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 ...

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

What are the metric units of DENSITY?

$$\text{DENSITY} = \frac{\text{Kg}}{\text{m}^3}$$

← base unit of mass

← simplest volume unit

But both the kilogram and the cubic meter are too large for lab work, so we'll need to scale this down!

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

$$\frac{g}{mL}$$

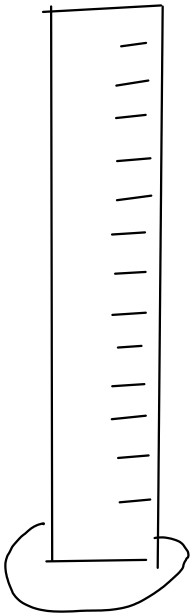
$$\left(\frac{g}{cm^3}\right) \quad \left(\frac{g}{cc}\right)$$

A useful density to remember:

WATER at room temp: Density = 1 g/mL

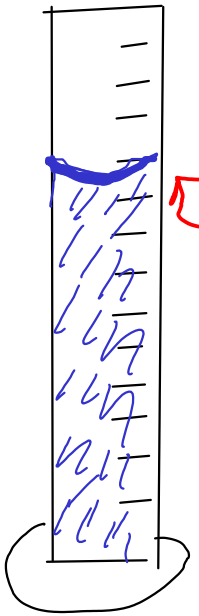
Measuring density

... 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

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

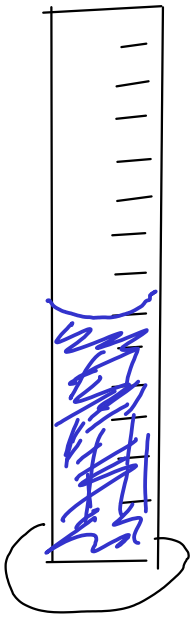
5) Density = mass liquid / volume liquid

$$\text{Density} = \frac{33.20\ \text{g}}{25.3\ \text{mL}} = 1.31\ \text{g/mL}$$

...of an object

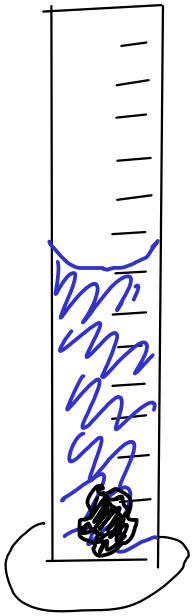
1) Measure mass of object

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

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

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

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

$12\ \text{in} = 1\ \text{ft}$

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 the base unit!

How do we actually USE a conversion factor?

Convert 15.75 m to cm

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

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

* Similar to...

If X = 2, then

$$\frac{X}{2} = 1$$

15.75 / EE −2 .. on TI-83

* This fraction equals one, so multiplying by it does not change the VALUE of the number, only its UNITS!

Convert 0.01893 kg to g

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

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

DRAG AND DROP

- Drag the part of the factor that contains the unit you want to get rid of (cancel out) to the BOTTOM.

- Then, drag the other half of the factor to the TOP

Convert 14500 mg to kg

$mg = 10^{-3} g$ $\quad Kg = 10^{3} g$

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

Note: When writing factors, use the base unit in this expression, NOT the squared or cubed form!

Convert 0.147 cm^2 to m^2

$cm = 10^{-2} m$

$$0.147\,cm^2 \times \frac{10^{-2}\,m}{cm} \times \frac{10^{-2}\,m}{cm} = \boxed{1.47 \times 10^{-5}\,m^2}$$

This example makes sense if you remember that :

$Cm^2 = Cm \times Cm$ ... and that you have to convert BOTH prefixes!

For squared units, use each factor twice. For cubed units, use each factor three times!

8.45 kg to μg

$kg = 10^{3} g$ $\quad \mu g = 10^{-6} g$

$$8.45\ kg \times \frac{10^{3}\ g}{kg} \times \frac{\mu g}{10^{-6}\ g} = 8.45 \times 10^{9}\ \mu g$$

88100 kHz to MHz

$Hz = s^{-1}$ (Frequency)

$kHz = 10^{3} Hz$ $\quad MHz = 10^{6} Hz$

$$88100\ kHz \times \frac{10^{3}\ Hz}{kHz} \times \frac{MHz}{10^{6}\ Hz} = 88.1\ MHz$$