CHEMISTRY 101 CHAPTER 5: EARLY ATOMIC THEORY AND STRUCTURE pgs. 78-97
WEEK 4

THE ATOMIC MODEL

For a concise history of the atomic model, see handout and pgs. 81-88 in text.

Law of Definite Composition

A given compound always has the different elements it contains combined in definite proportion by mass.

Examples: NaCl, In salt, the ratio of mass of Na to mass of Cl is always around **0.65.** 22.99 **: 35.45 = 0.65**

In H_2SO_4, the ratio would be 2.02 g H : 32.07 g S : 64.00 g O. The substance would NOT be sulfuric acid if these mass ratios were not apparent.

LAW OF MULTIPLE PROPORTIONS

Atoms of different elements can combine in different whole number ratios to produce compounds of differing properties.

Example: H_2O (water) and H_2O_2 (hydrogen peroxide)

ELECTRIC CHARGE AND ITS BEHAVIOR

Electric charge is due to electrons (negatively charged particles outside the nucleus). It has the following attributes:

a. Charges can be positive (as in a proton) or negative (as in an electron).

b. Like charges repel (negative next to negative repel or north with north for a magnet) while opposite charges attract (north and south poles of a magnet).

c. Charge can be moved from one object to another by contact or induction.

d. The attractive or repulsive force between unlike charges increases as the charges become closer togetherbased upon an "inverse square law" relationship; $\frac{1}{r2}$, as r (distance) doubles, the intensity of attraction/repulsion decreases to $\frac{1}{4}$ of its original strength.

IONIC SUBSTANCES

Some substances when placed in water or melted can conduct electricity. This is due to the formation of ions.

Negative ion = anion Positive ion = cation

Examples: Na^{+}, Cu^{+2}, and Al^{+3} are cations; Cl-, P^{-3}, and O^{-2} are anions.

The work of Michael Faraday and Svante Arrhenius provided initial insight into ions and their properties.

Subatomic particles example problem

If the mass of a H atom is 1.673×10^{-24} g, a 20 g sample of hydrogen has how many atoms?

Using Factor Label:

20 g H x 1 atom/1.673×10^{-24} g =

See Table 5.2 p. 87 for Masses of Subatomic Particles, Symbols, and Charges

ATOMIC NUMBERS

This represents the number of protons of an atom. (The number above the symbol of the element in the periodic table)

Each element has a unique atomic number.

Examples: Sodium (Na) = 11; Uranium (U) = 92; Helium (He) = 2

ATOMIC MASSES (ATOMIC WEIGHTS)

Based upon atomic mass units (a.m.u.)

The a.m.u. = mass of a C-12 atom ÷ 12; mass of a C-12 atom = 1.9927×10^{-23} g ÷ 12 = 1.6606×10^{-24} g.

The atomic mass or weight is the number below the symbol in the periodic table.

Examples: Oxygen (O) = 16.00; Chlorine (Cl) = 35.45; Na = 22.99

NOTE: These numbers have been rounded to the nearest hundredth place.

The atomic mass of an element takes into account that there are isotopes of that element which differ in atomic mass.

ISOTOPES

Elements of the same atomic number (same identity) but different atomic masses

Differences in the atomic masses are due to different numbers of **neutrons** in each atom.

NOTE: Neutrons do NOT affect the identity of an element, only protons do.

MASS NUMBER

Mass number is the <u>number of protons + number of neutrons</u> in an atom.

For instance, carbon (atomic number 6) can have 6 neutrons (mass number = 6 p^+ + 6 n^o = 12), 7 neutrons (6 p^+ + 7 n^o = 13), or 8 neutrons (6 p^+ + 8 n^o = 14) among others but the element is still carbon!

The number of neutrons can be found be taking the number of protons and subtracting it from the mass number.

Knowing the atomic and mass numbers, abbreviations (symbols) for isotopes can be written.

See pg. 90 in text.

$$\frac{A}{Z}\mathbf{E}$$

Where E = the element symbol, A = mass number (protons + neutrons), Z = atomic number

Hence, A – Z = number of neutrons.

Each isotope in a sample of an element or a compound containing that element is taken into account in the overall atomic mass. *The greater the abundance of an isotope, the more influence it has on the atomic mass.*

<u>Example</u>: A mystery element *A* occurs as 3 isotopes. Analysis of a sample of *A* showed:

Isotope	Mass	%
1	80.125 a.m.u.	60
2	84.468 a.m.u.	30
3	82.279 a.m.u.	10

Determine the average atomic mass of the element.

Example 2

Element *So* has four isotopes. Isotope A = 21.0 a.m.u. (11%); Isotope B = 23.0 a.m.u. (61%); Isotope C = 20.0 a.m.u. (7%); and Isotope D = 22.0 a.m.u. (21%).

a. **What would the atomic mass for this element be?**
b. **What element is this most likely to be?**