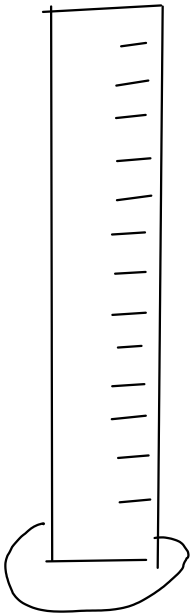
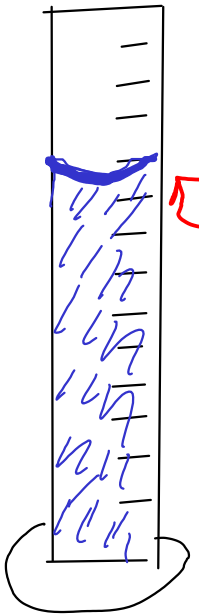
Measuring density

... 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

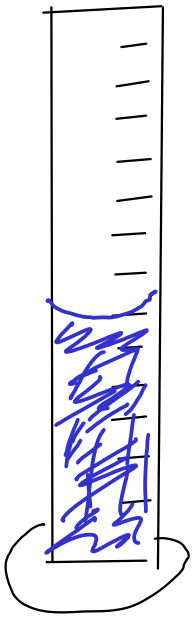
$$\text{Density} = \frac{33.20\ \text{g}}{25.3\ \text{mL}}$$

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

...of an object

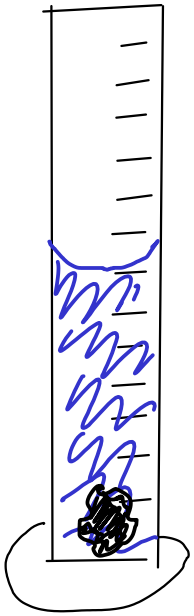
1) Measure mass of object

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

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

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

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

* Similar to...

If X = 2, then

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

15.75 / EE −2 .. on TI-83

Convert 0.01893 kg to g

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

$$0.01893\text{ kg} \times \frac{10^{3}\text{ g}}{1\text{ kg}} = 18.93\text{ g}$$

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

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

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

Convert 0.147 cm^2 to m^2

$cm = 10^{-2} m$

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

$(0.0000147\ m^2)$

For squared and cubed units, use each conversion factor two (squared) or three (cubed) times. Think of squared units this way:

$$(m^2 = cm \times cm$$

... and it'll make sense!

8.45 kg to mg

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

$$8.45\ \cancel{kg} \times \frac{10^{3}\ \cancel{g}}{\cancel{kg}} \times \frac{mg}{10^{-6}\ \cancel{g}} = \boxed{8450000000\ mg}$$

$$(8.45 \times 10^{9}\ mg)$$

88100 kHz to MHz $\quad kHz = 10^{3} Hz$

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

$MHz = 10^{6} Hz$

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

Convert 38.47 in to m, assuming 2.54 cm = 1 in

$2.54\ cm = 1\ in \qquad cm = 10^{-2}\ m$

$$38.47\ in \times \frac{2.54\ cm}{1\ in} \times \frac{10^{-2}\ m}{1\ cm} = \boxed{0.9771\ m}$$

Convert 12.48 km to in

$2.54\ cm = 1\ in \qquad cm = 10^{-2}\ m \qquad km = 10^{3}\ m$

$$12.48\ km \times \frac{10^{3}\ m}{1\ km} \times \frac{1\ cm}{10^{-2}\ m} \times \frac{1\ in}{2.54\ cm} = \boxed{491300\ in}$$