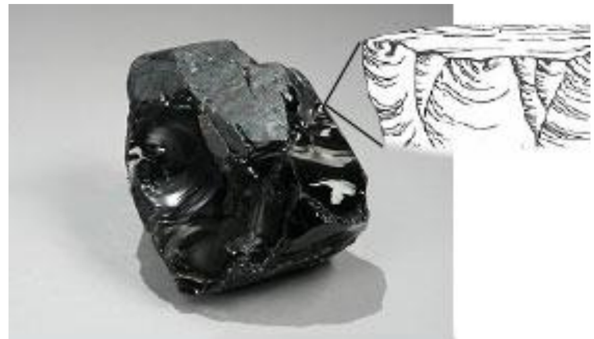
In practical usage, it is not usually necessary to determine the exact Mohs hardness to identify a mineral. The most common approach is to compare the mineral in question to two reference materials, typically glass (about 5½ on the Mohs scale) and a human fingernail (about 2½ on the Mohs scale). This, in effect, places the mineral into one of three categories:

- softer than a fingernail (<2.5)
- between the hardness of glass and a fingernail (>2.5 and <5.5)
- harder than glass (>5.5)

Cleavage and Fracture

Cleavage and fracture describe how a mineral breaks apart. Fracture is an irregular break that does not produce a planar (flat) surface. Although irregular, a fracture surface can have a distinctive appearance. In chrysotile, for example, broken fragments look like splinters while broken surfaces in obsidian may have a **conchoidal fracture** in which one or more surfaces are smooth and curved like the interior of a seashell.

Chrysotile
Broken fragments may look like splinters.



Obsidian
Broken surface may have a **conchoidal fracture** with one or more smooth, curved surfaces.

Figure 3.1 Types of fracture Chrysotile photo by Eurico Zimbres, Creative Commons License, 2.5

Light reflects differently from fracture and cleavage surfaces. On a fracture surface, light rays coming from one direction are scattered in different directions so the surface looks dull. On the other hand, cleavage produces a **planar** (flat) broken surface. Light rays coming from one direction are all reflected in the same direction from a cleavage surface. Consequently, the cleavage surface looks shiny, like a mirror, and gives a ''flash" when turned if it catches the light in just the right direction. Sometimes perfect cleavage can be so mirror-flat that it looks like the mineral specimen has been sawn in two. To determine whether a surface is a cleavage surface, look at parallel surfaces of the mineral specimen under a bright light. As the specimen is rotated 180 degrees to its opposite side, a vivid flash of reflected light reveals a smooth surface that is often a cleavage surface. A stair step surface is really made of flat, parallel surfaces that also reflect light in the same direction and flash when rotated. Not all cleavages are perfect; the lesser conditions are described with words like "good," "fair," or "poor."

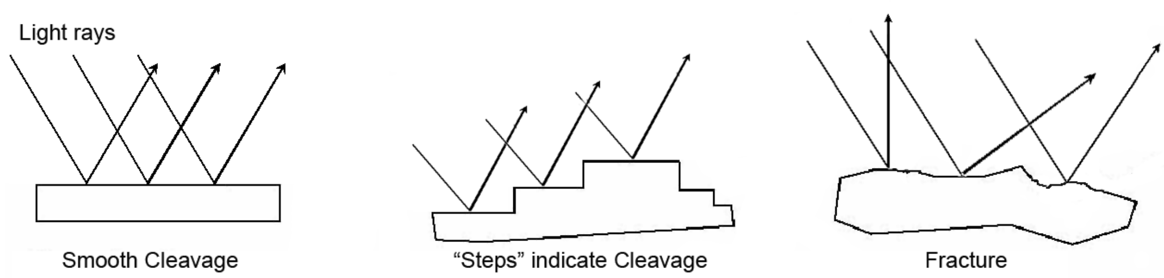


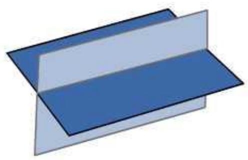
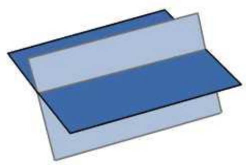
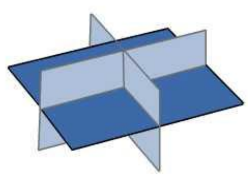
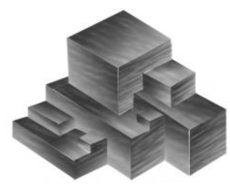
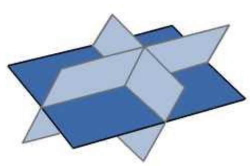
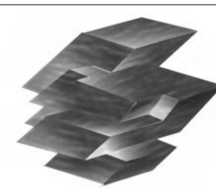
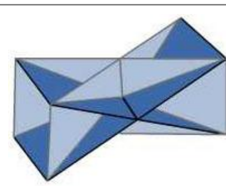
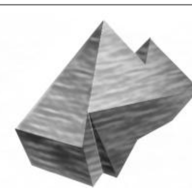
Figure 3.2 Light reflections on cleavage and fracture surfaces.
http://pasadena.wr.usgs.gov/office/given/geo1/pdfs/GEO1_L6INTROMIN.pdf

Cleavage develops because weaker chemical bonds within the building block structure are aligned along a plane, causing the structure to be easily broken in that direction.

Because cleavage is caused by a certain arrangement of weak bonds in a particular crystalline structure, it can be very characteristic of certain minerals and useful for identification. Minerals can have multiple directions of cleavage, depending upon their crystal structure, and some cleavages can be more perfect than others. Common combinations of cleavage direction are described below.

It is important to understand that two parallel cleaved surfaces represent one cleavage direction. Since minerals are 3-dimensional solids, they can have more than one surface which is broken along the same planar direction.

Table 3.2 Cleavage Possibilities

Number of cleavage directions	Angles between cleavage directions	Illustration	Shapes of broken crystal	Illustration
1	180		Tabular	
2	90		Rectangular prism	
2	Not at 90		Non rectangular prism	
3	90		Cubes	
3	Not at 90		Rhombohedrons	
4	Varied		Octahedrons (8 sided)	

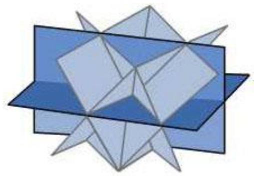
6	Varied		Dodecahedrons (12 sided)	

Table 3.2 Cleavage Possibilities

The size of individual mineral crystals determines what you can observe about a mineral's cleavage. Masses of crystals do not produce cleavage as one large flat cleavage surface per side of a specimen. Instead the cleavage surface often appears as an irregularly broken surface with many small flat "sparkles" as you move the specimen slowly from side to side. Only large single crystal specimens can produce naturally "flat" surfaces that completely cover one whole side of a specimen. Earthy masses of microscopic crystals do not show cleavage at all. If microscopic mineral crystals with good cleavage are aligned, as in some metamorphic rocks, the cleavage can cause the rock to break into flat, smooth pieces.

