Lab Exercise: Density Names: _____

We speak of a dense forest (many trees in a small space) or a densely populated area (many people in a small space). The same number of objects, spread out over a larger space would give a lower density. Mathematically, density is expressed as a ratio:

$$\text{Density} = \frac{\text{number of objects}}{\text{amount of space available}}$$

In science, we use the term **density** to describe the amount of mass packed into a certain amount of space. For example, a cast-iron skillet is heavier than an aluminum skillet of the same size because iron is a more dense metal than aluminum. (On an atomic scale, this is determined by the mass of each individual atom and how tightly the atoms are packed together). The density definition can thus be written:

$$\text{Density} = \frac{\text{mass}}{\text{volume}} \qquad \text{metric density units: } \frac{\text{g}}{\text{mL}}$$

Materials vary widely in density, as you can see by the table below.

Table I: Densities of common substances in (g / mL) (20^{o}C unless otherwise noted)

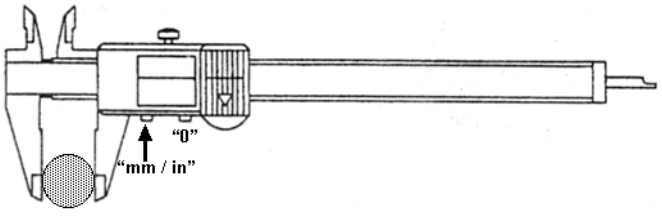
Substance	Density (g/mL)	Substance	Density (g/mL)
Gold	19.3	Seawater	1.03
Mercury	13.5	Pure water (4^{o}C)	1.00
Lead	11.4	Ice (0^{o}C)	0.92
Iron	7.9	Gasoline	0.70
Diamond	3.5	Wood (pine)	0.50
Aluminum	2.7	Air	0.0012

These densities were determined by measuring the mass and the volume of a sample of the material and "dividing out" the results. For example, a piece of aluminum with a mass of 13.77 grams and a volume of 5.1 mL would give the density of 2.7 g/mL shown on the chart (13.77 g / 5.1 mL). Thus, the density means that 2.7 grams is the mass of 1 mL of aluminum. Also remember that 1 mL is the same thing as 1 cc or 1 cm^3 thus g/mL is the same thing as g/cc or g/cm^3.

Determination of the density of regular solids:

Thus far, you have used a ruler to measure lengths, but calipers are easy to use, and more accurate. You will use them in this lab. Our calipers read either in inches or in millimeters. We will record our readings in mm for this experiment. Because the measurements need to be in cm to calculate the volume, you will need to convert your measurements from mm to cm. Note that 10 mm = 1 cm. Thus, a measurement of 12.65 mm would be equal to 1.265 cm.

Caliper Picture:



Directions for the use of calipers:

1. Close the calipers using the wheel to the right of the display panel.
2. Turn the calipers on by pressing the "mm/in" button. (If the display does not come on, the battery must be replaced. Bring the calipers to your instructor.)
3. Press the "0" button to zero the display. The display should read 0 mm, NOT in for inches.
4. Without touching the "0" button, open the calipers and insert the object to be measured in the lower part of the caliper jaws. Close the jaws snugly around the object like a clamp, and write down **all** the numbers for the measurement. Make sure the calipers are in mm, not inches.
5. Record the measurement in mm. Be sure to record **all the numbers** on the display.

Your tray contains two solid metal cubes of approximately equal volume. Measure the length, width, and height of each cube in mm. (In a perfect cube, the sides should be the same length, but check to make sure). Then convert your measurements to cm as shown on page 1.

Cube #1 Length _____ mm = _____ cm

Width _____ mm = _____ cm

Height _____ mm = _____ cm

Cube #2 Length _____ mm = _____ cm

Width _____ mm = _____ cm

Height _____ mm = _____ cm

Calculate the volume of each cube using your **cm** measurements (l x w x h). The unit for your answer will be cm^3.

Cube #1 _____ cm^3 Cube #2 _____ cm^3

Determine the mass of each cube on our balances. Remember to record **all** the numbers displayed.

Cube #1 = _____ g Cube #2 = _____ g

Calculate the density of each cube. (grams/cm^3).

Density of cube #1 =_____ g/cm^3 **Density of cube #2 =_____ g/cm^3**

Your tray also contains a metal slab. It may be made out of the same metal as one of the cubes, or a different metal entirely. You can determine this by comparing densities.

Mass of the slab _____ grams

Length _____ mm = _____ cm Volume = _____ cm^3

Width _____ mm = _____ cm

Height _____mm = _____ cm

Calculate the density of the slab: **Density slab =_____g/cm^3**

Is the slab made out of the same metal as either cube? _____ If so, which one? _____

Determination of the density of a liquid.

A liquid also has a density. Oil will float on water because they don't mix and oil is less dense than water. The denser liquid is the bottom liquid!

To determine the density of a liquid, you must measure the mass and volume of a sample of the liquid, and divide the numbers like you did for the solids. The most convenient container to use for this is a graduated cylinder, because when you add the liquid to it, you can read the total volume of liquid from the volume marks on the cylinder.

Determine the density in g/mL of an unknown liquid according to the procedure below.

Wear goggles when handling chemicals or glassware!

Procedure for Finding the Density of a Liquid

1. Obtain an unknown from the supply cart. Record its number below.
2. Put the dry empty 10.00 mL graduated cylinder on the balance and **re-zero** by hitting the O/T button so the balance says 0.0000g. Stay at this balance, don't let anyone else use it until you are done.
3. Remove the 10.00 mL graduated cylinder from the balance and don't touch any buttons. Use a disposable pipet to transfer about 3 to 4 mL of liquid into the graduated cylinder. Read and record the **exact volume** of the liquid to 2 decimal places below.
4. Now weigh the graduated cylinder with the liquid in it. Record **all the numbers** below.
5. Remove the cylinder and liquid from the balance. Pour the liquid and any leftover liquid down the drain. Rinse your graduated cylinder with water and the unknown container with water several times. Return the empty unknown container to the cart by the instructor's desk.
6. Calculate the density using the data below. Round off your answer to two decimal places.

Unknown number #_____

	Trial #1
Mass liquid	g
Volume liquid	mL
Density	g / mL

Problems:

1. Suppose you have a block of wood that is 2.0 cm by 4.8 cm by 0.85 cm.
    a. What is its volume? Pay attention to the units.

    b. The wood has a mass of 4.9159 grams. Calculate its density below.

2. Bromine is one of the few liquid elements. Calculate its density if 14.0 mL of a bromine sample has a mass of 43.7 grams.