

# Density

Name \_\_\_\_\_

## Introduction:

Mass is a measurement of the amount of matter in a sample, volume is a measurement of the space occupied by a sample of matter. In this investigation, you will measure the mass and volume of several substances. You will then calculate the density of these samples. Once density is determined you will compare your results with those of the rest of the class.

Mass may be measured on balances of different types. Today you will use an electronic centigram balance.

Volume can be determined in a variety of ways depending on the substance being measured. A solid with a regular geometric shape may be measured for length, width, height, diameter and the volume can then be calculated using the appropriate equation. A solid with an irregular shape needs to be evaluated by a method called water displacement. This is done by first accurately measuring a given amount of water in a graduated cylinder. Then submerging the sample in the water and determining the change in the overall volume.

For liquids, you will place a graduated cylinder on the balance and determine its mass or tare the balance. Then add a given amount of liquid to the cylinder and reweigh. The mass of the liquid is determined by subtracting the mass of the empty cylinder by the combined mass.

## Objectives:

1. To determine the mass and volume of several samples of matter using the centigram balance and the method of water displacement as well as length, width, height, and diameter.
2. To determine whether there is a constant relationship between the mass and the volume of samples of a substance.
3. To calculate the density of a substances from mass and volume.

## Solids

### Regular Geometric Shapes

1. Measure length, width, height and diameter as needed.
2. Carefully determine the mass of each sample on the electronic balance.

### Irregular Shapes

1. Carefully determine the mass of each sample on the electronic balance. **(Before determining volume)**
2. Start with a given volume of water in a 100 mL graduated cylinder.
3. Submerge the sample in the cylinder. Record the new volume.
4. Subtract the difference in volume to determine the volume of the sample.

## Liquids

1. Determine the mass of an empty graduated cylinder.
  2. Add a given volume of liquid to the cylinder and determine the new mass. **(Not over the balance)**
  3. Record the volume used.
  4. Subtract the difference in mass to determine the mass of the liquid alone.
- (For this lab we will return the liquids to their original container as they are only used for this lab.)

Enter all data collected into the table provided.

| Description        |                             | Measurements   |                       |                       |                | Calculations                 |         | Accepted | % error |
|--------------------|-----------------------------|----------------|-----------------------|-----------------------|----------------|------------------------------|---------|----------|---------|
| Rectangular Blocks |                             | mass(g)        | length<br>(cm)        | width<br>(cm)         | height<br>(cm) | volume<br>(cm <sup>3</sup> ) | DENSITY | DENSITY  |         |
|                    | Aluminum                    |                |                       |                       |                |                              |         |          |         |
|                    | Copper                      |                |                       |                       |                |                              |         |          |         |
|                    | Zinc                        |                |                       |                       |                |                              |         |          |         |
|                    | Brass                       |                |                       |                       |                |                              |         |          |         |
|                    | Steel                       |                |                       |                       |                |                              |         |          |         |
|                    | Wood                        |                |                       |                       |                |                              |         |          |         |
| Cylindrical Solids |                             | mass(g)        | diameter<br>(cm)      | (radius)              | height<br>(cm) | volume<br>(cm <sup>3</sup> ) | DENSITY | DENSITY  |         |
|                    | Lead                        |                |                       |                       |                |                              |         |          |         |
|                    | Copper                      |                |                       |                       |                |                              |         |          |         |
|                    | Aluminum                    |                |                       |                       |                |                              |         |          |         |
|                    | Tin                         |                |                       |                       |                |                              |         |          |         |
|                    | Zinc                        |                |                       |                       |                |                              |         |          |         |
|                    | PVC (blue) (# )             |                |                       |                       |                |                              |         |          |         |
|                    | Polypropylene (red)<br>(# ) |                |                       |                       |                |                              |         |          |         |
|                    | Wood                        |                |                       |                       |                |                              |         |          |         |
| Irregular Solids   |                             | mass(g)        | volume<br>(w ater)    | volume<br>(together)  | volume<br>(mL) | volume<br>(solid)(mL)        | DENSITY | DENSITY  |         |
|                    | Lead                        |                |                       |                       |                |                              |         |          |         |
|                    | Zinc                        |                |                       |                       |                |                              |         |          |         |
| Liquids            |                             | volume<br>(mL) | mass(g)<br>(cylinder) | mass(g)<br>(together) | mass(g)        |                              | DENSITY | DENSITY  |         |
|                    | Water                       |                |                       |                       |                |                              |         |          |         |
|                    | Ethyl Alcohol               |                |                       |                       |                |                              |         |          |         |
|                    | Propylene Glycol            |                |                       |                       |                |                              |         |          |         |

## Accepted Values

1. Using a table of properties, find the accepted values for the densities of these substances

Aluminum  
Copper  
Lead

Tin  
Zinc  
Iron

2. The accepted values for the following are given here.

|                  |                         |
|------------------|-------------------------|
| PVC              | 1.406 g/cm <sup>3</sup> |
| Polypropylene    | 0.91 g/cm <sup>3</sup>  |
| Water            | 1.00 g/mL               |
| Ethyl alcohol    | 0.810 g/mL              |
| Propylene glycol | 1.036 g/mL              |

|                            |                        |
|----------------------------|------------------------|
| Brass (alloy of Cu and Zn) |                        |
| Steel (primarily iron)     |                        |
| Oak                        | 0.85 g/cm <sup>3</sup> |
| Pine                       | 0.45 g/cm <sup>3</sup> |
| Balsa                      | 0.12 g/cm <sup>3</sup> |

Determine the percent error in the results for density for all of your materials.

$$\% \text{ error} = \frac{|\text{accepted value} - \text{experimental value}|}{\text{accepted value}} \times 100$$

## Questions:

1. Using results for the density of Aluminum from several lab groups, what generalization can you make about the values determined by the class?
2. Explain how density might be used to identify a substance.
3. In the objectives we mentioned the “constant relationship between the mass and volume of samples of a substance”. What is the “constant relationship” between mass and volume of a substance?
4. What do you suppose led to the greatest experimental error in this investigation?
5. Who is Archimedes? What significance would his findings have with regard to this lab?