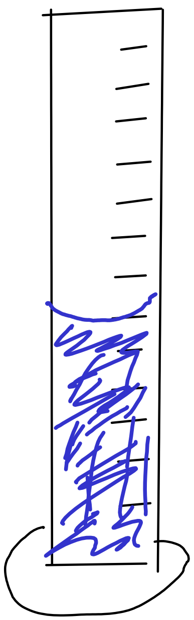
...of an object

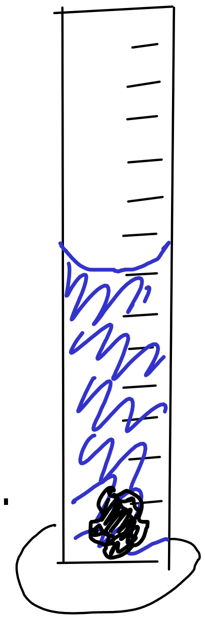
1) Measure mass of object

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

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

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

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

$$km = 10^3 m$$

$$kg = 10^3 g$$

$$kL = 10^3 L$$

$$ks = 10^3 s$$

Just apply the prefix to the base unit!

How do we actually USE a conversion factor?

$cm = 10^{-2} m$

Convert 15.75 m to cm

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

DRAG AND DROP!

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

... put what it equals on the top!

Convert 0.01893 kg to g

$kg = 10^{3} g$

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

Convert 14500 mg to kg

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

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

Convert 0.147 mm to μm

micro-

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

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

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

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

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

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!

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

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

$Hz = \frac{1}{s}$ (frequency)

88100 kHz to MHz

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

0.004184 kJ to J

$kJ = 10^3 J$

J = energy

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

For nurses, one use of this method is for 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?

$$50 \text{ mg drug} = 1 \text{ mL}$$

This is a conversion factor relating the mass of drug to the volume of the solution we need to inject. Use it like we used the other factors in the unit conversions problems.

$$40 \text{ mg } \cancel{\text{drug}} \times \frac{1 \text{ mL}}{50 \text{ mg } \cancel{\text{drug}}} = \boxed{0.8 \text{ mL}}$$

A client is ordered 75 mg of amoxicillin orally.
125 milligrams in 5 mL of syrup is available.
How many mL will you administer?

125mg drug = 5 mL

$$75\text{mg } \cancel{\text{drug}} \times \frac{5\text{ mL}}{125\text{mg } \cancel{\text{drug}}} = \boxed{3\text{ mL}}$$

Accuracy and Precision

- two related concepts that you must understand wheh working with measured numbers!

Accuracy

- how close a measured number is to the CORRECT (or "true") value of what you are measuring

- "Is it right?"

- checked by comparing measurements against a STANDARD (a substance or object with known properties)

Precision

- how close a SET of measured numbers are to EACH OTHER

- "Can I reproduce this?"

- checked by repeated measurements

More on precison

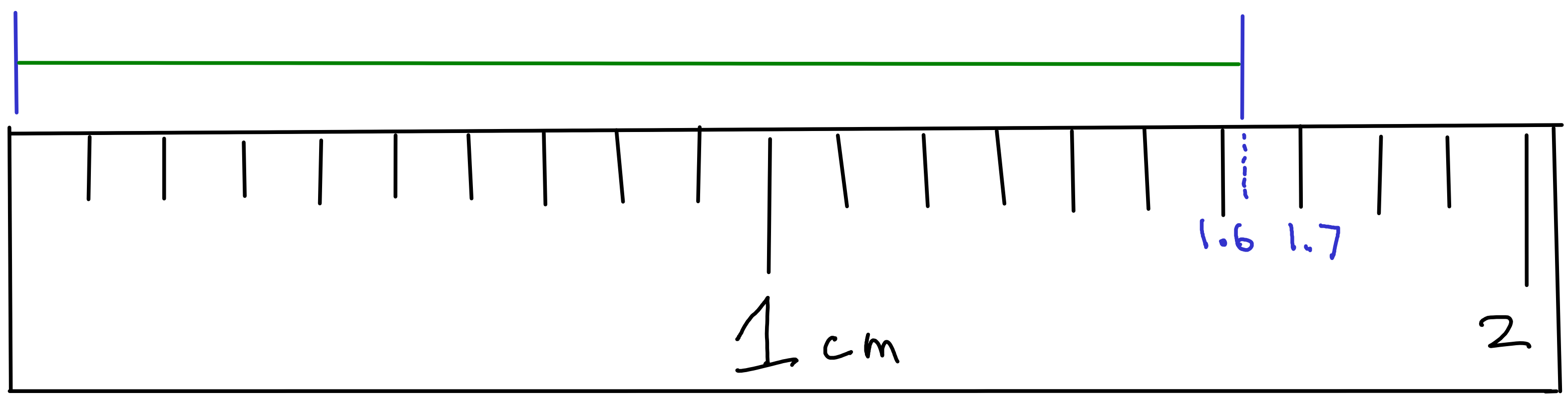
Every measurement contains some amount of ERROR, or some amount of deviation from the true value of what is being measured.

RANDOM ERROR is the variability in a measurement that cannot be traced back to a single cause. Random errors cause measurements to fluctuate around the true value, but can be averaged out given enough measurements.

When reporting measurements, we want to indicate how much random error we think is present. How?

An experiment ...

___ . ___ ___ cm



How long is the green line?

For this experiment, measure the line and record your answer in the form: X.XX cm
(In other words, measure to the nearest 0.01 cm)

Write your answer on the sheet, then fold the sheet in half and pass it up to the front!

Our classroom experiment: Results

After throwing away obvious mistakes in reading the scale, we had:

Value	# students
1,62	13
1,63	9
1,64	2
1,67	1

25 measurements

1,6272 cm : unrounded average

Overall average

$$\underbrace{1.6}_{\text{Certain}}\underbrace{3}_{\text{Uncertain}} \pm .01 \text{ cm}$$

Certain. Little to no variation expected. Same almost every time

Uncertain. Expected to vary by about +/- 1

When reading measurements from a scale, record all CERTAIN digits and one UNCERTAIN (or estimated) digit.