Plagioclase feldspar has two cleavages at right angles. Thin, perfectly straight lines can often be seen on ONE of these cleavage faces (magnification is often helpful to see this). These lines may appear like the lines on a phonograph record. When turned so the cleavage surface reflects light, the lines form tiny stripes. One set of stripes reflects light and when the specimen is turned very slightly, the alternate set of stripes reflect light. These are called striations, and if present, the specimen MUST be plagioclase.

Figure 3.3 Striations on plagioclase feldspar.

Unfortunately, not all plagioclase specimens have striations. The striations are sometimes extremely tiny and hard to see and they only occur on one of the cleavage faces. It is important to distinguish these from striations on crystal faces, such as on quartz crystals, that are slight deflections in a crystal face caused by changing conditions during crystal growth. Striations can be felt with a fingernail while plagioclase striations on cleavage surfaces cannot be felt.

Streak

Streak is the color of a powdered mineral and is considered to be the true color of a mineral. Different specimens of a mineral may have different colors, but the powdered streak is constant. Dolomite, for example, can be virtually any color imaginable; however, the streak of dolomite is always white.

Streak is most useful as a diagnostic feature for minerals with metallic luster. Most minerals with nonmetallic luster have a white streak. If you are unsure as to the luster of dark-colored minerals, a white streak is a strong indication that you should explore the nonmetallic possibilities first.

The test for streak is conducted by dragging an edge of the mineral specimen across an unglazed porcelain tile called a streak plate. Minerals powder if their hardness is less than that of the streak plate, which has a hardness of about 7. If a mineral is harder than the streak plate, the mineral scratches the streak plate and you see what appears to be a white streak composed of powdered streak plate. Minerals that are harder than the streak plate are listed on your identification charts with a white streak to help prevent confusion, although their streak is sometimes described as “none.”

Specific Gravity

Specific gravity is the relative density of a mineral compared with water. Since it is a relative measure, it has no units. If a mineral has a density equal to water (1 gram/cc), its specific gravity (SG) is 1. A mineral with a SG = 2.65 is 2.65 times denser than water (2.65 gm/cc). For this course, the specific gravity does not need to be precisely measured. Instead, by hefting the unknown specimen, and comparing it to a known mineral, the approximate specific gravity can be estimated as light, medium, or heavy. This is most easily performed with one specimen in each hand. Be careful to choose specimens of about the same size, and try to mentally adjust if the sizes are different.

Miscellaneous Properties

Some miscellaneous or special properties are unique to one or only a few minerals. These properties include magnetism, reaction with acid, salty taste, unique odors, and odd light-bending features such as double refraction. The uniqueness of miscellaneous properties makes them particularly useful in the identification process.

Table 3.3 Miscellaneous Properties

Properties	Mineral Name
Salty taste	halite
Magnetic	magnetite
Effervesces in cold, dilute HCl on unpowdered surface	calcite
Effervesces in cold, dilute HCl, but only when powdered	dolomite
Earthy, “fresh-dirt” odor when moist	kaolinite
Double refraction	calcite
Piezoelectric effect	quartz
Burnt match smell	sulfur
Burnt match smell when scratched	sphalerite, sulfur
Greasy or soapy feel when rubbed	talc, graphite
Thin cleavage fragments are elastic/flexible	biotite, muscovite
Easily writes on paper	graphite
Iridescent play of colors – blue, green or yellow	plagioclase
Perfectly straight striations on cleavage faces	plagioclase

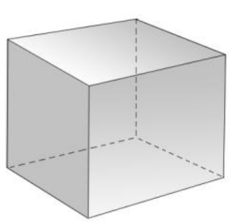
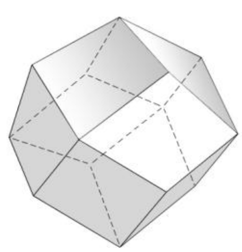
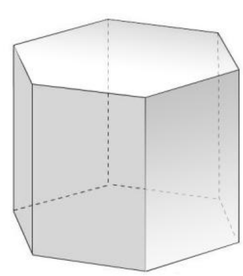
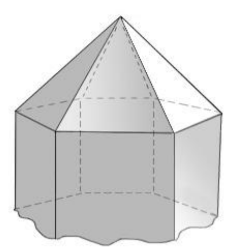
Table 3.3 Miscellaneous Properties

Mineral Crystals

By definition, minerals have a regular crystal structure, in other words, atoms in minerals are arranged in regular geometrical patterns. The crystal shape is the external expression of the mineral's regular internal atomic structure.

However, mineral crystals typically grow in crowded conditions, causing adjacent crystals to interfere with the growth of neighboring crystals. This results in a network of interlocking crystals that do not exhibit external crystal faces. Most specimens you will analyze in your lab kit do not exhibit their crystal forms because they are small pieces, often cleavage fragments, of larger crystals. Crystal forms you may see in textbooks, websites, or museums are summarized in Table 3.4.

Table 3.4 Crystal Shapes and Minerals

			
Cube – diamond, fluorite, galena, halite, pyrite	Dodecahedron - garnet	Hexagonal prism - corundum	Hexagonal pyramid – apatite, quartz

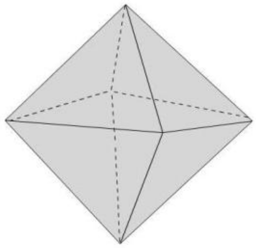
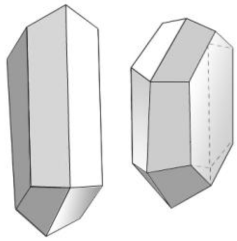
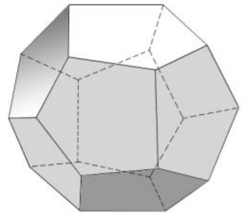
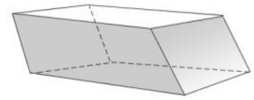
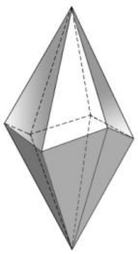
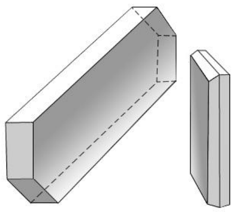
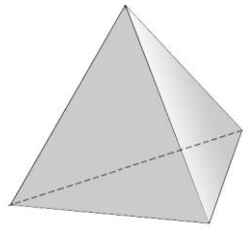
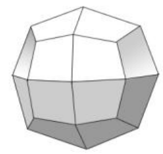
			
