Name: _____ Course/Section: _____ Date: _____

A All of the samples below are from Earth's crust (Figs. A3.1.1–Fig. A3.1.4). Record how many mineral grains you see in each sample (write 1, 2, 3, or many). Then make a numbered list of how many different kinds of minerals are in the sample and describe each one in your own words.

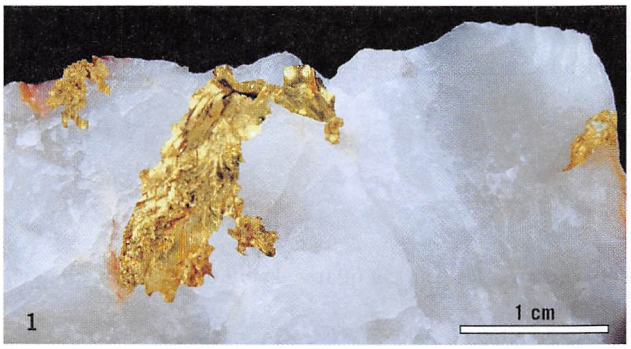

Figure A3.1.1 The white mass is a single mineral grain of milky quartz. How many **mineral grains** do you see in this sample? _____
List the number of different types of **minerals** in the sample and give a general description of each type of mineral:

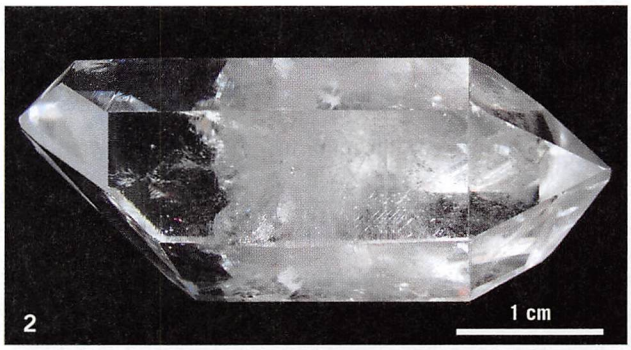

Figure A3.1.2 How many **crystals** do you see in this sample? _____
List the number of different **minerals** in the sample and give a general description of each type of mineral:

Figure A3.1.3 About how many **crystals** do you see in this sample? _____
List the number of different types of **minerals** in the sample and give a general description of each type of mineral:

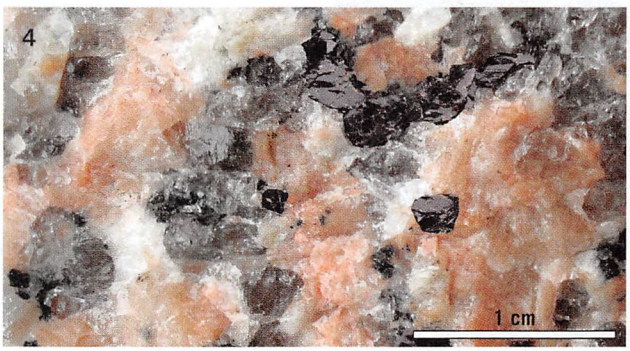

Figure A3.1.4 About how many **mineral grains** do you see in this sample? _____
List the number of different types of **minerals** in the sample and give a general description of each type of mineral:

B Which of these samples seems to have crystals of a valuable chemical element? _____ What element? _____

C **REFLECT & DISCUSS** Based on your observations in this activity, how are crystals, minerals, and rocks related to—and distinguished from—each other?

Activity 3.2 Mineral Properties

Name: _____ **Course/Section:** _____ **Date:** _____

A Indicate whether the luster of each of the following materials looks metallic (M) or nonmetallic (NM):

1. a mirror: _____ 2. butter: _____ 3. ice: _____ 4. a rusty nail: _____

B What is the streak color (i.e., color in powdered form) of each of the following substances?

1. salt: _____ 2. wheat: _____ 3. pencil lead: _____

C What is the crystal form or habit (**Figs. 3.5** and **3.6**) of the:

1. quartz in **Fig. 3.2A**? _____ 2. native copper in **Fig. 3.4**? _____

D Look up quartz in the Mineral Database (**Fig. 3.22**) to find a list of the varieties (var.) of quartz. Then identify each quartz variety below (**Figs. A3.2.1–A3.2.4**), and write its name beneath the image.

