Lecture 1

Atomic Theory I

History of Atomic Theory
Isotopes
Atomic Mass
Empirical and Molecular Formulas

The History of Atomic Theory

- Democritus (*c*. 460 – *c*. 370 B.C.)
- Antoine Lavoisier (1743 – 1794)
- Joseph Proust (1754 – 1826)
- John Dalton (1766 – 1844)

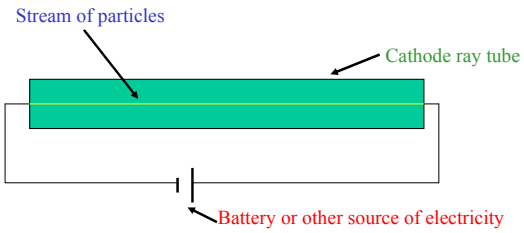
The History of Atomic Theory

John Dalton's Four Postulates:

1) Each element is composed of tiny particles called atoms.
2) All atoms of a given element are identical, and all atoms of different elements are different.
3) Atoms are not created or destroyed in chemical reactions. They are dissociated, combined, or recombined.
4) Compounds are formed when atoms of different elements combine with one another. A given compound always contains the same relative numbers and types of atoms.

The History of Atomic Structure

J.J. Thompson (1856 – 1940)



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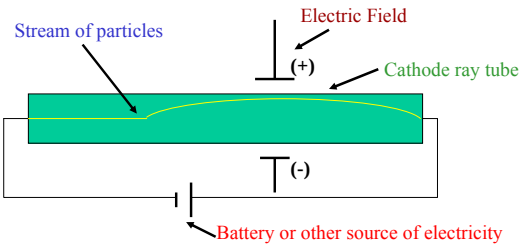
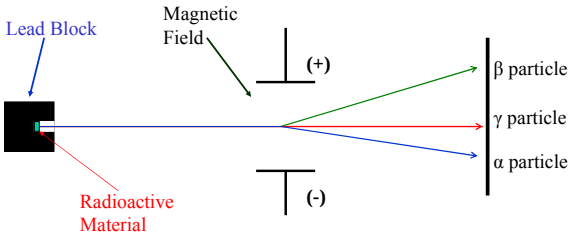


The History of Atomic Structure

Earnest Rutherford (1871 – 1937)



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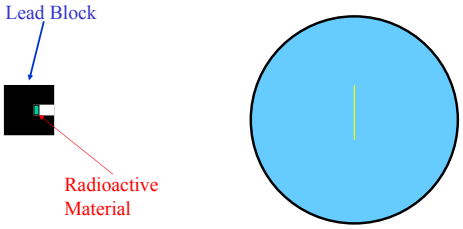

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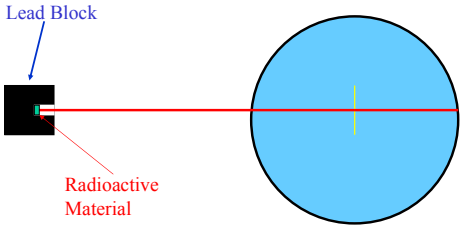

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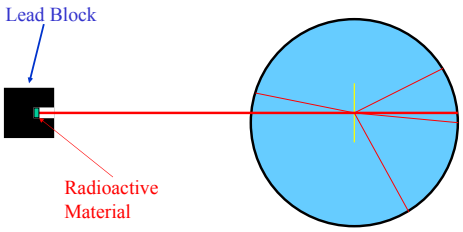

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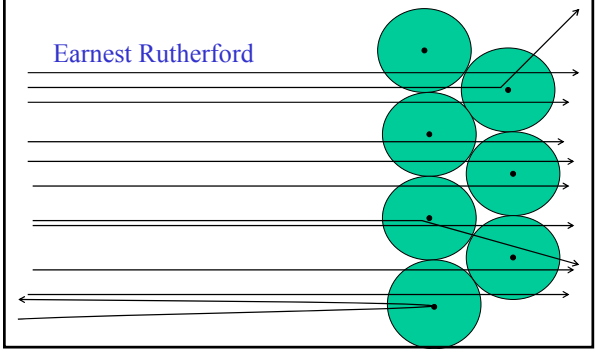

Rutherford's Model

- The nucleus is a very small positively charged core containing protons and neutrons.
- Negatively charged electrons are extremely tiny and occupy the vast majority of the atoms volume.