Octahedron – diamond, gold, magnetite	Prismatic crystals – azurite, gypsum, orthoclase	Pyritohedron - pyrite	Rhombohedron – calcite, dolomite
			
Scalenohedron - calcite	Tabular crystals – augite, barite	Tetrahedron - chalcopyrite	Trapezohedron - garnet

Table 3.4 Crystal Shapes and Minerals

Twinning occurs when two different crystals of the same mineral occupy some of the same space. Part of the “body” of each crystal is shared with the other, giving the appearance of being intertwined. Crystals often grow in clusters or radiating groups, but these are not necessarily twins. With true twins, the crystals have an exact angle where they join.

Figure 3.4 Examples of twinning of staurolite. Note that staurolite twins meet at either 60 or 90 degree angles.

Crystal Habit

Because of their unique internal crystal structure, some minerals tend to occur in certain distinctive crystal shapes, as shown in the chart in the previous section. In addition, some minerals tend to occur in distinctive aggregates of crystals or with peculiar crystal modifications.

Table 3.5 Crystal Habit

Habit	Mineral
Pea-sized concretions (round, concentric bodies)	bauxite, calcite
Sharp pointed ("dog-tooth") crystals	calcite
Concentric bands of different colors, sometimes filling a geode	chalcedony
Six-sided prisms expanded to bulging barrel shape	corundum
"Ball-shaped" crystals of 12 (or even more) faces	garnet
Small spheres or egg shapes resembling fish eggs	hematite, calcite
Radiating clusters of crystals forming rounded masses	malachite
Striations from twinning visible on one cleavage face	plagioclase
Six-sided prisms with growth striations across the crystal faces	quartz
Twinned crystals forming crosses	staurolite

Differentiating augite from hornblende, both black minerals common in igneous rocks, can be difficult when the crystals are small, but crystal habit can be used to distinguish them:

Blocky, squarish crystals	augite
Elongated to needle-like crystals	hornblende

Table 3.5 Crystal Habit

IDENTIFICATION PROCESS

In the mineral identification process, you will make observations, collect and record data, and analyze the data collected to determine the true identity of minerals. As you examine the minerals, be sure to record your observations along with the information gained from tests performed and all other details for each specimen on the data sheets included in the lab manual. Writing in pencil with an eraser available is advised.

As you prepare to identify lab kit specimens, you are encouraged to watch the videos. Since you will be writing down information during each segment, you will need to print the "Demonstration Mineral Data Sheet" and the "Mineral Data Sheet" prior to viewing. Some information covered in the lab videos is also presented in this portion of the lab manual so you have another resource to become familiar with the material if you want it.

Having the decision tree, mineral charts, your notes, and reference materials such as the mineral chapters of your lab manual and textbook on hand will help you work through the process. The cleavage possibilities (Table 3.2), the miscellaneous properties (Table 3.3), and the crystal shapes and minerals diagram (Table 3.4) are also very helpful references.

Accurately assessing the physical properties of each mineral specimen is very important. At first it may be difficult to determine which characteristics or properties of the mineral specimen are important, but if you write down everything you observe on your data sheets, the decision tree will help you sort through the details. The tree will lead you to the important information as you work through it, once your data is recorded.

A decision tree is an organized series of "yes or no" questions that eliminate many choices as you work through a careful, methodical analysis, similar to the approach biologists use to identify plants. Your answer to each step eliminates many choices, thus narrowing the likely possibilities to a small group. When you arrive at the end of the process, you will be directed to the group of minerals that remain. By comparing your careful observations to the detailed descriptions on the mineral charts, you can eliminate the wrong answers one by one and arrive at the correct mineral name.

Students often make two common mistakes as they begin identifying minerals. The first mistake is trying to match mineral specimens to a color picture often found in a textbook or on the Internet, and mostly skipping the tests for physical properties. The picture-matching guesswork and focusing on the appearance of a particular specimen can be unreliable; the same mineral can have many different appearances. The second common mistake is to decide that color is the most important feature of a mineral. For example, because clear, colorless quartz crystals are relatively common and often appear in photographs and lab kits, students often conclude that a clear, colorless mineral is always quartz. However, almost half of the mineral specimens in your lab kit could be clear and colorless, and quartz can, in fact, be any color. Another common misconception is that all green minerals are olivine; it is possible that half of the minerals in your kit could be green.

STEPS TO IDENTIFY MINERALS

Using the Decision Tree

Follow each step on the Decision Tree to narrow the possible minerals to a small group.

1. *Determine the luster of the mineral*. Does the specimen appear to be metallic or nonmetallic? As light reflects off the surface of the specimen, how does it appear? What does the surface of this mineral most resemble: something metallic or something other than a metal? For most specimens, this is fairly

straightforward. If the specimen is nonmetallic, decide if it is also dull, resinous, earthy, or glassy (vitreous). Record that information on your data sheet to help you later in the process.

2. *Determine the hardness of the specimen*. Does it scratch glass? If not, can you scratch it with your fingernail? (If unable to use your natural fingernails to do a scratch test, use a penny to get similar information.) Be sure to place the glass on your work surface and press the mineral specimen firmly into the glass as you drag it across the glass surface. Brush any mineral grains away with your finger and closely inspect the glass surface for a groove where the scratch test was executed. When the scratches are very shallow, it is sometimes difficult to see them, so give your fingernail a chance to fall into the scratch to help you detect the minor indention on the glass surface.

3. *How does the mineral break?* Does it cleave or does it fracture? If it cleaves, in how many directions is there cleavage for the same mineral crystal? When the specimen has more than one cleavage direction, it is important to note the number of directions and the angles between these different cleavage planes. By answering these questions in the Decision Tree, you will be directed to a chart of detailed mineral descriptions.

Using the Mineral Charts

Now that you have narrowed your choices to a chart of detailed mineral descriptions, use all other properties: streak, specific gravity, special types of luster (especially for nonmetallic varieties), and miscellaneous properties. The question to ask is, “Does this specimen have any of these special characteristics?” If color is going to be helpful at all, it is at this last step that it will be applied. Color can be used to rule out impossible mineral choices.

