Physics Toolkit

SCIENTIFIC MEASUREMENT

- SCIENTIFIC NOTATION
  - A way to write very large or small numbers.
  - General form of:
    - $A \times 10^{B}$

    Where A = a number between 1 and 10

    B = any integer (Positive number = big number, Negative number = small number).

    Examples:

    602,000,000,000,000,000,000,000 atoms H

    6.02×10^{23} atoms H

    0.000 000 000 000 000 000 000 327 grams Au

    3.27×10^{-22} grams Au

SI UNITS

- Worldwide adaptation of metric system and base units makes it easy to communicate.
- Length = meter = m
- Mass = kilogram = kg
- Time = second = s
- Temperature = kelvin = k
- Amount of substance = mole = mol
- Electric Current = ampere = A
- Luminous Intensity = candela = cd

Metric/SI Conversions

Prefix	Abbreviation	Meaning	Example
Giga	G	10^9	1 gigameter (Gm) = 1×10^9 m
Mega	M	10^6	1 megameter (Mm) = 1×10^6 m
Kilo	k	10^3	1 kilometer (km) = 1×10^3 m
Deci	d	10^{-1}	1 decimeter (dm) = 0.1 m
Centi	c	10^{-2}	1 centimeter (cm) = 0.01 m
Milli	m	10^{-3}	1 millimeter (mm) = 0.001 m
Micro	μ[a]	10^{-6}	1 micrometer (μm) = 1×10^{-6} m
Nano	n	10^{-9}	1 nanometer (nm) = 1×10^{-9} m
Pico	p	10^{-12}	1 picometer (pm) = 1×10^{-12} m
Femto	f	10^{-15}	1 femtometer (fm) = 1×10^{-15} m

[a]This is the Greek letter mu (pronounced "mew").

Prefixes convert the base units into units that are appropriate for the item being measured.

To convert between units you have to multiply/divide by factors of ten.

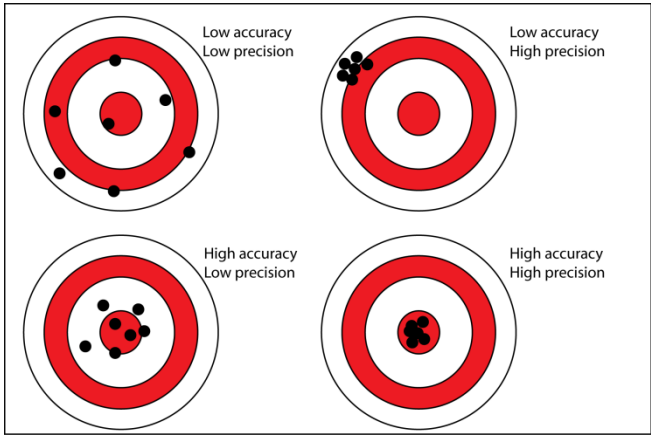
Metric/SI Conversions

- OR you can move decimals!

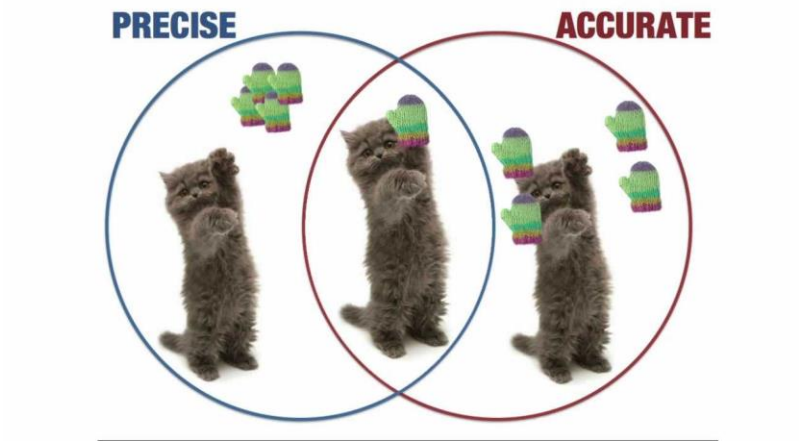
Prefix	*M*ega	*K*ilo	*H*ecto	*D*eka	Base *U*nit	*D*eci	*C*enti	*M*illi	*M*icro
Means	10^6	1000	100	10	1	1/10	1/100	1/1000	$1/10^6$
Symbol	Mm	km	hm	dam *or* dkm	m (meter)	dm	cm	mm	µm
	Ml	kl	hl	dal *or* dkl	l (liter)	dl	cl	ml *or* cc	µl
	Mg	kg	hg	dag *or* dkg	g (gram)	dg	cg	mg	µg

- Ex: Convert 43.1 cm to km

Measurement-Accuracy, Precision and Error



- Accuracy
  - How close a measurement is to the true value.
- Precision
  - How much a group of measurements agree with each other.
- Error
  - Error = experimental value – accepted value
- Percent Error
  - % Error = $\frac{|\text{error}|}{\text{accepted value}} \times 100\%$



SIGNIFICANT FIGURES

- When making measurements you can't record as many numbers as you want!
- All measuring tools have limits, when we write down numbers they have to show these limits.
- In a measurement, significant figures include all the digits that are known **plus** the last digit, which is estimated.
- There are rules for adding/subtracting and multiplying/dividing sig figs too!

Rules for determining Sig. Figs.

1. All nonzero digits are significant.
    1. Ex: 19 m
2. Zeroes between two significant figures are themselves significant.
    1. 1,907 m 280,785 L 6,700,594 s
3. Zeroes at the beginning of a number are never significant.
    1. 0.00005697 Kg 0.004067 m
4. Zeroes at the end of a number are significant if a decimal point is written in the number.
    1. 7650.0 mL 1.05 m 45.00 s 60.070 nm
    2. 7650 mL 60 nm

Sig. Figs. In Calculations

- Addition and Subtraction
  - Answer should be rounded to the same number of decimal places as the measurement with the least number of decimal places.
  - 12.52m + 349.0 m + 8.24 m =
  - 36.00 mL – 12.0 mL =
  - 35.00 mm – 36 mm =
    - In addition, you can “gain” significant figures.

    Ex: 12.52 m + 49.10 m + 43.65 m =

    - In subtraction, you can “lose” significant figures.

    Ex: 45.74 m – 40.89 m =

- Multiplication and Division
  - Round the answer to the same number of significant figures as the measurement with the least number of significant figures.
  - Examples:
    - (3.9 cm) (4.596 cm) =
    - 65 701 g / 245 mL =
    - 75.02 g / 350 mL =
    - Note that in multiplication and division no sig. figs. can be gained, or lost.

Problem Solving

- Write the equation/given information.
- Rearrange equation/give the answer in proper units.
- Substitute into equation/supply path.
- Calculate value of answer & Evaluate
  - How far have I traveled if I drive 45.6 m/s for 1 hour? (d = vt)

Dimensional Analysis

- When completing DA, follow the three step approach.
  - Write your given (usually only one unit)
  - Write where you are ending up. (What's the answer's unit(s)?)
  - Supply the path you choose to use to get to the answer.

  Ex: Jane drove her tractor for 4.5 hours. If her tractor used 25.6 gallons (1 gal = 3.87 L) of diesel, how many liters per hour were used? How many mL per s were used?