Activity 19: The Density of Minerals

Maine Geological Survey

Objectives:

To have the students realize the usefulness of density as a physical mineral test; to have them gain practice in performing density tests.

Time:

This activity is designed to last one (1) class period.

Background:

Physical mineral tests are still extremely useful in field situations where limited equipment and resources often prevent the use of more sophisticated identification techniques. Like hardness, fracture/cleavage, streak, and luster, the density test is a very useful and simple test to perform which aids greatly in common mineral identification.

Specific gravity, which is virtually identical to density, is the ratio of the weight of a substance (mineral sample) to the weight of an equal volume of water at a specified temperature. Since most tests are performed at room temperature with ordinary tap water at ~ 20 degrees Celsius, it is assumed that the volume of the water in milliliters is identical to weight of the water in grams. Thus 45 ml of water weighs 45 grams. This assumption simplifies matters greatly. Due to the historical nature of most mineralogy textbooks, the term specific gravity (abbreviated Sp.Gr.) is still commonly used.

While there are a number of methods of determining density, the following is the simplest technique. Weigh a pure specimen of a mineral in air. Slide the sample into a graduated cylinder filled with water to a predetermined level. Observe the increase in the water level. Divide the weight of the mineral sample by the volume of the DISPLACED water and this equals the density.

Thus a 42 gram sample that displaces 11.6 ml of water has a density of:

$$\frac{42\text{g}}{11.6\text{ml}} = 3.62\text{g/ml}$$

The accepted values for the density of the minerals tested are as follows: quartz = 2.65, galena = 7.5, garnet = 3.5-4.3, feldspar (microcline) = 2.5-2.6

Materials:

Each group of students will need a 50 ml graduated cylinder, a 250 ml beaker, one sample of each of the following minerals - quartz, galena, microcline, garnet; pocket calculator, pens, and notebooks. The class as a whole will need access to pan or electronic balances with 300 gram minimum capacity. The mineral specimens need to be as pure as possible; small single crystals are ideal for this activity. Be certain that all specimens will slide easily in and out of the graduated cylinder.

Procedure:

Students should weigh each specimen and record its weight to two decimal places if possible. Fill the graduated cylinder with 20 ml of tap water. Discuss proper reading technique of the meniscus if students are not practiced in the use of graduates. Gently, so as not to spill or splash any water, slide the specimen into the graduated cylinder and below the level of the water. Record the INCREASE in the volume of water. Have students record this data in the data table and calculate the density of the mineral. Repeat this process for the other three mineral species. Be certain to refill the graduated cylinder to exactly the 20 ml mark before each new immersion. Have students look up the accepted values of density for the minerals they have tested. Record these values in the data table and compare. See student sheets. There are no special safety precautions for this activity.

Follow-Up:

If students are familiar with percent error calculations you may wish to have them calculate any degree of error associated with the activity and see if students can determine a REASON for the cause of the variation. The most common cause is an impure sample. For example, many galena samples contain varying amounts of silver which would change the density. The formula for % error is:

$$\%\text{Error} = \frac{\text{Standard Value} - \text{Experimental Value}}{\text{Standard Value}} \times 100$$

That is, the absolute value of the difference between the standard value and the experimental value, divided by the standard value multiplied by 100.

Have students "heft" a sample of pure quartz (density 2.65) in each hand, separately, and have them get a feel for it. Quartz is so common that it is easy to find pure samples in the field and it thus makes a good field standard. Once they have the feel for quartz, try pure samples of other common Maine minerals.

References:

Activity developed by Duane Leavitt.

Name___________________________

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Student Sheet

Purpose:

In this exercise you will learn to use density as a diagnostic property of minerals; you will also gain practice in calculating density.

Materials:

Each group of students will need a 50 ml graduated cylinder, a 250 ml beaker, one sample of EACH of the following minerals - quartz, galena, garnet, and feldspar; a pocket calculator, pens, and notebooks. The class will need access to balances for weighing.

Procedure:

Weigh one of the mineral specimens and record the weight to two decimal places if possible. Fill the graduated cylinder to the 20 ml mark with water. Tip the graduated cylinder so that it makes about a 45 degree angle with the table top and very GENTLY slide the mineral specimen into and totally below the surface of the water. Be careful not to splash any of the water. Return the graduated cylinder to the upright position; let the water come to rest and read the increased volume in the cylinder. Record this data. Calculate the density of the mineral by dividing the weight by the volume of water displaced. Carefully pour the mineral out of the cylinder; refill the cylinder with water to the 20 ml mark. Repeat this process for the other minerals you are to test, making certain to fill the water level back to 20 ml before each new test.

Specimen	Quartz	Galena	Garnet	Feldspar
Weight (g)				
Volume of Water displaced (ml)				
Calculated density				
Class Average				
Listed density				

Questions:

1. What are the units associated with the calculation for density? What do these units mean?

2. Do ALL of your density values agree with the standard values listed in your textbook or provided by your teacher? If the answer in so, explain why this variation may exist?

3. Look up the formula for the mineral tourmaline, record it below. What do you think happens to the density of tourmaline crystals as the amount of iron in them increases?