Thinking is particularly important at this stage of the process. Take each possibility and carefully compare its characteristics to your data sheet. Use the process of elimination to rule out unlikely possibilities and look for diagnostic properties. You will most likely determine a list of two or three potential minerals fairly quickly. Check other properties to confirm or contradict your hypothesis. The more matching properties you use, the more confidence you can place in your identification.

It is extremely important to carefully record your observations as you investigate the properties of your mineral specimens. This is an important aspect of scientific work. Practicing scientists keep careful and copious notes of their work. One simply cannot depend on memory to pull up every detail during the decision tree phase of the investigation. Filling out a data sheet forces an observer to carefully consider and test each observation. It also prevents jumping to an incorrect conclusion.

What happens if you get a wrong answer? It means you made an error in the process. This can happen in “real science” investigations too. Go back and recheck your data and retrace your steps on the decision tree. If you are stuck, leave that specimen until later and then take a fresh look at it. You might even want to start from “scratch” with a fresh data sheet and re-record your data. Identifying other specimens and then returning to the problematic ones may help. Again, practice and persistence pay off.

Examples

The following examples illustrate how to utilize mineral charts in determining a mineral’s identity.

1. Example A
   Looking at your data sheet, suppose the decision tree has taken you to Mineral Identification Chart C to identify a specimen. This means you have identified a non-metallic luster, the specimen does not scratch glass, and it has cleavage, even though you are not sure how many directions. Looking at your data sheet, you see you were not able to scratch the specimen with your fingernail. You may need to test the specimen again – feel free to do that as needed. This means you have just ruled out the first four choices on Chart C. The next two choices are biotite and muscovite. You re-examine your specimen and see that it does not break into thin, flexible, elastic sheets; this means it is neither of those two choices. Looking again at Chart C, you see calcite, so you powder a “crumb” and test the powder with vinegar. Nothing happens, so it is not calcite. Now you see that your specimen is white and you notice that sphalerite cannot be white, so it is not sphalerite. This leaves barite, anhydrite, dolomite and fluorite. Looking through the characteristics of these four, you realize that barite is considerably dense or heavy for its size. You heft your specimen again, comparing it to several other white ones and realize this specimen is heavy for its size. You can now eliminate the three less dense minerals and name your specimen as the one with the significantly higher density – barite.

2. Example B
   Let’s say the specimen has metallic luster and scratches glass. This leads you to Mineral Identification Chart E. You notice the specific gravity is about the same for all three mineral possibilities, and your specimen is heavy for its size. None of the choices have cleavage and your specimen does not show any either. Your specimen is neither brassy/gold-colored nor black, but it is gray. You suspect hematite, but since color is not usually diagnostic, you keep looking at Chart E for more clues. Now you notice that the streak color is very different for these three minerals. Your specimen has a streak that is brick-red. The only possibility for that streak color is hematite.

Distinguishing Minerals with Similar Appearances

Minerals often have similar appearances and are often confused with each other, yet can be distinguished by certain characteristics. Study the mineral identification charts to discover the distinguishing characteristics (diagnostic properties) for the following minerals:

- pyrite and chalcopyrite
- galena and graphite
- halite and calcite
- magnetite and hematite
- muscovite and biotite
- gypsum and muscovite
- quartz and topaz
- hematite and goethite
- olivine, epidote, chlorite and apatite (all commonly green)
- talc, gypsum and kaolinite
- orthoclase and plagioclase
- augite and hornblende
- calcite and dolomite

LAB MATERIALS

Glass plates are ordinary window glass, produced by melting quartz sand with sodium or calcium carbonate and then cooling the material quickly so it cannot form crystals. Ordinary window glass has a hardness of 5.5. (Note that lead crystal and laboratory glassware can be harder or softer.) If your glass plate becomes so scratched that you cannot distinguish a new scratch from all the old ones, you may use a piece of ordinary window glass, but be careful of sharp broken edges.

Essential Safety Tip

When doing a scratch test, be sure to place the glass plate on a table. Do NOT attempt a scratch test with the glass plate in your hand! When performing a scratch test, there is always a chance the glass may break, so be sure it breaks on the work surface and not in your hand. You may want to put several layers of newspaper or an old towel on your work surface to catch rock fragments and to prevent damage to the table if the plate slides or breaks.

Streak plates are unglazed porcelain tiles. With repeated use, they become covered with mineral powder making it difficult to find a spot to test streak color. Wash with water and an old toothbrush if you need cleaner surfaces to test.

Steel Nails have a hardness near to that of glass (5.5) and are used to test mineral grains that are recessed in a rock so that they cannot be tested against the glass plate.

Pennies minted 1982 or before were made mostly of copper, so their hardness is 3 (as in native copper). Pennies minted 1983 and later are an alloy of zinc and copper, so they have a hardness a little greater than 3 (3.2–3.5). The penny in your kit is supposed to be one minted 1982 or earlier.

Magnets are used to test for the special property of magnetism. Of the minerals that are provided in your lab kit, the only one that is strongly attracted to a magnet is magnetite. If the magnet can be suspended from a specimen, then it is strongly magnetic.

A **hand lens** is used to examine minerals grains closely, especially in rocks. An inexpensive magnifying glass may also be used, but typically provides only low magnification (3x to 5x). A hand lens is used by holding the lens very close to your eye (as close as eyeglasses), and then bringing the specimen up to within an inch or two of the magnifier. The lens can be held steady by holding your hand against your face. Focus the image by moving the specimen, not the hand lens. It is tricky to not block the light with your head, but a hand lens allows high magnification (typically 10x, but up to 20x) with little distortion and a bright image. Because of its small size and protective sleeve, it is ideal for field work.

White vinegar is included in your lab kit in a dropper bottle as a safe substitute for hydrochloric acid (HCl). Practicing geologists use HCl because vinegar is not strong enough to test for dolomite. Because dolomite was not included in your lab kit, the vinegar will be adequate for acid tests.

Metal spoons are used to crush tiny rock crumbs in order to do the acid test with the white vinegar. They are not included in your kit, but you can use a common tablespoon.

Pencil and eraser are preferred for most of your lab work over pen as many of your lab activities are processes which include revision of your initial marks. Using a pen makes for messy and illegible papers.

Mineral specimens vary. Not every property listed in the mineral charts will be apparent in every specimen of that mineral. Minerals can occur in fine-grained masses in which crystals are microscopic (microcrystalline) or even sub-microscopic (cryptocrystalline) in size and cleavage can therefore not be observed. Hardness and density may be lower than normal due to the loose and porous nature of some specimens. Large single crystals are relatively rare in nature, especially for some minerals, so crystal form may not always be visible.

