

# Groupings

## Section 003

Group 1: Aboushawish to Lubchansky: Lab Check in, then review quiz

Group 2: Luo to Zirk: Review quiz, then lab check in

Tutorial in NS7; lab check in Chemistry Rooms 10, 11, 12, 13 ground Floor

## Significant Figures (M&H, Ch. 1 p. 11)

More importantly read lab manual p. 12 – 19; instructions for the calculator are also given there.

Significant figures indicate the reliability of experimental measurements, which usually contain some error or uncertainty

There are two types of experimental uncertainty:

**Accuracy:** how close is the result to the “true” value

**Precision:** How well do repeated measurements agree?

The number of sig. figs. used in reporting a result gives an estimate of the limits of error/uncertainty

The error is assumed to be  $\pm 1$  in the last (least significant) digit; that is, the last digit on the right hand side.

Examples:

➤ 2.35 g has 3 sig. figs. and means  $2.35 \pm 0.01$  g

➤ 2.3568 g has 5 sig. figs. and means  $2.3568 \pm 0.0001$  g

Are zeros significant? **Sometimes!**

2.350 has four sig. figs. Hence,  $2.350 \pm 0.001$   
i.e. trailing zeros are significant

However zeros are not significant when they are used to indicate the position of the decimal point; e.g. 0.0235

How about 235,000?

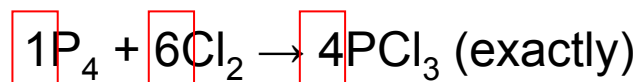
This is ambiguous and it is better to express it in exponential or scientific notation:

- $2.35 \times 10^5$  has an error of  $0.01 \times 10^5 = 1000$
- $2.3500 \times 10^5$  has an error of  $0.0001 \times 10^5 = 10$

Note for exact or defined quantities the concept of significant figures does not apply since there is no uncertainty

1 m = exactly 100 cm      1 L = exactly 1000 mL

In chemical equations, coefficients are exact numbers:



The number of sig. figs. may change in a calculation, and this is detailed in the lab manual.

At the moment consider the following simpler method summarized below:

### 1. Addition and Subtraction

Find the measurement with the fewest figures to the right of the decimal point (dp). Your final answer should also have this many figures to the right of the dp.

2.3468	4.15
+0.026	-3.0815
<hr/>	<hr/>
2.373	1.07

## 2. Multiplication and Division

Find the measurements with the fewest number of sig. figs., and this is how many sig. figs. should be in your final answer

Examples:

**4SF**    **3SF**    **3SF**

➤  $17.15 \times 0.0977 = 1.68$

**4SF**    **3SF**    **3SF**

➤  $4.383 \text{ g} / 2.72 \text{ L} = 1.61 \text{ g L}^{-1}$

Even though your calculator will give you many more digits, always think about sig. figs. before writing them down.

# Sample Standard Deviation (ssd)

= mathematical measure of precision

A large value of ssd relative to the average of your measurements (or mean) suggests that measurements were inconsistent

Formulas:  $\bar{x}$  = average value = mean

$$\bar{x} = \frac{x_1 + x_2 + \cdots + x_N}{N} = \frac{1}{N} \sum_{i=1}^N x_i$$

Symbol means summation

$$\text{ssd} = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (x_i - \bar{x})^2}$$

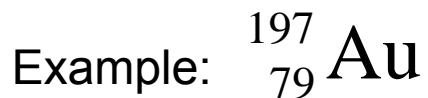
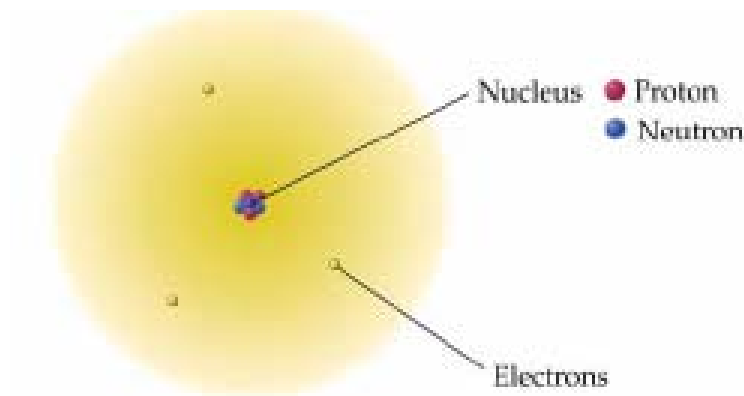
N = number of runs;  $x_i$  = the value of each run,

Don't worry both mean and ssd can be found using the required calculator!

The first non-zero digit shows where measurements become unreliable. This determines the last digit reported for the mean.

## Atoms, Molecules and Ions (M&H Ch. 2)

All matter is composed, ultimately, of **atoms** with a nucleus of protons and neutrons, and a surrounding shell (cloud) of electrons



79 = **atomic number** = Z = number of protons = # electrons in the neutral atom

197 = **mass number** = number of protons and number of neutrons; that is, the number of neutrons in Au is  $197 - 79 = 118$

Protons carry +1 charge while neutrons carry 0 charge      Electrons carry -1 charge.

Mass (proton and neutron) >>>> mass of electron

Virtually all the atom's mass lies in the nucleus

An element is a substance in which all the atoms have the same atomic number.

Most naturally occurring elements however are mixtures of **isotopes**  
(= atoms which have the same atomic number but different mass numbers)

For example:  ${}^1_6\text{C}$       98.90% natural abundance

${}^{13}_6\text{C}$       1.100% natural abundance

∴ The average atomic mass of elemental carbon is

$$\frac{98.90}{100.0}(12.0) + \frac{1.100}{100.0}(13.0) = 12.01 \text{ amu} \quad \text{amu} \equiv \text{atomic mass unit}$$



There is another isotope of carbon  $^{14}\text{C}$  which is radioactive, and is widely used in carbon dating to estimate the age of old plants and animal matter

## Radioactivity

- Radioactivity is a term used to describe the decomposition of unstable isotopes. Usually the atomic number  $Z$  changes in radioactive decay; that is, a new element is formed
- In carbon dating the amount of  $^{14}\text{C}$  present in an artefact is measured. Since  $^{14}\text{C}$  decays over time, the amount of this unstable isotope can be correlated to the age of the material

# Molecules and Compounds

- A molecule consists of two or more atoms joined together by covalent bonds where the electrons of the atoms are shared
- A compound is a substance in which the atoms of more than one element are present, usually in a whole number ratio; that is, a compound must have two or more different elements
- These can be classified as compounds and molecules:
  - H<sub>2</sub>O (one oxygen and two hydrogen atoms)
  - CH<sub>4</sub> (one carbon and four hydrogen atoms)
- However, molecules need not be compounds:
  - O<sub>2</sub> (two oxygen atoms), N<sub>2</sub>, Cl<sub>2</sub>, H<sub>2</sub>, etc.
  - By convention these are still called elements

