Identifying Minerals Using Hardness and Density

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2017

Key Concept: Density and hardness are two of several physical mineral properties that are easily investigated and can be used to identify minerals. Density and hardness are ***intrinsic physical mineral*** properties that relate to the composition of the mineral and to the pattern in which the mineral's atoms are arranged. ***Intrinsic*** means that the property is the same for the mineral no matter what the color, size or shape of the sample. For example, the harness of halite (salt) will always be 2.5 and the specific gravity, or density, will always be 2. Please note that these properties may be different depending on how pure you mineral sample is.

Skills: Observing, Investigating, Measuring, Recording, Classifying, Communicating, Calculating

Time: 45 minutes to one hour, depending on number of samples

Objective: To determine the density and relative hardness of unidentified minerals and to make reasoned speculation as to their identities on the basis of data gathered.

Materials:
Large paper to cover desk and arrange minerals on
Assortment of minerals
Mineral worksheet
Mineral properties sheet
Mohs scale of hardness
Steel nail
Copper penny
Porcelain (streak) plate
1-2 liter graduated cylinder with gradations of no more than 10 mL
Scale capable of weighing about 1-200 grams
Calculator

Procedure: Lay out minerals on the sheet of paper to protect the surface of the desk or table. Observe the minerals, looking at their shape, size and color. Scratch the minerals on the streak plate and note the color of the streak. Note that some minerals are harder the streak plate and will actually scratch the place. It is important to determine if the mineral is leaving a while streak, or if the mineral is scratching the streak plate.

Although you can start with either the hardness or density portion of the activity, it might be easier to start with hardness because the samples will be dry.

Part 1: Hardness

- Using your tools (fingernails, penny, steel nail, etc.) scratch each mineral to determine a hardness range, e.g., harder than a fingernail, softer than a steel nail.
- Start arranging the minerals in order from softest to hardest

- Remember, a mineral can scratch the surface of any other mineral that has a lower hardness than itself. You can further constrain the relative hardness of the minerals by scratching them against each other.
- Consult the Mohs scale to find a numerical value or range that fits the specimen and record the hardness for each mineral on the sheet.

Part 2: Density

You can estimate the density of minerals by using your senses of sight and touch. You should be able to determine the relative density of the minerals by comparing their size (estimated by sight) to how heavy they feel in your hand. Handle your samples to get an idea of how dense each one is, or how heavy each mineral feels for its size.

To determine the actual density of a mineral, you divide the mass or weight of a sample by its volume. Written out, the formula for calculating density is:

$$D = M/V$$

Where D = density (g/mL), M= mass (g), and V=volume (mL)

The mass of each sample is measured using a balance or electronic scale. The volume of each sample can be measured (in milliliters) by the amount of water displaced by the sample in a graduated cylinder.

- Weigh each sample (in grams) and record on the sheet
- Fill graduated cylinder with water and note starting volume (in mL)
- Gently place sample in cylinder and record the change in volume (in mL) subtract your starting volume from the final volume to get the volume measurement for your sample.
- Use the formula mass/volume to determine density
- Record the density for each sample on your sheet

Note: You can leave the sample in the water and add your next sample (providing that it can be completely submerged). The starting measurement should be the same as the final measurement from the previous sample.

To determine the unknown mineral name:

- Use the mineral ID sheet to compare properties of the known named minerals with your unknown minerals.
- Minerals with the same (or very similar) density may have quite different hardness values and vice-versa.
- Luster and/or cleavage sometimes can help with identification.

Compare your results with the key provided by the instructor. Where are some sources of error? How would you modify this activity for your classroom?