More minerals are included in your identification charts than you have in your lab kit for several reasons. Different textbooks choose slightly different sets of minerals for students to study, plus geology professors may choose to include minerals important to their particular geologic specialty. Also, an instructor may want you to be familiar with a particular mineral that is common where you live, even though the mineral is uncommon in most areas of the country or even the world. The online lab activities provide opportunities to practice the mineral identification process for some of these other minerals.

TIPS

Luster

For most minerals, luster is blatantly obvious, but black, shiny mineral specimens can be troublesome. Black and shiny do not automatically mean “metallic.” To determine whether these specimens are actually metallic, remember the following tips:

- Minerals with metallic luster are generally dense; they have a higher specific gravity than minerals with non-metallic luster.
- Minerals with metallic luster are generally opaque; if the specimen is translucent, then consider the specimen to have non-metallic luster.
- Minerals with metallic luster generally have streaks that are not white.

Hardness

- A few minerals have a hardness range that does not always fit neatly into the three categories of softer than a fingernail (<2.5), harder than glass (>5.5), or between the hardness of glass and a fingernail (>2.5 and <5.5). Augite and hornblende, which have a hardness range of 5-6 on Mohs scale, are the two most common. Since the hardness of glass is between 5 and 6, some specimens of each of these two minerals scratch glass and some do not.
- The harder the mineral, the easier it will be to make the scratch and the deeper the scratch is likely to be. Minerals that have a hardness near to that of glass, for example, 5.5 or 6 on Mohs scale, will probably not scratch glass at all with light pressure. Press the mineral firmly against the glass plate to get the best test results. If considerably harder than glass, the mineral can be heard and felt scratching the glass plate with ease. A mineral less hard than glass will not scratch the glass plate no matter how much pressure you use.
- Fine-grained, earthy specimens often appear considerably softer than large crystals of the same mineral. This can happen when the scratch test dislodges tiny crystals, disaggregating the specimen, but the test does not truly scratch the crystals. To help narrow your search for the proper identification, minerals that commonly occur in earthy varieties are listed in

the mineral identification charts twice: once for crystalline specimens and again for massive varieties.

Cleavage

- Determining the number and angles of cleavage can be confusing. Start simply. The first question to ask is, “Does this specimen exhibit fracture alone or cleavage on at least one side?” If the specimen has cleavage, then ask: “How many cleavages are present?” If you determine that there is more than one cleavage direction, then ask: “What is the angle between the cleavage directions?” Even if you cannot confidently answer the second and third questions, often the fact that a mineral has cleavage [or not] is enough information to get past this part of the analysis successfully.
- When the specimen is a mass of crystals, the crystals may not be aligned to produce one smooth, flat cleavage surface on each side. You may be able to determine only the presence of cleavage without knowing just how many directions of cleavage the specimen has. Even this incomplete information is often enough to help you determine the mineral’s true identity.
- When specimens are very fine grained and you cannot see crystals, you cannot accurately determine cleavage. If the mineral ALWAYS occurs in very fine grained aggregates, the mineral charts list the cleavage as “none,” even though cleavage may be present under the microscope. The identification process accounts for the fact that cleavage, even if actually present, cannot be observed.
- Some minerals occur very frequently in fine-grained massive varieties that do not exhibit cleavage. These minerals (calcite, dolomite, and gypsum) appear in two places in the mineral identification charts: once for crystalline specimens and again for massive varieties.

Streak

- White streaks are sometimes difficult to distinguish on the white porcelain streak plate. If you cannot see a streak, rub your finger over the place where you attempted the streak and inspect your finger for a white powder.
- You may notice that some minerals grind up the streak plate instead of being ground to a powder themselves. This indicates the mineral is harder than the streak plate (around 7). Sometimes the streak of such hard minerals is termed “none”, but the identification process does not depend upon this subtlety. The question you ask is simply, “What color is the streak?”

Crystal Faces and Cleavage Surfaces

Since cleavage surfaces and crystal faces are both planar features, they can be difficult to distinguish. They have different patterns, so it is useful to study the diagrams of crystal shapes and cleavage possibilities. Here are some other clues as to whether a planar surface is a cleavage surface or a crystal face.

- Crystal faces can grow irregularly, leaving small pits or triangular depressions. In an extreme case, the crystal edges can grow much faster than the center of a face, turning the face into a stepped, inward depression like a sunken garden or inverted Mayan temple.
- Crystal faces, since they are exposed to mineral solutions, can become etched and pitted if they dissolve slightly, dulled by exposure to air and water, or stained by iron oxides and other minerals. Cleavage faces will not be etched or pitted, but can be stained if groundwater has seeped into a cleavage crack that was later broken to give the cleavage surface.
- A common crystal form is the hexagonal prism, like a fat wooden pencil. Cleavage never takes this shape.
- Crystal faces often have visible growth lines, or striations, which you can see easily and feel with your fingernail. For example, quartz often has growth striations CROSS-WISE on the hexagonal prism crystal faces, and pyrite often has striations on cube crystal faces. Cleavage surfaces won't show striations. An exception is plagioclase, which shows striations on one of its cleavage faces that are due to twinning and that usually cannot be felt with a fingernail.
- Crystals often have four or more faces joining at a point. Cleavage rarely does this. Fluorite is the only common mineral that can do this because it has four cleavage directions. It is possible, however, for SOME of the surfaces joining at a point to be cleavage surfaces, while others are crystal faces.
- Crystal faces are often mirror-like and very smooth. Only perfect cleavage can produce surfaces of such extreme smoothness.
- Crystal faces can only be created when a crystal grows into a fluid-filled space, such as an open vein, hollow geode, or molten magma, so that other crystals do not interfere with its growth. When SOLID rocks are broken, most of the planar surfaces that sparkle in the light are probably cleavage surfaces, not crystal faces. Two common exceptions to this are porous (not solid) quartz sandstones and dolostones, where crystal faces have grown on quartz sand grains or dolomite crystals, creating sparkling surfaces.
- Cleavage surfaces can be observed as planar cracks INSIDE transparent and translucent crystals. If these are parallel to an external face, the external face may also be a cleavage surface, although it is possible that a crystal face parallels a cleavage direction (e.g., halite).

