Convert 14500 mg to kg

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

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

Or, you can square the factor itself:

$$cm^2 = (10^{-2})^2 m^2$$

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

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

For squared units, we have to convert both parts of the unit - so we use each conversion factor twice. Think of square centimeters as

$$cm \times cm$$

... and it makes sense. For cubed units, just use each factor three times.

8.45 kg to $\mu g$

$$Kg = 10^3 g \qquad \mu g = 10^{-6} g$$

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

---

88100 kHz to MHz

$$kHz = 10^3 Hz$$

$$MHz = 10^6 Hz$$

$$Hz = 1/s \; (Frequency)$$

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

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

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

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

---

Convert 12.48 km to in

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

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

# 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

1. cm    1.6  1.7    2
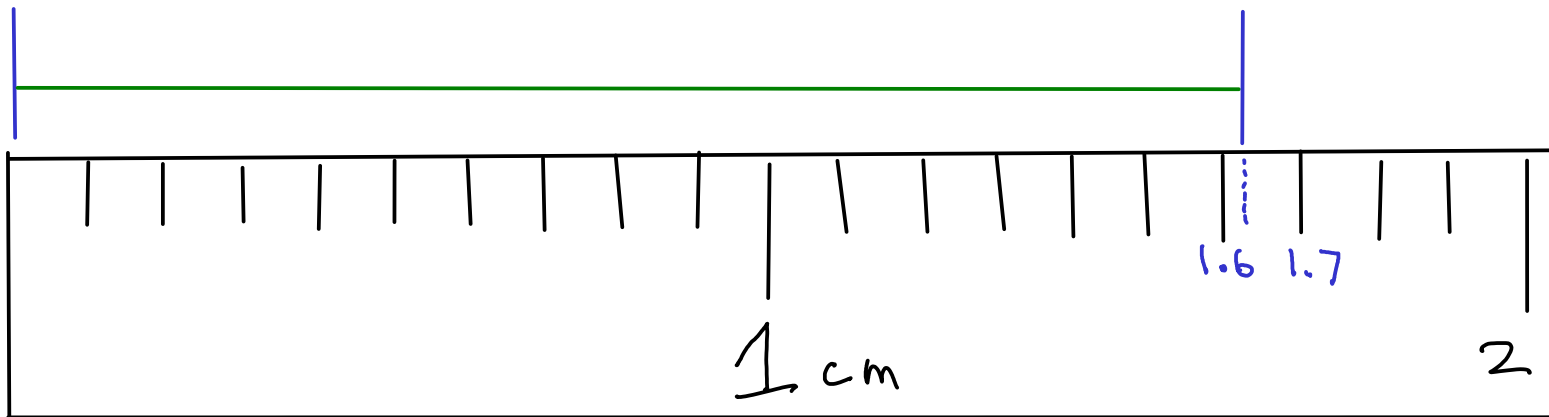
How long is the green line?

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 |
|-------|-----------|
| 1.61  | 1 |
| 1.62  | 10 |
| 1.63  | 17 |
| 1.64  | 2 |
|       |  |

**30 measurements**

Overall average

$$\bar{x} = 1.626666667 \text{ cm (unrounded)}$$

$$= 1.63 \pm 0.01 \text{ cm}$$

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.

When using a digital device, record all the displayed digits.

# 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,

1.63 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"!