DENSITY

- Density is a measure of the concentration of matter; of how much matter is present in a given space

- Density is defined as the MASS per unit VOLUME, or ...

$$\text{Density} = \frac{\text{mass}}{\text{Volume}}$$

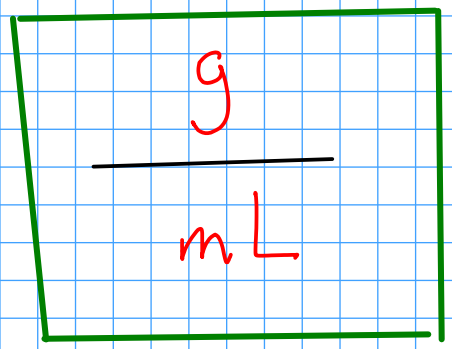
UNITS?

metric mass unit = kilogram

metric volume unit = cubic meter

So, density unit = $\frac{kg}{m^3}$

In the lab, we typically measure masses as grams and volumes as milliliters, so the density unit we will use most often is:

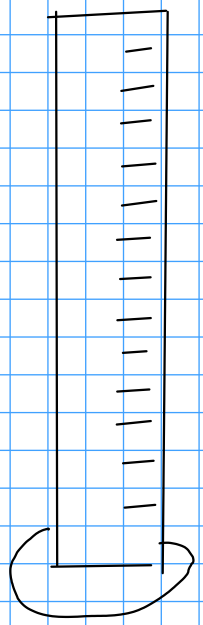


A useful density to remember:

WATER at room temp: Density = 1 g/mL

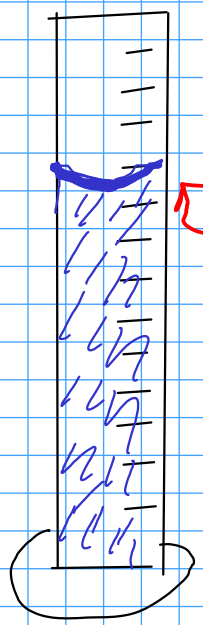
Measuring density

... of a liquid



1) Measure mass of empty cylinder

mass = 97.35 g



2) Fill cylinder and measure volume of liquid

volume = 25.3 mL

3) Measure mass of filled cylinder

mass = 130.55 g

4) Subtract to find mass of liquid

$$\begin{array}{r} 130.55\ \text{g} \\ -\ 97.35\ \text{g} \\ \hline 33.20\ \text{g} \end{array}$$

5) Density = mass liquid / volume liquid

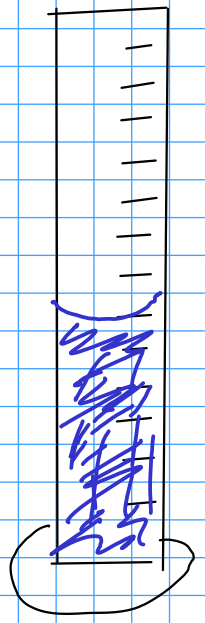
$$\text{Density} = \frac{33.20\ \text{g}}{25.3\ \text{mL}}$$

$$= 1.31\ \text{g/mL}$$

...of an object

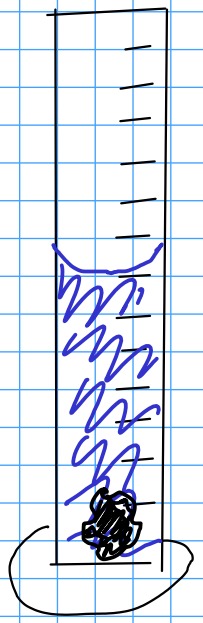
1) Measure mass of object

mass = 9.78 g



2) Partially fill cylinder with liquid, record volume.

volume = 25.0 mL



3) Put object into cylinder, record new volume

volume = 26.6 mL

4) Subtract to find volume of object

$$\begin{array}{r} 26.6\ \text{mL} \\ -25.0\ \text{mL} \\ \hline 1.6\ \text{mL} \end{array}$$

5) Density = mass object / volume object

$$\text{Density} = \frac{9.78}{1.6}\ \frac{\text{g}}{\text{mL}}$$

$$= 6.1\ \text{g/mL}$$

Converting from one unit to another

We will use the method of dimensional analysis, sometimes called the factor-label method.
... or, the "drag and drop" method!

Dimensional analysis uses conversion factors to change between one unit and another

What's a conversion factor? A simple equality.

Example:

12 in = 1 ft

Conversion factors in metric

In the metric system, conversion factors between units may always be made from the metric prefixes!

For example, "kilo-" means 10^3

$$k = 10^3$$

so

$$km = 10^3\,m$$

$$kg = 10^3\,g$$

$$kL = 10^3\,L$$

$$ks = 10^3\,s$$

Just apply the prefix to your base unit!

How do we actually USE a conversion factor?

Convert 15.75 m to cm

$1\text{ cm} = 10^{-2}\text{ m}$

$$15.75\text{ m} \times \frac{\text{cm}}{10^{-2}\text{ m}} = 1575\text{ cm}$$

Convert 0.01893 kg to g

$1\text{ kg} = 10^{3}\text{ g}$

$$0.01893\text{ kg} \times \frac{10^{3}\text{ g}}{\text{kg}} = 18.93\text{ g}$$

Convert 14500 mg to kg

$1\,mg = 10^{-3}\,g$

$1\,kg = 10^{3}\,g$

$$14500\,mg \times \frac{10^{-3}\,g}{1\,mg} \times \frac{1\,kg}{10^{3}\,g} = 0.0145\,kg$$

Convert 0.147 mm to μ m

$=$

$=$

$$0.147\,mm \times \frac{10^{-3}\,m}{1\,mm} \times \frac{1\,\mu m}{10^{-6}\,m} = 147\,\mu m$$

$1\,mm = 10^{-3}\,m$

$1\,\mu m = 10^{-6}\,m$