- Often, an external cleavage surface is broken by steps and offsets. If a surface continues beyond the step INTO the mineral, then it must be cleavage. This can result in thin flakes or sheets barely adhering to the rest of the specimen. Thin cleavage flakes and narrow cleavage cracks can cause interference colors (like an oil film on water) and internal flashes of light.
- Two cleavage directions will often intersect to create stair-steps on a broken face. All of the "tops" of the stairs reflect light at the same orientation, and upon turning the specimen, all of the "sides" of the stairs reflect light at a different orientation. The difference in orientation gives the angle between the two cleavage directions, which is important to note. Stair-step features can also be created with crystal faces when a crystal grows irregularly, but is much more commonly caused by cleavage.
- Of course, creating the surface yourself by breaking a specimen obviously proves the surface is cleavage. It is usually not desirable to break a mineral specimen any more than necessary, but frequently, small bits of minerals will break off while handling and storing a mineral specimen. Small cleavage fragments are often created when performing hardness and streak tests. These can be inspected with a hand lens to determine cleavage directions.

Color

- Remember that color is not a reliable identifying characteristic of many minerals. Minerals with highly variable color are quartz, calcite, and fluorite. Color can be diagnostic for only a few minerals. (Sulfur-yellow, malachite-bright green)
- The only minerals that are never clear and colorless are the ones with metallic luster.
- Green is a common color for minerals with nonmetallic luster, but relatively uncommon for minerals with a metallic luster.

EXERCISES

Assignments:

Part 1:

- Print the Demonstration Mineral Data Sheet.
- Fill in the missing information as you view each Mineral Properties video.
- Use the Mineral Identification Charts to fill in any remaining properties not covered in the lab videos.

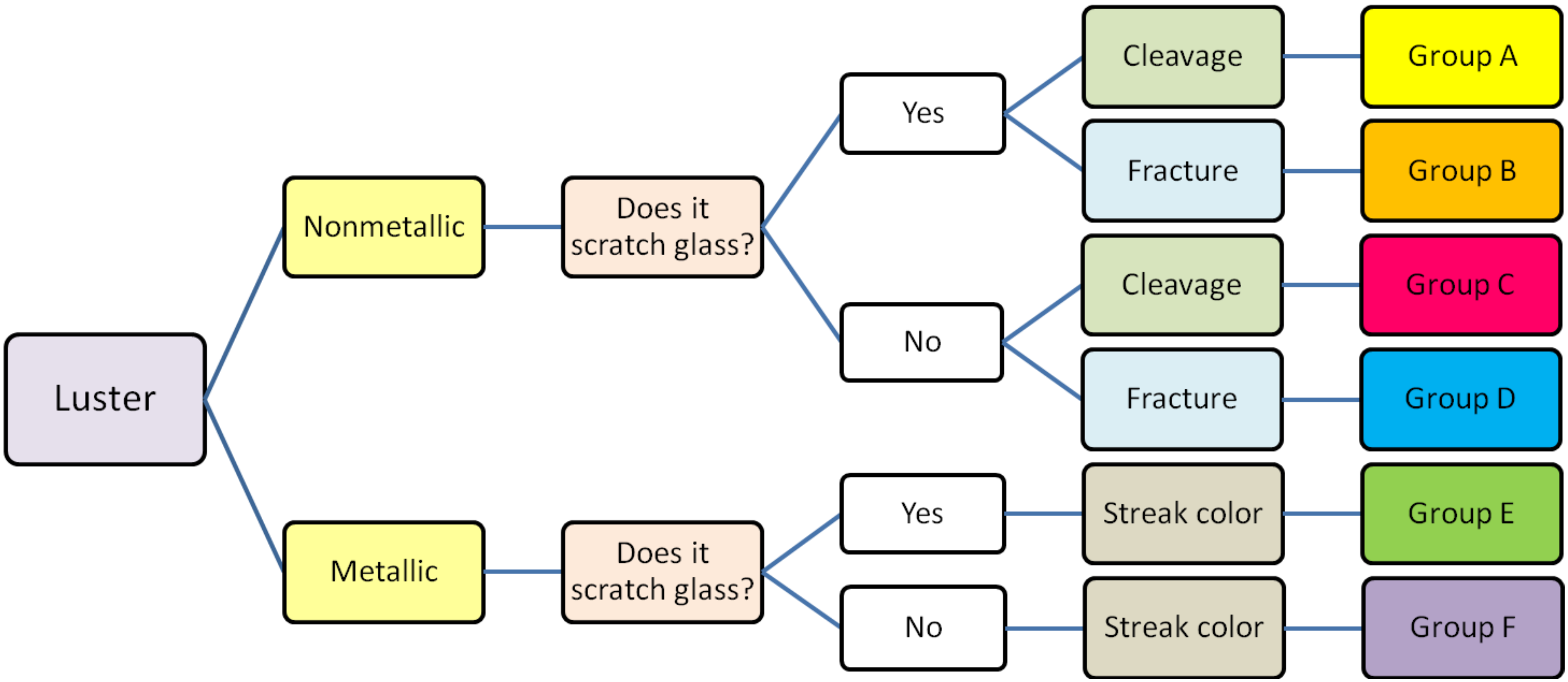
Part 2:

- Download the Mineral Data Sheet (pdf file) and/or print the page from your lab manual. (You may want to first work with a hard copy and then transfer your answers to an electronic format.
- Record your observations on the Mineral Data Sheet.
- Identify the twenty-one (21) minerals.

READ THIS BEFORE YOU BEGIN

1. View the lab videos for mineral identification.
   - Minerals: Lab intro
   - Mineral Properties: Luster
   - Mineral Properties: Hardness
   - Mineral Properties: Cleavage & Fracture
   - Mineral Properties: Specific Gravity
   - Mineral Properties: Miscellaneous
   - Mineral Identification
2. Review the lab manual chapter.

