

DENSITYINTRODUCTION

Density is one of the most important properties of all matter. Simply defined, density is the amount of matter (“mass”) in an amount of space (“volume”)

$$D = m / v$$

We usually measure mass in grams (g) and volume in cubic centimeters (cm³).

The importance of density lies in the fact that when there are two objects with different densities and **phases**, the more density will sink. The fact that you are here at the bottom of the ocean of air is one trivial example. Also, when two fluids (liquids or gases) have different densities, the less dense will rise. “Warm air rises, cool air sinks.” This is the physical basis for much of our weather.

Differences in density inside Earth’s crust and upper mantle involving **molten** rocks are behind volcanic eruptions and the slow, massive movement of **crustal plates** that create oceans and continents. Large-scale, long-term circulation of ocean water that affects climate are also among the many other examples of density-driven circulation patterns that produce our world.

ACTIVITY: DETERMINING THE DENSITY OF FIVE MINERALS AND ROCKS

In this activity, you will determine the densities of five mineral and rock **specimens**. Finding the mass is easy—use a **balance scale**. Finding the volume is not so easy because they have irregular shapes. But a Greek scientist who lived about 2,500 years ago discovered a way to measure volumes using the **water-displacement** method.

There are two ways you can do this:

- 1) Fill a **graduated beaker** or **cylinder** to a marked level (such as 100 mL). Slowly put the specimen in, and record the new water level, making the best estimate you can. Subtract the two to find the volume.
- 2) Place the specimen in an empty beaker or cylinder. Carefully add water until the specimen is completely covered and record the water level. Then slowly removed the specimen and record the new level. Subtract to find the volume.

The five mineral and rock specimens you are using are:

Quartz

Calcite

Galena

Granite

Basalt

Procedure:

Before you begin:

Examine the samples and predict their order of densities, from least to greatest. Give a reason for your prediction.

1. Obtain a set of specimens, balance scale, beaker, cylinder, calculator, and paper towel.
Have access to water.
2. Find the mass and volume of your samples, then calculate the density ($D = m / v$)

Mineral/rock	mass (g)	volume (cm ³)	density (g/cm ³)	Class average density
Quartz				
Calcite				
Galena				
Granite				
Basalt				

3. Share your results with the rest of the class, then calculate and record the averages for each specimen.
4. Discuss possible sources of error.

5. "Percent error (also called percent deviation)"

Scientists often try to determine the percentage a result varies from an "accepted" value. The "accepted" value is one that has been very accurately measured many times over a long period, and can be considered "correct." There are many reasons why an individual or even group result may differ from the "accepted" value, and in serious science investigations, these have to be identified.

To find percent error or deviation, we use this equation:

$$\% \text{ error/deviation} = [(\text{"accepted" value} - \text{"measured" value}) / \text{accepted" value}] \times 100\%$$

For example, if the "accepted" value is 2.5 (g/cm³) and students measure 2.3 (g/cm³), the

$$\% \text{ error} = (2.5 - 2.3 / 2.5) \times 100\% = 0.08 \times 100\% = 8\%$$

The table below provides the "accepted" values for the materials used. Calculate the percent error for your individual measurements and the class averages.

"Accepted" value	Percent deviation from your individual result	Percent deviation from class average
Quartz: 2.7 g/cm ³		
Calcite: 2.3 g/cm ³		
Galena: 7.5 g/cm ³		
Granite: 2.7 g/cm ³		
Basalt: 3.0 g/cm ³		

Explain possible reasons for the deviations:

This image shows a single sheet of white paper with horizontal blue ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.