Figure A3.2.1
var. _____

Figure A3.2.2
var. _____

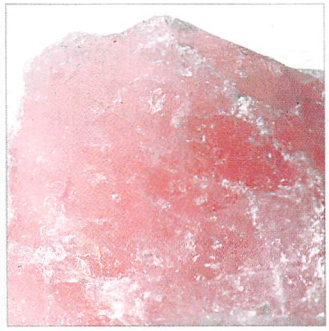

Figure A3.2.3
var. _____

Figure A3.2.4
var. _____

E A mineral can be scratched by a masonry nail or knife blade but not by a wire nail (**Fig. 3.14**).

1. Is this mineral hard or soft? _____
2. What is the hardness number of this mineral on Mohs Scale? _____
3. What mineral on Mohs Scale has such a hardness? _____

F A mineral can scratch calcite, and it can be scratched by a wire nail.

1. What is the hardness number of this mineral on Mohs Scale? _____
2. Which mineral on Mohs Scale has this hardness? _____

G The brassy, opaque, metallic mineral in **Fig. 3.3A** is the same as the mineral in **Fig. 3.13**. What is this mineral's hardness, and how can you tell?

H A mineral sample has a mass of 27 grams and takes up 10.4 cubic centimeters of space. What is the specific gravity of this mineral? Show your work.

I Analyze these two photomicrographs of ice crystals (snowflakes) by William Bentley (Fig. A3.2.5).

1. Both ice crystals have the same number of arms that radiate out from the center. How many arms do ice crystals have?

2. There are seven different crystal systems: triclinic, monoclinic, orthorhombic, tetragonal, trigonal, hexagonal, and cubic. Using the number of arms on a snowflake as a hint, what crystal system do ice crystals belong to? What is the basis for your interpretation?

3. Which of the crystal forms shown in **Fig. 3.5** or crystal habits shown in **Fig. 3.6** do you recognize in the ice crystals?

4. Why do you think ice crystals do not all have the same shape?

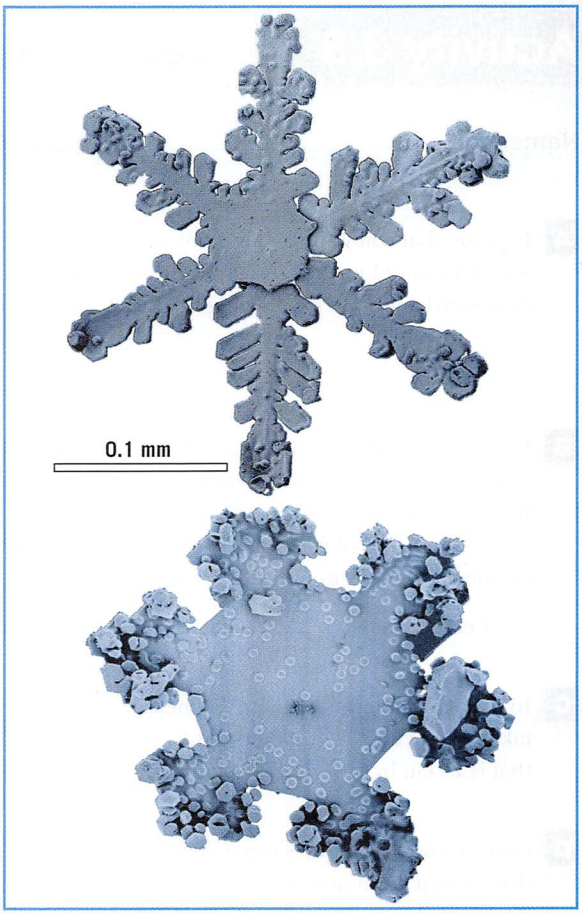

Figure A3.2.5

J Analyze each crystalline household material pictured below (Figs. A3.2.6–A3.2.8). (Use a hand lens or microscope to observe actual samples of the materials if they are available.)

Figure A3.2.6

Figure A3.2.7

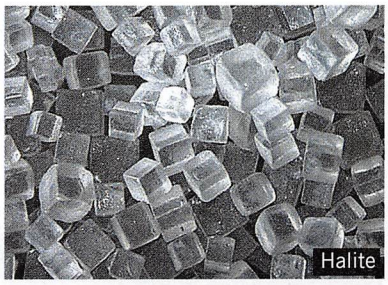

Figure A3.2.8

1. Sucrose (table sugar) displays the following crystal form(s) or habit (**Figs. 3.5** and **3.6**): _____

   How can you tell?