Sub Atomic Particles

	Charge (e)	Mass (amu)
Proton	+1	1
Electron	-1	0.0005
Neutron	0	1

Atomic and Mass Numbers

Mass Number

- Equal to the number of protons plus the number of neutrons.

$^{12}_{6}C$

Atomic Number

- The number of protons (or electrons in a neutral atom)

Atomic and Mass Numbers

Mass Number (A)

$^{12}_{6}C$

Atomic Number (Z)

6 protons
6 neutrons
6 electrons

Isotopes

Mass Number (A)

$^{14}_{6}C$

Atomic Number (Z)

6 protons
8 neutrons
6 electrons

Isotopes

Mass Number (A)

$^{1}_{1}H$

Atomic Number (Z)

1 protons
0 neutrons
1 electrons

Isotopes

Mass Number (A)

$^{2}_{1}H$

Atomic Number (Z)

1 protons
1 neutrons
1 electrons

Isotopes

Isotopes of an element have the same number of protons, but different numbers of neutrons.

- Isotopes of an element exhibit identical chemical behavior.
- This is why $^{1}_{1}H$ and $^{2}_{1}H$ will both bond with Oxygen to form water.
- Carbon – 14 and carbon – 12 both bonding with Oxygen to form CO_2.

Atomic Masses

The mass of one ^{12}C atom is exactly 12 amu.

All other atoms are measured on a scale relative to ^{12}C.

Average Atomic Mass

The atomic mass given to you on the periodic table is an average of all the isotopes of that element.

Ex1) Silver has two isotopes.

Isotope	Mass	% Abundance
^{109}Ag	108.90476 amu	48.16
^{107}Ag	106.90509 amu	51.84

Average Atomic Mass

To find the average atomic mass of Silver you must multiply the mass of each isotope by decimal equivalent of its percent abundance and add them together.

(108.90476 X 0.4816) + (106.90509 X 51.84)
= 107.87 amu. (written on the periodic table)

Average Atomic Mass

Ex2) Find the average atomic mass of Chlorine.

Chlorine has two isotopes.

Isotope	Mass	% Abundance
^{35}Cl	34.969 amu	75.78
^{37}Cl	36.966 amu	24.22

Average Atomic Mass

(34.969 amu x 0.7578) + (36.966 amu x 0.2422)

= 35.45 amu (as written on your periodic table)

Ex3) Finding % Abundance

Ex3) Lithium has two naturally occurring isotopes. The average atomic mass of Lithium is 6.94 amu. Find the percent abundance of each.

Lithium – 6	6.02 amu
Lithium – 7	7.02 amu

Ex3) Finding % Abundance (cont)

Let (y) represent the abundance of Li – 6 in decimal form.

$6.02y + 7.02 (1 - y) = 6.94$ amu

$6.02y + 7.02 - 7.02y = 6.94$ amu

$-1.00y = -0.08$ amu

$y = 0.08$ amu

8 % Lithium–6, and 92 % Lithium–7

Molecular and Empirical Formulas

Molecular Formulas

- Chemical formulas that provide the actual number of each type of atom in molecule.

Empirical Formulas

- Chemical formulas that provide the relative number of each type of atom in molecule. (a ratio in simplest form)

Molecular and Empirical Formulas

Common Name	Molecular Formula	Empirical Formula
Hydrogen Peroxide	H_2O_2	HO
Ethylene	C_2H_4	CH_2
Dextrose	$C_2H_{12}O_6$	CH_2O

Molecular and Empirical Formulas

Common Name	Molecular Formula	Empirical Formula
Water	H_2O	
Acetylene	C_2H_2	
Hydrazine	N_2H_4	