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

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

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

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

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

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

0.004184 kJ to J

$\mathrm{KJ} = 10^3\ \mathrm{J}$ J = energy

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

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 can use it the same way we wpuld use the other conversion factors we've worked with.

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

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

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 mi = gal   50 mi = hr

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

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

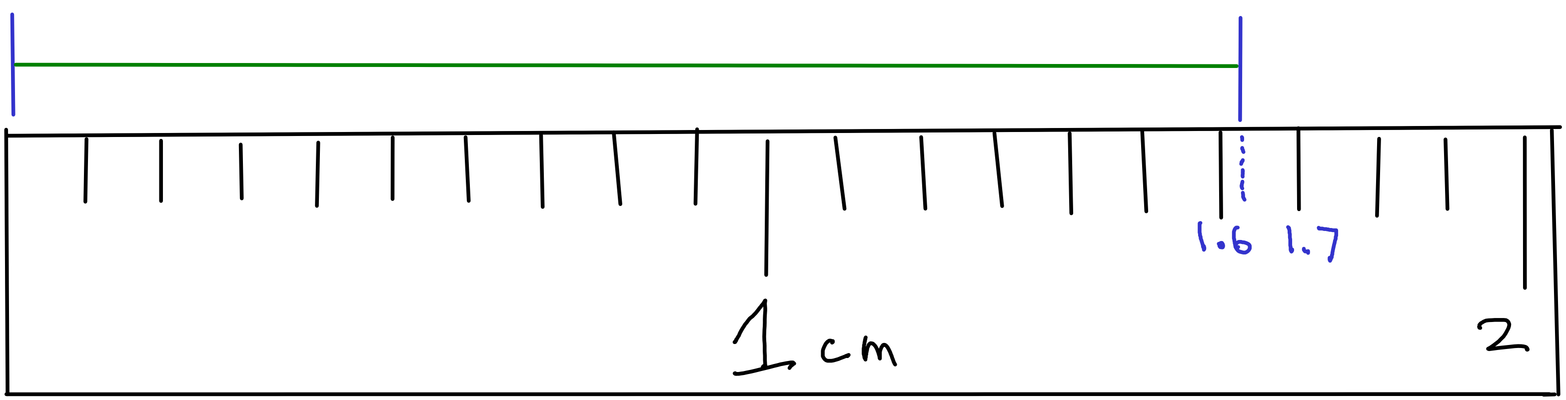
Every measurement contains some amount of ERROR, or some amount of deviation from the true value of what is being measured.

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 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
1.62	15
1.63	13
1.64	1

29 measurements

(combining data with CHM 110)

1.62517241 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.

Significant figures

SIGNIFICANT FIGURES are a way to indicate the amount of uncertainty in a measurement.

The significant figures in a measurement are all of the CERTAIN DIGITS plus one and only one UNCERTAIN (or estimated) DIGIT

Example:

From our classroom experiment,

$\underbrace{1.6}\underbrace{3}$ cm

We estimated the last digit, It's uncertain

These digits were obtained in all measurements. They are certain

THIS MEASUREMENT HAS "THREE SIGNIFICANT FIGURES"!

Determining significant figures

When you read a measurement that someone has written using the significant figures convention, you can tell how precisely that measurement was made.

approximate uncertainty

1.473 g ± 0.001 g

This was measured to the nearest +/- 0.001 g
The last digit is always UNCERTAIN (or estimated)

21 m ± 1 m

37.26 kg ± 0.01 kg

Some other examples

3.2076 g ± 0.0001 g

uncertain digit

27.3 m ± 0.1 m