2. Epsomite (epsom salt) displays the following crystal form(s) or habit (**Figs. 3.5** and **3.6**): _____

   How can you tell?

3. Halite (table salt) displays the following crystal form(s) or habit (**Figs. 3.5** and **3.6**): _____

   How can you tell?

4. **REFLECT & DISCUSS** Which of these crystalline household materials (sucrose, epsomite, or halite) is not a mineral? Why not?

Activity 3.3 Determining Specific Gravity (SG)

Name: _____ **Course/Section:** _____ **Date:** _____

A Imagine that you want to buy a box of breakfast cereal and get the most cereal for your money. You have narrowed your search to two brands of cereal that are sold in boxes of the exact same size and price. The boxes are made of opaque cardboard and have no labeling of weight. Without opening them, how can you tell which box contains the most cereal?

B Like the cereal boxes above, equal-sized samples of different minerals often have different weights. If you hold a mineral sample in one hand and an equal-sized sample of a different mineral in the other hand, then it is possible to act like a human balance and detect that one may be heavier than the other. This is called **hefting**, and it is used to estimate the relative densities of two objects. Heft the three mineral samples provided to you, and then write sample numbers/letters on the lines below to indicate the sample densities from least dense to most dense.

(Least dense) _____ _____ _____ (Most dense)

C In more exact terms, **density** is a measure of an object's mass (in kilograms, kg) divided by its volume (how much space it takes up in cubic centimeters, cm^3). Density is usually expressed in units of g/cm^3. What is the density of a box of cereal that is 20 cm by 25 cm by 5 cm and has a mass of 0.453 kg? Show your work.

D Geoscientists sometimes use specific gravity to help identify an unknown mineral. Specific gravity is the ratio of the density of a mineral divided by the density of distilled liquid water, which we will assume to be 1 g/cm^3. Specific gravity is a dimensionless number. For example, the density of quartz is 2.6 g/cm^3, so the specific gravity of quartz is 2.6.
Return to the three mineral samples that you hefted above, and do the following:

1. First (while they are still dry), determine and record the mass of each sample in grams in Table A3.3.1.
2. Use the water displacement method to measure and record the volume of each sample (**Fig. 3.18**). Recall that 1 fluid milliliter (mL or ml on the graduated cylinder) equals 1 cubic centimeter.
3. Calculate the specific gravity of each sample.
4. Identify each sample based on the list of specific gravities of some common minerals (Table A3.3.2).

Sample	Mass in grams (g)	Volume in cubic cm (cm^3)	Specific gravity (SG)	Mineral name

Table A3.3.1

SG OF SOME MINERALS	
2.1	sulfur
2.6–2.7	quartz
3.0–3.3	fluorite
3.5–4.3	garnet
4.4–4.6	barite
4.9–5.2	pyrite
7.4–7.6	galena
8.8–9.0	native copper
10.5	native silver
19.3	native gold

Table A3.3.2

E **REFLECT & DISCUSS** Were your data and calculations accurate enough to be useful in identifying the samples? If not, how could they be made more accurate?

Activity 3.4

Name: _____ Course/Section: _____ Date: _____

Describe the samples provided by your teacher, using the table below.

MINERAL DATA CHART

Sample Letter or Number	Luster*	Hardness	Color / Streak	Cleavage / Fracture	Other notable properties; tenacity, magnetic attraction, reaction with acid, specific gravity, smell, etc	Name (Fig. 3.19, 3.20, or 3.21) and chemical composition (Fig. 3.22)	How do you depend on this mineral or elements from it? (Fig. 3.22)

*M = metallic or submetallic, NM = nonmetallic

Table A3.4.1

Name: _____ Course/Section: _____ Date: _____

Table A3.4.1 (*continued*)

Sample Letter or Number	MINERAL DATA CHART						
	Luster*	Hardness	Color / Streak	Cleavage / Fracture	Other notable properties; tenacity, magnetic attraction, reaction with acid, specific gravity, smell, etc	Name (Fig. 3.19, 3.20, or 3.21) and chemical composition (Fig. 3.22)	How do you depend on this mineral or elements from it? (Fig. 3.22)

*M = metallic or submetallic, NM = nonmetallic

Name: _____ Course/Section: _____ Date: _____

Table A3.4.1 (*continued*)

