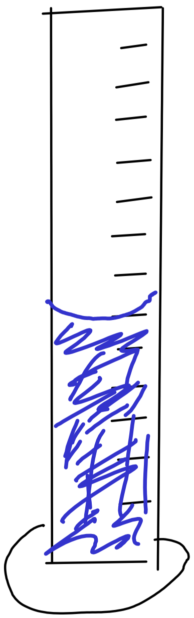
...of an object

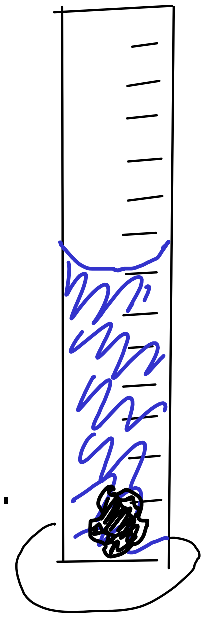
1) Measure mass of object

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

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

5) Density = mass object / volume object

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

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

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

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

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

$$km = 10^3 m$$

$$kL = 10^3 L$$

$$kg = 10^3 g$$

$$ks = 10^3 s$$

Just apply the prefix to the base unit!

How do we actually USE a conversion factor?

DRAG
AND
DROP!

Put what you want to cancel on the bottom, then ...

... put what it equals on the top!

Convert 15.75 m to cm

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

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

Convert 0.01893 kg to g

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

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

Convert 14500 mg to kg

$mg = 10^{-3} g$ $kg = 10^{3} g$

$$14500\,\cancel{mg} \times \frac{10^{-3}\,\cancel{g}}{\cancel{mg}} \times \frac{kg}{10^{3}\,\cancel{g}} = \boxed{0{,}0145\ kg}$$

If you have TWO prefixes in your problem, you will apply TWO conversion factors in your solution!

Convert 0.147 mm to µm

µ — micro-

$mm = 10^{-3} m$ $\mu m = 10^{-6} m$

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

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

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

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

Even though English units are involved, we can solve this problem the same way we solved the previous problem where only metric units were used!

20 Even if you're unfamiliar with the metric units involved in a problem, you can still do conversions easily.

88100 kHz to MHz

$KHz = 10^3 Hz$ $MHz = 10^6 Hz$ $Hz = \frac{1}{s}$ (frequency)

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

0.004184 kJ to J

$KJ = 10^3 J$ J = Joule (energy)

$$0.004184\ \cancel{kJ} \times \frac{10^3\ J}{\cancel{KJ}} = \boxed{4.184\ J}$$

Practical applications of dimensional analysis: Drug calculations.

Example: A patient is ordered 40 mg of codeine phosphate by subcutaneous injection. 50 mg in 1 mL liquid is available. How much of this liquid should be adminstered?

This is a conversion factor. It equates the mass of drug to the volume of the solution containing the drug. We use it the same way that we use any other conversion factor.

Hint: Many statements that give conversion factors connect the numbers with "per" or "in" or a similar word.

$$50 \text{ mg drug} = \text{mL}$$

$$40 \text{ mg drug} \times \frac{\text{mL}}{50 \text{ mg drug}} = \boxed{0.8 \text{ mL}}$$

Mileage

A car (averaging 17.5 miles per gallon) is traveling 50 miles per hour. How many gallons of gas will be used on a trip that lasts 0.75 hours?

$17.5 \text{ mi} = \text{gal}$ $\qquad$ $50 \text{ mi} = \text{hr}$

$$0.75\ \cancel{\text{hr}} \times \frac{50 \text{ mi}}{\cancel{\text{hr}}} \times \frac{\text{gal}}{17.5 \text{ mi}} = \boxed{2.1 \text{ gal}}$$

If gas is \$3.45 per gallon, what is the cost of the trip?

$\$3.45 = \text{gal}$

$$2.1 \text{ gal} \times \frac{\$3.45}{\text{gal}} = \boxed{\$7.39}$$