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Title: Lab Activity: Mineral Identification by Density Determination

Subject: Measurement of a Physical Property used for Qualitative Analyses

Grades: 8-12

Description: Students will be divided into groups and each group will receive an unknown mineral sample that is to be identified by finding its specific gravity. The students are required to perform and record data for density analyses on their samples in triplicate. If their analyses show reasonable precision, each group will attempt to identify its mineral by comparing the average experimental value with values of known minerals. Otherwise, they will need to repeat the procedure. Although the groups of students only have 3 different minerals to test, there are 8 different minerals listed on the specific gravity chart. This makes accuracy a crucial factor in the students' investigations, since an incorrect density value will probably result in a misidentification.

Length: 1 class period

Objectives: Students will develop an understanding that:

1.) Substances can be identified by physical properties.
2.) Good precision and accuracy are important when measuring.
3.) The application of science for a useful purpose is technology.
4.) Density is a mathematical relationship of mass and volume.

Materials:
1.) student activity handouts and report sheets
2.) mineral samples to be tested
3.) balances accurate to at least 0.1 g
4.) 50-100 ml graduated cylinders

Procedure: After presenting the concept of density and demonstrating how to perform an experimental density determination, the students will solve practice density problems. This will probably require one class period. For homework they will be assigned to read the *Mineral Identification* handout in preparation for the lab activity. The following day they will receive their report sheets and perform the activity.

Scientific Explanation:

Since the mineral samples form irregular shapes, the sample volumes need to be determined using a water displacement method. Each sample should be small

enough to fit inside a 50 or 100 ml graduated cylinder for ease of measurement. A balance that is accurate to 0.1 g is fine for this activity because students' accuracy will be limited by their ability to correctly estimate sample volumes to 0.1 ml using the graduated cylinders. Additionally, most minerals have a range of specific gravity values, so there will usually be some uncertainty in matching experimental values to those listed in the table. However, with careful measurement students should achieve reasonably good precision. If their tests are performed in triplicate and percent spread values are in the 5 % range, then their results should be fairly accurate.

Assessment: 3 points - experiment performed in triplicate
3 points - measurements contain correct numbers of significant figures
3 points - correctly calculate the average experimental value
3 points - correctly calculate the percent spread
3 points - correctly identify unknown mineral
3 points - correctly calculate percent error (based on students' results)
3 points - neatness

{21 point total}

Kansas Science Standards:

Standard 1, Benchmark 1, Indicator 3: The student correctly uses the appropriate technological tools and mathematics in their own scientific investigations.
Standard 5, Benchmark 1, Indicator 1: The student understands technology is the application of scientific knowledge for functional purposes.

Mineral Identification - *(a practical application of density)*

Geologists routinely identify minerals by their physical properties. The most common method of identification is simply "looking" at a sample. Frequently, however, a mineral's appearance is not enough information to make a positive identification and additional analyses must be performed. One of the standard methods of mineral identification is a determination of "specific gravity". This is a geologist's term for density.

In this experiment you will be given several unknown minerals. Your challenge is to identify the minerals according to specific gravity, which you are to determine experimentally. Your mineral samples are among those listed in the data table below, but be cautious! Some minerals have nearly the same values for specific gravity, so you must exercise careful laboratory procedures to insure good precision and accuracy.

Record your experimental data, calculations, and conclusions on a separate page. Your calculations should include the experimental density values, the average experimental values, and an evaluation of your analytical precision. Your conclusion will be the names of the unknown minerals! Assuming your conclusions are correct, calculate your accuracy as percent error using values from the table below for the accepted values of specific gravity. Your finished report should be both neat and thorough.

Mineral	**Composition**	**Specific Gravity** (g/cm^3)
sphalerite	(Zn,Fe)S	3.9 - 4.2
chalcopyrite	CuFeS2	4.2 - 4.3
marcasite	FeS2	4.8 - 4.9
pyrite	FeS2	5.0 - 5.2
antimony	Sb	6.7
galena	PbS	7.2 - 7.6
silver	Ag	10.0 - 12.0
gold	Au	15.3 - 19.3

unknown # _____

trial 1 H_2O vol. with sample =
H_2O vol. w/o sample =
_____

sample volume = sample mass =

density - trial 1 *(show calculation)*

trial 2 H_2O vol. with sample =
H_2O vol. w/o sample =
_____

sample volume = sample mass =

density - trial 2 *(show calculation)*

trial 3 H_2O vol. with sample =
H_2O vol. w/o sample =
_____

sample volume = sample mass =

density - trial 3 *(show calculation)*

Results: average density *(show calculation)*

precision *(show % spread equation and all math)*

mineral name =

accepted sp. gravity value =

accuracy *(show % error equation and all math)*