Sample Letter or Number	MINERAL DATA CHART						
	Luster*	Hardness	Color / Streak	Cleavage / Fracture	Other notable properties; tenacity, magnetic attraction, reaction with acid, specific gravity, smell, etc	Name (Fig. 3.19, 3.20, or 3.21) and chemical composition (Fig. 3.22)	How do you depend on this mineral or elements from it? (Fig. 3.22)

*M = metallic or submetallic, NM = nonmetallic

Name: _____ Course/Section: _____ Date: _____

Table A3.4.1 (*continued*)

Sample Letter or Number	MINERAL DATA CHART						
	Luster*	Hardness	Color / Streak	Cleavage / Fracture	Other notable properties; tenacity, magnetic attraction, reaction with acid, specific gravity, smell, etc	Name (Fig. 3.19, 3.20, or 3.21) and chemical composition (Fig. 3.22)	How do you depend on this mineral or elements from it? (Fig. 3.22)

*M = metallic or submetallic, NM = nonmetallic

Name: _____ Course/Section: _____ Date: _____

A Refer to the list of selected net nonfuel mineral resource imports by the United States (**Fig. 3.23**).

1. Based on **Fig. 3.23**, complete the table below (**Fig. A3.5.1**).

Element used to make cell phones	**Mineral ore(s)** from which it is extracted	How is the element used to make cell phones?

Figure A3.5.1

2. Would it be possible to manufacture cell phones in the United States if a world crisis prevented it from importing minerals and elements? _____ yes _____ no What evidence from **Fig. 3.23** supports your answer?

B Refer to **Fig. 3.23** and your uses of minerals recorded in your completed Worksheet 3.4. How might the lifestyle of U.S. residents change if they could no longer import the minerals and elements on which they depend 100% on foreign suppliers?

C **REFLECT & DISCUSS** What concerns do you have about reliance on foreign sources of essential minerals? Do you have similar concerns for U.S. sources of essential minerals that are controlled by private companies based in the United States? What if the companies are based elsewhere? How do your views change, if at all, when you consider manufacturing by U.S. companies in other countries where they can more easily access essential minerals?

Activity 3.6 Urban Ore

Name: _____ **Course/Section:** _____ **Date:** _____

A Recall that "ore" is a rock or mineral from which elements or compounds can be extracted at a profit. More than half of the gold mined in the United States is from mines in northern Nevada. These mines produced an average of 3.2 grams of gold per 2,000-pound short ton of ore in 2012.

1. Search the Internet for "New York spot gold price" in U.S. dollars (USD) per ounce, and enter it here. Note that ounces of gold are always quoted in troy ounces (ozt), but some people incorrectly report it as "oz." For example, the spot price was $1322.10 per troy ounce on July 24, 2016. What is the current spot price?

   NY spot gold price: _____

2. There are 31.1 grams (g) in 1 troy ounce (ozt). How many ozt of gold are extracted from 1 short ton of average Nevada ore? Show your work.

3. What is the gold worth (in USD) from 1 ton of the Nevada ore? Show your work.

4. It costs about USD $640 to extract 1 troy ounce of Nevada gold from the mine. So how much does it cost to mine and extract the gold from 1 short ton of the Nevada ore? Show your work.

5. Based on your answers in **3** and **4** above, what is the current average profit per ton of gold ore from northern Nevada?

B A typical smartphone contains 0.0012 grams of gold and weighs 3.951 ounces (avdp).

1. There are 16.00 ounces in 1 avoirdupois pound and 2,000 pounds in 1 short ton (avoirdupois ton). How many smartphones are there in 1 short ton? Show your work.

2. Based on your work above and the fact that there are about 0.0012 grams of gold in a typical smartphone, how many grams of gold are there in 1 short ton of smartphones? Show your work.

3. There are 31.1 grams in 1 troy ounce. How many troy ounces of gold are there in 1 short ton of smartphones? Show your work.

4. Based on the New York spot gold price in USD per troy ounce that you determined above (part **A1**), what is the current value of the gold in 1 short ton of smartphones?

C **REFLECT & DISCUSS** What materials besides cell phones could the U.S. recycle or mine as "urban ore" for metals noted in **Fig. 3.23**, and what impact would this have on the environment and the ability of the United States to sustain its need for metals and mineral ores?