Analyzing Data

Chemistry Chapter 2

SI Units

- Base Units

- **Derived Units**
  - Not all quantities can be measured with SI base units.
- A unit that is defined by a combination of base units is called a **Derived unit**

Base SI Units

- *Le Systéme Internationale* (SI) units are standard in science

Quantity	*Base Unit*	*Symbol*
length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

Derived Units

- built from base SI units

area	length x length	m^2
velocity	length/time	m/s
density	mass/volume	kg/m^3

- Example: *Give derived units for force and for energy.*

Derived Units (cont.)

- **Density** is a derived unit, g/cm^3, the amount of mass per unit volume.

The density equation is

density = mass/volume.

Sample Problem:

When a piece of aluminum is placed in a 25 ml graduated cylinder that contains 10.5 mL of water, the water rises to 13.5 mL. What is the mass of the aluminum? The Density of Aluminum is 2.7 g/mL

Sample Problem, ***continued***

1. Step one

- **Given:**

  D = 2.7 g/mL

  Initial volume = 10.5 mL

  Final volume = 13.5 mL

Unknown:

m= ? g

Step 2 Equation selection - Must show beginning Eqns

D = m/v

Volume of sample = final volume – initial volume

Rearrange the equation to isolate the unknown:

m = D V

Sample Problem, ***continued***

Step 3 Calculate – Must show work!!!

Substitute the values into the equation and solve:

Volume of sample = 13.5 mL – 10.5 mL

Volume of sample = 3.0 mL

Mass = (3.0 mL) (2.7 g/mL)

$\boxed{\text{Mass} = 8.1\ \text{g}}$

- Box your final answers

SI Prefixes

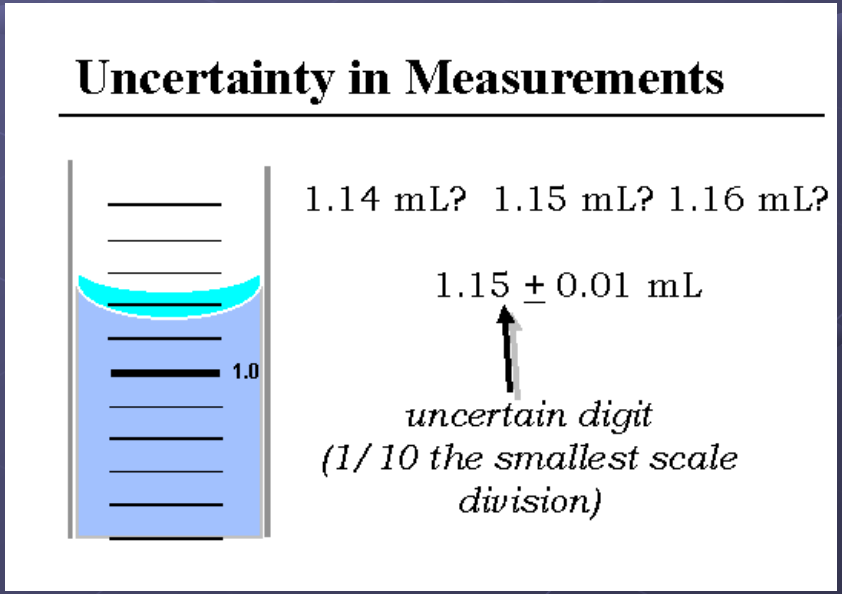
Prefix	Unit Abbr.	Exponent
Mega	M	10^{6}
Kilo	k	10^{3}
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	µ	10^{-6}
Nano	n	10^{-9}

Significant Figures

A digit that must be estimated is called uncertain.

A measurement always has some degree of uncertainty

- **Measurements are performed with instruments**
- **No instruments can read to an infinite number of decimal places**
- **1.15 ml implies 1.15 ± 0.01 ml**



Significant Digits

Measurements

- Science is based on measurement
- Measurements are inexact
- All measurements have:
  - Magnitude
  - Uncertainty
  - Units

Exact Numbers

- Mathematics is based on numbers
- Exact numbers are obtained by:
  - Counting
  - Definition (1km = 1000m)
  - 1 dozen, 1 person

Significant Figure Rules

- Nonzero integers always count as sig figs
  - 3456 has 4 sig figs
- Leading zeros do not count as sig fig
  - 0.0486 has 3 sig figs
- Captive zeros always count as sig fig
  - 16.07 has 4 sig fig
- Trailing zeros are only significant only if the number contains a decimal point
  - 9.300 has 4 sig fig
  - 9300 has 2 sig fig

How many Sig Figs?

