Rock Density Lab

by

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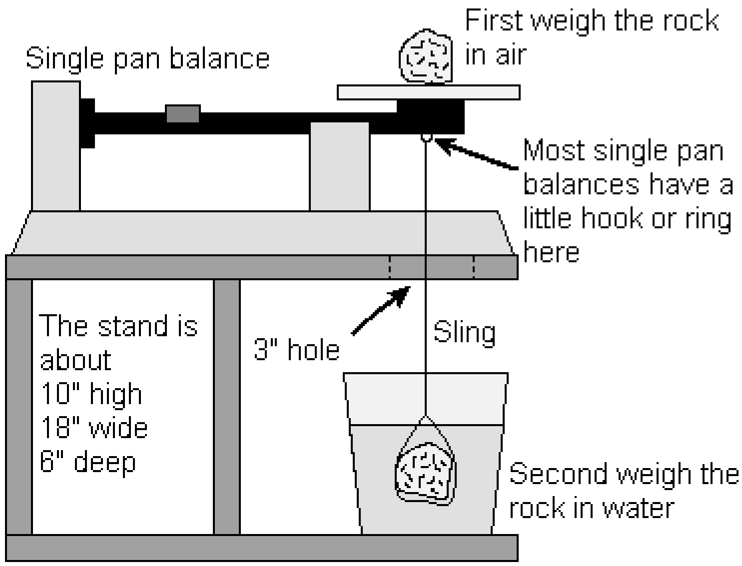
Introduction:

Density is one of the most fundamental properties of geological materials, from rocks to water to air. Minerals on Earth have a rather limited range, from about 2.0 g/cc for some zeolites (~0.9 for ice) to 7.6 g/cc for galena (22.6 for native iridium). Rocks, which are masses of various minerals, have an even more restricted range of density. Density is easy to measure and can be used to help teach the use of graphs and math.

NOTE: I use the word density here, even though what you will actually measure is "specific gravity". Density is mass per unit volume (such as grams/cubic centimeter). Specific gravity is a dimensionless number (no units), since it is the ratio of the weight of a rock to a weight of an equal volume of water (weight units cancel). Specific gravity values are very close to those of density, so there is no practical difference for classroom purposes.

Materials:

1. A single pan balance or balances, number depending on how many are available and how you want to run the exercise. Check the maximum weight the balances can measure, since this limits the maximum weight of rocks that can be weighed (most are ~500 g).
2. Paper for data tables.
3. A collection of different rock types and sizes. A good size range is from golf ball size to half the size of a fist.
4. A beaker or jar of water big enough to hold the largest rock easily.
5. Some thin wire, fishing line, or thick thread (not string) to make a sling to hold the rocks suspended in the water.
6. A stand for the balance. Here is what the set up looks like:



Procedure:

Students weight a variety of rocks in air, then suspended on the sling in water, tabulating the weights as they proceed. The sling should stay in the water at all times, even when the rock is being weighed on the pan. The data table might look like this:

Sample	Rock type (optional)	Rock weight in air (g)	Rock weight in water (g)	Rock density, g/cc
A	Granite	152.3	97.2	2.76
B	Granite	481.1	305.5	2.74

Density is calculated like this:

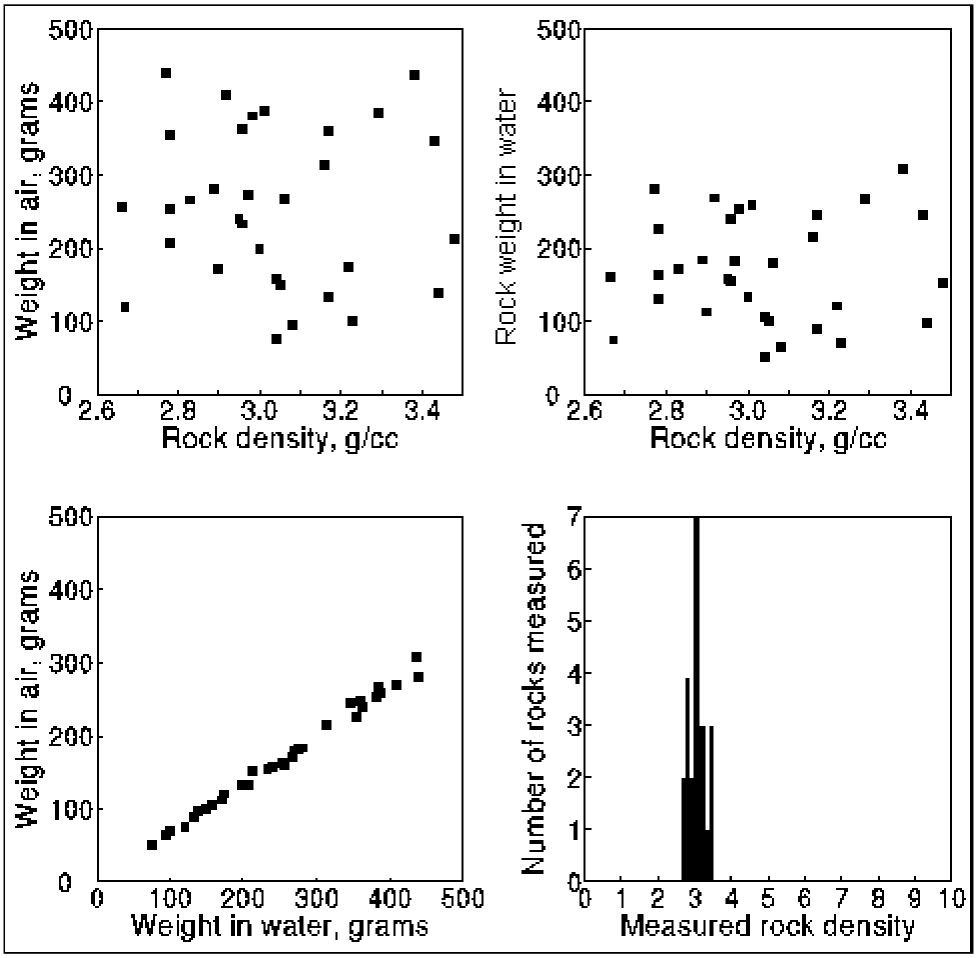
Density = (Weight in air) / [(Weight in air) - (Weight in water)]

You can see that the rock weights are very different but the densities are almost the same, just as you would expect for similar kinds of rocks that have different sizes. Reasonable care should be able to yield densities that are correct to ±1% or 0.03 g/cc.

Related work:

Students can make X-Y scatter graphs (shown below) of rock weight in air, weight in water, and density, and can also make a histogram of the densities found. As can be seen in the figure below, rock weight in air and density have no correlation. This is because density is a property of a rock, whereas the rock weights depended mostly on the size of the rock chosen. The same is true for rock weight in water and rock density; no correlation. Rock weight in air and weight in water are strongly correlated, however, since all common rock densities are similar, about 3 g/cc. The histogram shows that, although a wide range of densities are possible, common rocks span only a narrow range.

Notice that rocks weigh less in water than in air. This is because of buoyancy. Water, with a density of 1 g/cc, buoys up anything within it by 1 gram per cubic centimeter of displacement. For example, the mass of water displaced by a floating ship equals the mass of the ship; the displaced mass of water below the hull pushes up and floats the ship. The volume of water displaced by a stone is the amount of buoyancy the stone has in water. Also, the weight difference in grams between a rock in air and in water is the same as the volume of the rock in cubic centimeters. What would happen of the density of a ship was >1 g/cc?



Before or after measuring the rock densities students can identify the rocks. Do the different rock types have different densities? In general they do, although the differences are small. One way to do this is to line up all the rocks from densest to least dense, and see if rock types at one end of the line are different from the rock types at the other end.

Rock type	**Typical density**
Granite	2.8 g/cc
Gabbro	3.1 g/cc
Limestone	2.7 g/cc
Sandstone	2.6 g/cc

Several students or groups of students could measure the density of one rock. The different values are then averaged, and the maximum value and minimum value examined. The density range between the maximum and minimum values is a measure of the analytical error, or uncertainty of each measurement. A more sophisticated value of measurement error is the standard deviation of the mean (average), a function most scientific calculators have. This is important since all measurements have inherent uncertainty. No measurement is perfect.

Internet links:

- What is the difference between a continent or an island: size or crust density?
- How Much Rock is in an Icy Moon? Another exercise!
- How much rock is in an icy moon? Voyager probe measurement!

Science labs web page
Pedagogy web page

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