Mineral Decision Tree



Mineral Identification Chart

Group A — Nonmetallic
- Scratches glass
- Has cleavage

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	• Nonmetallic • Vitreous • opaque	5 - 6	Two planes at nearly 90 degrees, poor to fair	White to pale green	3.2 – 3.6	• Dark green to black • Often appears as squarish, blocky grains	Augite (Pyroxene Group)
	• Nonmetallic • Vitreous • Fresh surfaces are often glossy • Opaque but can be translucent on thin edges	5 - 6	Two planes intersecting at 56 and 124 degrees Cleavage often has splintery appearance	White to pale green	3 – 3.4	• Dark green to black • 6-sided crystals common • Often appears as elongated, needle-shaped grains	Hornblende (Amphibole Group)
	• Nonmetallic • Vitreous to pearly • Often translucent	5 - 7	One good cleavage	White	3.56 – 3.66	• Blue, white gray, green • Color may be patchy • Commonly occurs as bladed crystals and as crystal masses	Kyanite
	• Nonmetallic • Vitreous • Grains have glossy appearance • Can be translucent	6	Two planes at nearly 90 degrees	White	2.56	• Color varies from white to cream to pink and salmon pink • Crystals uncommon • May exhibit internal color streaks and variations but boundaries are not perfectly straight	Orthoclase (Feldspar Group)
	• Nonmetallic • Vitreous • Can be translucent	6	Two planes at nearly 90 degrees Cleavage surfaces may show striations	White	2.6 – 2.75	• Color varies, usually white to gray • Striations diagnostic, if present • Some samples may show play of iridescent colors (blue, green, or yellow) on cleavage surfaces	Plagioclase (Feldspar Group)
	• Nonmetallic • Vitreous to dull • Translucent	6 - 7	One perfect cleavage, only rarely seen	Pale yellow to white	3.34 – 3.45	• Yellow green to green to black • Granular masses common • Occasionally slender prisms	Epidote
	• Nonmetallic • Vitreous	8	One perfect cleavage	White or colorless	3.4 – 3.6	• Colorless, yellow, blue, pink, or brown	Topaz

Mineral Identification Chart

Group B — Nonmetallic — Scratches glass / No cleavage

Specimen No.	Luster	Hardness	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	• Nonmetallic • Vitreous to resinous • Transparent to translucent	6.5 – 7.5	None - Fracture may resemble a poor cleavage or be conchoidal Brittle, splintery breakage common	White or shade of the mineral color	3.6 – 4.3	• Color varies but dark red to reddish brown common, green and yellow possible • 12-sided dodecahedron ("ball-shaped") crystals common	Garnet
	• Nonmetallic • Vitreous • Transparent to translucent	6.5 - 7	None Conchoidal fracture	White or gray	3.2. – 4.3	• Color commonly olive green, can be yellowish-green to brownish green • Commonly in granular masses	Olivine
	• Nonmetallic • Vitreous to dull • Translucent	6 - 7	No visible cleavage	Pale yellow to white	3.34 – 3.45	• Green to black • Granular masses common • Occasionally slender prisms	Epidote
	• Nonmetallic • Waxy to dull • Opaque common, but may be translucent	7	None Characterized by conchoidal fracture with sharp edges	White to gray	2.6	• Wide variety of colors; "earth tones" more common • May have bands of variegated colors	Chalcedony (microcrystalline quartz)
	• Nonmetallic • Vitreous • Transparent to translucent	7	None Conchoidal fracture	White	2.65	• Colorless, white, or gray, but almost any color can occur • Hexagonal crystals with striations (growth lines) not uncommon • Also massive or granular	Quartz
	• Nonmetallic • Vitreous or resinous • Opaque to translucent	7 – 7.5	Poor Not usually seen	White to gray	3.65 – 3.75	• Color red-brown to brownish black • Tarnishes dull dark brown • Cross-shaped twins possible	Staurolite
	• Nonmetallic • Vitreous • Usually opaque • can be translucent	7 – 7.5	None Conchoidal fracture	White	3.0 – 3.25	• Color black, green, brown, pink • Can occur as long crystals with a triangular cross section • Crystal striations (growth lines) prominent	Tourmaline
	• Nonmetallic • Vitreous • Commonly opaque	9	None Occasional conchoidal fracture	White	4	• Color varies but commonly brown • Gray white • Barrel-shaped hexagonal crystals	Corundum

Mineral Identification Chart

Group C — Nonmetallic
- Does not scratch glass
- Has cleavage

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	• Pearly to dull, translucent	1	• One perfect cleavage	White	2.82	• Color pale green, also shades of white or gray • Greasy or soapy feel • Will mark on cloth	Talc
	• Vitreous/pearly • Transparent to opaque	2	• Cleavage good in one direction producing thin brittle sheets • Fracture may be fibrous	White	2.32	• Colorless to white, gray, red to yellow, brown • Bladed crystals common	Gypsum
	• Vitreous • Transparent to translucent	2 - 2.5	• Perfect Cubic – three at 90 degrees	White	2.2	• Colorless or white, blue, gray, yellow, red, or purple • Table salt taste	Halite
	• Vitreous to earthy	2.5	• Perfect cleavage forming flexible non-elastic sheets	White to pale green	2.7 – 3.3	• Green to greenish black • May have slippery feel	Chlorite
	• Vitreous to pearly	2.5 - 4	• Perfect cleavage forming thin, usually opaque, flexible and elastic sheets	White to gray	2.9 – 3.1	• Dark green, brown, to black	Biotite (Mica Group)
	• Vitreous to silky or pearly	2.5 - 4	• Perfect cleavage yields thin, translucent flexible and elastic sheets	White	2.8 – 2.9	• Colorless to shades of green, gray or brown	Muscovite (Mica Group)
	• Dull to vitreous • Transparent to translucent	3 – 3.5	• 2 cleavages – one perfect and one poor to fair	White or colorless	4.5	• White, red, brown, yellow, blue • Platy or bladed crystals, massive or in rose-like shapes	Barite
	• Vitreous • Transparent to translucent	3	• Perfect rhombohedral cleavage – three NOT at 90 degrees	White to gray	2.7	• Colorless and transparent, white, or variety of colors possible • Effervesces in cold dilute HCL, or when powdered in vinegar • Double refraction in transparent varieties	Calcite
	• Dull, resinous, vitreous or pearly	3 – 3.5	• Three good cubic cleavages – three at 90 degrees	White	2.9	• Clear, white, reddish, pale blue/gray	Anhydrite
	• Vitreous to pearly • Transparent to translucent	3.5 - 4	• Rhombohedral cleavage – three NOT at 90 degrees	White	2.85-3.2	• Colorless, white, pink, gray, greenish, or yellow-brown • Crystals common • Reaction with cold dilute HCL ONLY when powdered (does not react to vinegar	Dolomite
	• Resinous • Translucent to opaque	3.5 - 4	• Perfect cleavage in 6 directions (dodecahedral) • All 6 not commonly seen on one specimen • Cleavage faces common	Brown to light yellow or white	4.0	• Yellow brown to dark brown or black • Burnt match odor when scratched	Sphalerite
	• Vitreous • Transparent to translucent	4	• Perfect octahedral cleavage (4 planes – NOT at 90 degrees)	White	3.2	• Colorless but wide range of colors possible	Fluorite