- 5000 **1**
- 5010 **3**
- 5010. **4**
- 0.05 **1**
- 0.050 **2**
- 500. **3**
- 500.0 **4**
- 0000.5 **1**
- 0000.500 **3**

Rules: Multiplication & Division

- The value with the **fewest sig figs** determines the number of sig figs in the answer
  - **Least amount**
  - Keep track of units!

6.38 cm x 2.0 cm

$=12.76\ cm^2$

$= 13\ cm^2$ (2 sig figs)

$9680\ ml^3 / 1000.\ ml$

$= 9.6800\ ml^2$

$= 9.68\ ml^2$

56.4 m x 10.145m

$= 572.178\ m^2$

$= 572\ m^2$

Rules Addition & Subtraction

- The number of decimal places in the result equals the number of places in the least precise measurement
  - **Least precise** (poorest measurement)

6.8 L + 11.934 L

= 18.734 L

= 18.7 L

5.02 mm + 6.1 mm

= 11.12 mm

= 11.1 mm

90 ml + 4.5 ml =

= 94.5 ml

= 90 ml

Scientific Notation

Used to express very large or small values

- Coefficient x 10 ^{Power}
  - One number to the left of the decimal
    - #. ## x 10^2
    - 50.5 x 10^5 m = 5.05 x10^6m
    - 45.4 x 10 $^{-4}$ m = 4.54 x 10^{-3} m
  - Multiplication – add powers
    - 1x10^3 * 1x10^4 = 1x10^7
    - 5.6 x 10^5 m * 6.9 x10^{-2} m = 3.9 x10^4 m^2
  - Division – subtract powers
    - 1x10^6 m / 1x10^4 s = 1x10^2 m/s
    - 1x10^6 g / 1x10^{-4} ml = 1.x10^{10} g/ml

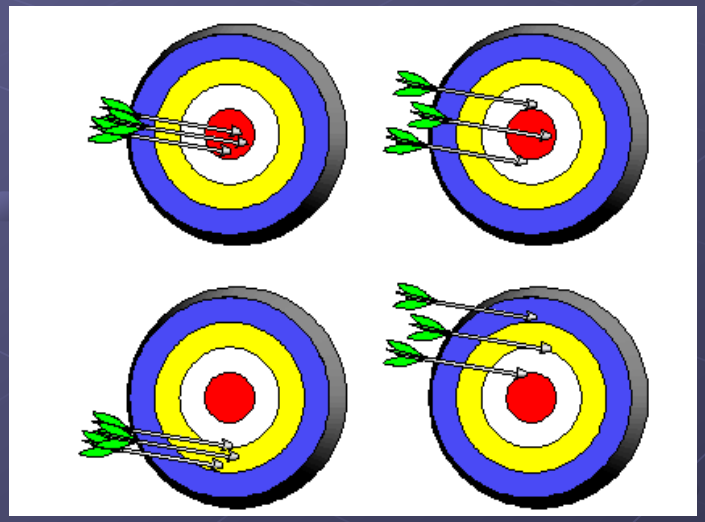
- Addition and subtraction
  - •Exponents must be the same.
  - •Rewrite values with the same exponent
  - •Add or subtract coefficients.

Precision vs. Accuracy

- **Accuracy** – describes how close a measured value is to the true value of the quantity measured.
  - **Correctness**
- **Precision** – the ability to repeat same measurement
  - **Reproducibility**

Good precision & Good Accuracy

Good Accuracy but poor precision



Poor Accuracy but good precision

Poor precision & poor accuracy

Precision Vs. Accuracy

- Reproducibility
- Check by repeating measurements
- Poor precision results from poor technique

- Correctness
- Check by using a different method
- Poor accuracy results from procedural or equipment flaws

Percent Error

- **Error** is defined as the difference between and experimental value and an accepted value.

Table 2.3 Student Density and Error Data (Unknown was sucrose; density = 1.59 g/cm^3)

	Student A		Student B		Student C	
	Density	Error (g/cm^3)	Density	Error (g/cm^3)	Density	Error (g/cm^3)
Trial 1	1.54 g/cm^3	−0.05	1.40 g/cm^3	−0.19	a 1.70 g/cm^3	+0.11
Trial 2	1.60 g/cm^3	+0.01	1.68 g/cm^3	+0.09	1.69 g/cm^3	+0.10
Trial 3	1.57 g/cm^3	−0.02	1.45 g/cm^3	−0.14	1.71 g/cm^3	+0.12
Average	b 1.57 g/cm^3		1.51 g/cm^3		1.70 g/cm^3	

Percent Error

- The error equation is
  error = experimental value – accepted value.

- Percent error expresses error as a percentage of the accepted value.

$$\text{percent error} = \frac{|\text{error}|}{\text{accepted value}} \times 100$$