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

$km = 10^3 m$

$kg = 10^3 g$

$ks = 10^3 s$

$kL = 10^3 L$

Just apply the prefix to the base unit!

How do we actually USE a conversion factor?

Convert 15.75 m to cm

$cm = 10^{-2} m$

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

* 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

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

$15.75 / \boxed{EE} -2$ .. on TI-83

Convert 0.01893 kg to g

$Kg = 10^{3} g$

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

DRAG AND DROP

- Drag the part of the factor that you want to cancel out to the BOTTOM.

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

Convert 14500 mg to kg $\qquad mg = 10^{-3}\,g \qquad Kg = 10^{3}\,g$

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

Convert 0.147 cm^2 to m^2 $\qquad cm = 10^{-2}\,m \qquad cm^2 = (10^{-2})^2\,m^2$

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

$(0.0000147\,m^2)$

For the squared unit, we have to convert BOTH PARTS of the unit, so we use the factor twice. Think of square cm as:

cm x cm

For cubed units, apply factor three times!

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

$$8.45\ \cancel{kg} \times \frac{10^3\ \cancel{g}}{\cancel{kg}} \times \frac{\mu g}{10^{-6}\ \cancel{g}} = \boxed{\begin{array}{l} 8450000000\ \mu g \\ 8.45 \times 10^9\ \mu g \end{array}}$$

88100 kHz to MHz $\quad kHz = 10^3 Hz \quad MHz = 10^6 Hz$

$\boxed{Hz: s^{-1}\ (\text{frequency})}$

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

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

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

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

Convert 12.48 km to in $\quad 2.54\ cm = in \qquad cm = 10^{-2} m \qquad Km = 10^{3} m$

$$12.48\ \cancel{km} \times \frac{10^{3} \cancel{m}}{\cancel{Km}} \times \frac{\cancel{cm}}{10^{-2} \cancel{m}} \times \frac{in}{2.54\ \cancel{cm}} = \boxed{\begin{array}{l} 491300\ in \\ 4.913 \times 10^{5}\ in \end{array}}$$

Convert 6521 g to μg $\qquad \mu g = 10^{-6} g$

$$6521\ \cancel{g} \times \frac{\mu g}{10^{-6} \cancel{g}} = \boxed{\begin{array}{l} 6521000000\ \mu g \\ 6.521 \times 10^{9}\ \mu g \end{array}}$$

Accuracy and Precision

- two related concepts that you must understand when 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

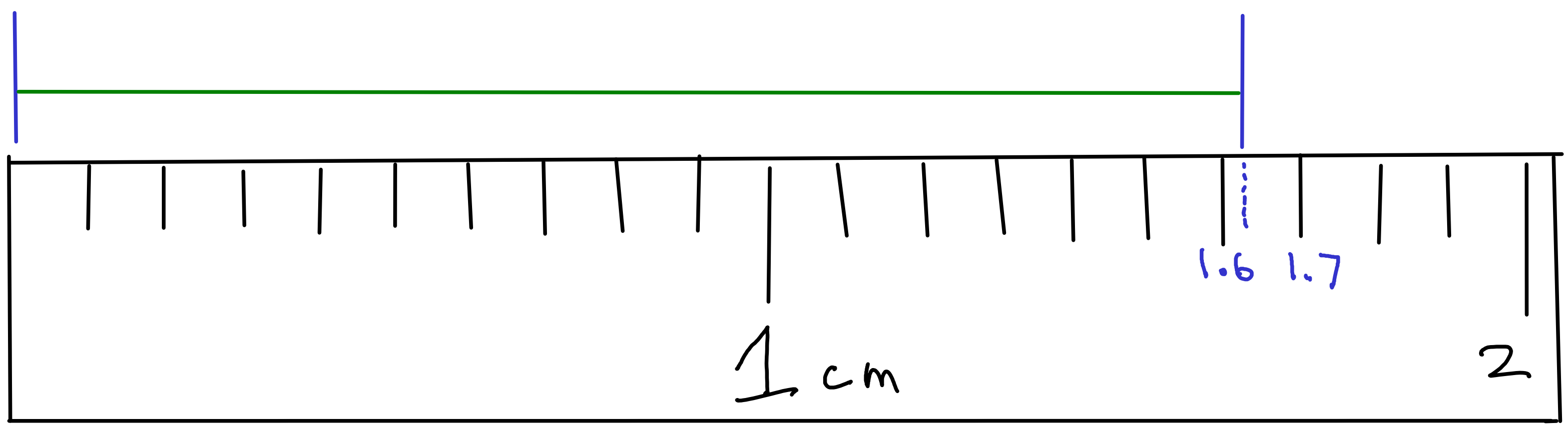
More on precison

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?

Form: X.XX cm



How long is the green line?

Write your answer on the card, then pass the card up to the front!

Our classroom experiment: Results

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

Value	# students
1.60	1
1.62	7
1.63	8

16 measurements

Overall average

$\bar{x} = 1.62375$ cm (NOT ROUNDED)

$= 1.62 \pm 0.01$ cm

CERTAIN DIGITS: Appear in nearly all repeats of the measurement

UNCERTAIN DIGITS: Vary.. Variation caused by estimation or other sources of random error.

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