Mineral Identification Chart

Group D — Nonmetallic — Does not scratch glass — No cleavage

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	• Pearly to greasy or dull luster, translucent	1	No apparent cleavage in massive varieties	White	2.82	• Pale green or shades of gray to white common • Greasy or soap feel diagnostic • Will mark on cloth	Talc
	• Opaque • Dull to earthy luster	2	No cleavage apparent in common massive varieties.	White	2.6	• Color white, often stained • Earthy smell when damp (like ceramic greenware)	Kaolinite
	• Earthy, opaque	1 – 5	None apparent	Brownish yellow	3.3 – 3.4	• Color variable: yellow, yellow-brown to brownish black • Common as earthy masses	Goethite (limonite)
	• Dull to resinous translucent to opaque	1.5 – 2.5	Brittle with no cleavage Sometimes conchoidal fracture	Pale yellow	2.1	• Yellow to red • Bright crystals or earthy masses • Smells like burnt matches	Native Sulphur
	• Vitreous to earthy translucent to opaque	2	No apparent cleavage in massive varieties	White	2.32	• White in color but impurities may cause shades of gray, brown, red, orange, or yellow • Massive fine-grained variety called alabaster	Gypsum
	• Earthy, dull, Commonly opaque	1 – 3	None	White to pale reddish brown	2 – 2.55	• White, gray, brick-red, to brown • Often has round concretions in a clay-like mass	Bauxite
	• Waxy, greasy or silky translucent to opaque	2.5	None Brittle with uneven and often splintery fracture	White	2.2 – 2.6	• Various shades of green, yellow or gray • Can occur as fibrous or platy masses • Smooth feel • Some varieties resemble snakeskin (hence the name)	Serpentine
	• Vitreous to earthy translucent to opaque	3 or less	No apparent cleavage in massive varieties	White	2.7	• White or various colors • Effervesces in cold weak HCL, or when powdered and exposed to vinegar	Calcite
	• Vitreous to earthy translucent to opaque	3.5 – 4	No apparent cleavage in massive varieties	White	2.85 – 3.2	• White or various colors • Reacts with cold weak HCL only when powdered	Dolomite
	• Earthy and opaque or vitreous crystals	3.5 – 4	Usually massive (has cleavage that is rarely seen)	Light blue	3.77	• Distinctive deep blue • Effervesces with weak HCL	Azurite
	• Earthy and opaque or vitreous crystals	3.5 – 4	Uneven splintery fracture common (one perfect cleavage, very rarely seen)	Green	3.9 – 4.03	• Green color • Effervesces with weak HCL	Malachite
	• Vitreous to subresinous translucent to opaque	5	Cleavage not obvious (One poor and direction difficult to see)	White	3.15 – 3.2	• Color variable: green, blue. brown, purple • Crystals common	Apatite
	• Submetallic to earthy, opaque	5 – 6	None	Brick red or reddish-brown	5 - 6	• Red to red-brown • Earthy appearance • Apparent hardness is lower in fine-grained, earthy masses which might be scratched easily	Hematite (soft iron ore)

Mineral Identification Chart

Group E — Metallic
- Scratches glass
- Streak color

Specimen No.	Luster	Hardness	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	Metallic	5 - 6	None	Brick red to red-brown	5.6	• Steel gray to black color • Tarnishes red • Often micaceous (tiny , glittering crystal flakes) or foliated • Brittle • May be weakly magnetic	Hematite (specularite)
	Metallic to dull	6	None	Black	5.2	• Dark gray to black in color • Strongly magnetic • Often massive • Oxidizes to a rusty brown	Magnetite
	Metallic to dull	6 – 6.5	None Uneven to conchoidal fracture	Greenish or brownish black	5	• Color commonly gold or brass-colored • Tarnishes brown • Cubic crystals with striated faces common • Brittle	Pyrite

Mineral Identification Chart

Group F — Metallic
- Does not scratch glass
- Streak color

Specimen No.	Luster	Hardness	Cleavage	Streak	S.G.	Other Properties	Mineral Name
	• Metallic to dull • Opaque	1 – 2	Perfect, but not obvious in massive specimens	Black, dark grey	2.1 – 2.25	• Color silver to dark gray to black • Greasy feel • Smudges fingers when handled • Writes easily on paper • Usually in foliated or scaly masses	Graphite
	• Metallic-often bright • Opaque	2.5	Apparent perfect cubic – three at about 90 degrees	Lead gray	7.5 – 7.6	• Shiny lead-gray color on unweathered surfaces • Cleavage, high specific gravity and softness diagnostic	Galena
	• Metallic • Opaque	3	None	Gray/black	5.06 – 5.08	• Color gray, oxidizes to iridescent blue/purple/gold/green • Common name - peacock ore • Usually massive	Bornite
	• Metallic • Opaque	3.5 – 4	None Brittle, uneven fracture	Greenish black	4.1 – 4.3	• Color brass-greenish yellow, often tarnished to bronze or iridescent • Usually massive	Chalcopyrite
	• Metallic to dull • Opaque	3	None Hackly fracture	Color of new pennies	8.9	• Copper color to dark brown • May oxidize green or black • Malleable and ductile • Irregular masses common	Native Copper
	• Submetallic to resinous • Opaque to translucent	3.5 – 4	Perfect in 6 directions (dodecahedral) All six are not commonly seen on one specimen.	White to light yellow, brown	3.9 – 4.1	• Color yellow to yellow-brown to dark brown • Cleavage faces common • Weak burnt match smell when scratched	Sphalerite
	• Metallic to dull • Opaque	5 – 5.5	Yes, but very rarely seen	Brownish yellow to orange-yellow	3.3 – 4.3	• Color yellow brown to dark brown, may be almost black • Brittle • Usually occurs as earthy masses • May seem very soft	Goethite

Demonstration Mineral Data Sheet

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
✓							Bornite
✓							Sphalerite
✓					Medium		Chlorite
✓							Topaz
✓							Tourmaline
✓							Malachite
✓		< 2.5	None	White		Yellow	Sulfur
✓	Nonmetallic vitreous	< 2.5	3 at 90 degrees	White		Translucent	Halite

Student Name ____________

Section ____________

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							

Mineral Data Sheet

Student Name ____________

Section ____________

Specimen No.	Luster	Hardness Number	Cleavage	Streak	S.G.	Other Properties	Mineral Name
14							
15							
16							
17							
18							
19							
20							
21							