

Chapter 2 → Atoms, Molecules, and Ions

Fundamental Chemical Laws

- Law of Conservation of Mass
 - Mass is not created nor destroyed
- Law of Definite Proportion or "Proust's Law"
 - A given compound always contains exactly the same proportion of elements by mass
- Law of Multiple Proportion
 - When 2 elements form a series of compounds, the ration of the masses of the 2nd element that combine with 1 gram of the first element can be reduced to the smalles whole number

Dalton's Atomic Theory

- 1) Each element is made up of tiny particles called atoms
 - 2) Atoms of a given element are identical; atoms of different elements are different in some fundamental way(s)
 - 3) Chemical compounds are formed when atoms of different elements combine with each other
 - a) A given compound always has the same relative numbers and types of atoms
 - 4) Chemical reactions involve reorganization of atoms and change the way they are bound together
 - a) Atoms themselves are not changed in a chemical reaction
- Atomic mass is also known as atomic weight
 - Avagadro's hypothesis
 - At the same temperature and pressure, equal volumes of different gasses contain the same number of particles

Early Experiments to Characterize the Atom

- Cathode ray tube
 - Fast moving electrons excite the gas in a tube causing a glow between electrodes
 - Electrons (e^-) → negatively charged subatomic particles
- Charge to mass ratio of an electron
- $\frac{e}{m} = -1.76 \times 10^8 \frac{C}{g}$
 - e → charge on the electron in coulombs (C)
 - m → electron mass in grams (g)
- Radioactivity
 - Spontaneous emission of radiation
 - Types of radioactive emission
 - α particle → +2 charge
 - β particle → high speed electron
 - γ ray → high energy “light”
- Rutherford gold foil experiment
- Discovered atoms have a dense positively charged nucleus

Modern View of Atomic Structure

- Nucleus have an average diameter of $10^{-13}cm$
 - Electrons orbit around $10^{-8}cm$ from the nucleus
- Nucleus contains protons (p) and neutrons (n)
 - Protons are positively charged subatomic particles
 - Neutrons are subatomic particles with no charge
- Isotope
 - Versions of an atom with different numbers of neutrons
 - Same number of protons and electrons
- Notation
 - $\overset{\text{mass number}}{\underset{\text{atomic number}}{\text{Element abbreviation}}}$
- Particles with their mass and charge
 - Electrons (e^-) have a mass of $9.109 \times 10^{-31}kg$ and a charge of -1
 - Protons (p) have a mass of $1.673 \times 10^{-27}kg$ and a charge of 1
 - Neutrons (n) have a mass of $1.673 \times 10^{-27}kg$ and a charge of 0

Molecules and Ion

- Chemical bonds
 - Force that holds atoms together
- Covalent bonds
 - Bonds that share electrons
 - Creates molecules
- Chemical formula
 - Atomic symbol with sub/super-scripts
- Structural formula
 - Individual bonds between atoms
- Ion
 - Atom(s) with a net positive/negative charge
 - Positive ions are called cations
 - Negative ions are called anions
- Ionic bonding
 - Force of attraction between opposite charged ions
- Ionic solid
 - Solid consisting of oppositely charged ions

Introduction to the periodic table

- Atomic number
 - Number of protons in an element
- Metals
 - Efficient conduction of heat and electricity; malleability; ductility; lustrous appearance; lose electrons
- Nonmetals
 - Opposite physical properties than metals; bonds to each other to form covalent bonds; gains electrons
- Group/family (columns)
 - Similar chemical properties
- Group 1A
 - Alkali metals
- Group 2A
 - Alkaline earth metals
- Groups 3-12
 - Transition metals
- Group 7A
 - Halogens
- Group 8A
 - Noble gases
- Atomic #58-71
 - Lanthanides
- Atomic #90-103
 - Actinides
- Periods
 - Horizontal rows

Naming simple compounds

- Binary compounds
 - Compounds composed of 2 elements or more
- Binary ionic compounds
 - Contain a cation and an anion
 - 1) Cation is named first, anion second
 - 2) Monoatomic cation takes name of element
 - 3) Monoatomic anion is the root word of element + "-ide"
- Binary ionic compounds (Type II)
 - If metal has multiple charges, add roman numeral representing the charge
- Different number of oxygen atoms
 - Oxyanions

Naming binary covalent compounds

- 1) The first element in the formula is named first using the full element name

- 2) Second element name as if it were an anion
- 3) Prefixes denote number of atoms
- 4) "Mono-" is *never* used for the *first atom* being named

PREFIX	NUMBER
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
dec-	10