

## Inorganic Chemistry

### 1: Composition of Matter

- Matter: anything that occupies space and has mass
- Mass: the quantity of matter of an object
  - The pull of gravity on the mass of an object gives the object the property of weight.
- Atom: fundamental unit of matter
  - Each element has distinct characteristics because of the structure of its atoms.
  - The structure of an atom:
    1. Nucleus: positively charged center of an atom
      - a. Neutrons ( $n^0$ ): neutral subatomic particles
      - b. Protons ( $p^+$ ): positive subatomic particles
    2. Electron Cloud: space in which electrons are likely to be found
      - a. Electrons ( $e^-$ ): negative subatomic particles
- Electrons are arranged in energy levels
  - Energy Level: the most likely location in an electron cloud that an electron can be found
  - Each energy level has a limited capacity for electrons:  
 $1^{\text{st}} \text{ Level} = 2 e^-$ ,  $2^{\text{nd}} \text{ Level} = 8 e^-$ ,  $3^{\text{rd}} \text{ Level} = 8 e^-$
- Atomic Number: the number of protons in the nucleus of an atom
- Atomic Mass/Mass Number: the number of protons and neutrons in the nucleus of an atom
- Atomic Mass Units (amu): units used to measure the masses of subatomic particles

### **Properties of Subatomic Particles**

<b>Subatomic Particle</b>	<b>Symbol</b>	<b>Location</b>	<b>Charge</b>	<b>Mass (amu)</b>
Neutron	$n^0$	Nucleus	0	1.0087
Proton	$p^+$	Nucleus	+1	1.0073
Electron	$e^-$	Electron Cloud	-1	0.00006

- Elements: substances that cannot be broken down chemically into simpler kinds of matter
  - Each element has a unique chemical symbol.
  - 92 elements occur in nature
  - CHNOPS are the six biologically important atoms that make up 99% of living tissue
- Isotopes: atoms of the same element that differ in the number of neutrons they contain
- Radioisotopes: isotopes with unstable nuclei
  - their nuclei tend to release particles or radiant energy or both
  - Uses: medical treatments, detection, function of body organs, tracers, radioactive dating, cancer treatment
- Compound: atoms of two or more elements that are joined by chemical bonds
- Ionic Bond: a bond formed by electrical attraction between two oppositely charged ions
  - Ion: an atom or polyatomic particle with an electrical charge
- Covalent Bond: a bond that forms when two atoms share one or more pairs of electrons
  - Molecule: a group of atoms held together by covalent bonds

## 2: Mixtures

- Mixture: a combination of two or more substances in which each substance retains its original chemical properties
- Solution: a mixture in which one or more substances are uniformly dissolved in another substance
  - Solute: a substance dissolved in a solution (ions, atoms, and smaller molecules)
  - Solvent: the substance into which a solute is dissolved
  - Concentration: a measurement of the amount of solute dissolved in a fixed amount of solvent
    - Saturated solution: no more solute can be dissolved in the solvent
  - Solutions can be mixtures of liquids, solids, or gases.
  - Aqueous Solution: a solution in which water is the solvent
- Suspension: a mixture in which particles spread through a liquid or gas but settle out over time (particles are larger than solute particles in a solution)
- Colloid: a mixture in which particles do not settle out over time (particles are intermediate in size between particles in a solution and those in a suspension)
  - Sol: a colloid in a liquid state
  - Gel: a colloid in a semisolid state
- Acids and Bases
  - Acidity or alkalinity is a measure of the relative amounts of hydronium ions ( $\text{H}_3\text{O}^+$ ) and hydroxide ions ( $\text{OH}^-$ ) dissolved in a solution.
  - In water, these ions form naturally: water molecules break up, or dissociate, to form hydrogen ions ( $\text{H}^+$ ) and hydroxide ions ( $\text{OH}^-$ ).
    - $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$
  - The hydrogen ions spontaneously recombine with water molecules to form hydronium ions ( $\text{H}_3\text{O}^+$ ).
    - $\text{H}_2\text{O} + \text{H}^+ \rightarrow \text{H}_3\text{O}^+$
  - Pure water:  $[\text{H}_3\text{O}^+] = [\text{OH}^-]$  (neutral solution)
- Acid Solution: a solution containing more hydronium ions than hydroxide ions
  - Properties of acids: sour taste, highly corrosive, laboratory acids are poisonous
- Base Solution: a solution containing more hydroxide ions than hydronium ions
  - Properties of bases: bitter taste, slippery, laboratory bases are poisonous
- pH Scale: a scale for measuring the relative concentrations of hydronium ions and hydroxide ions in a solution
  - The pH scale ranges from 1-14.
  - Acids =  $<7$ , Neutral = 7, Basic =  $>7$
  - The control of pH is important for living systems.

## 3: Energy

- One characteristic of living organisms is that they use energy.
- Energy: the ability to do work
- Work: the movement of a mass
- Forms of Energy: light energy, heat energy, electrical energy, chemical energy, and mechanical energy
- Potential Energy: stored energy or energy of position
- Kinetic Energy: energy of motion
  - All the atoms and molecules in any substance are in constant motion; thus they have kinetic energy.

- The kinetic energy of the atoms or molecules of a substance determines its state: solid, liquid, gas.
- With the addition of sufficient energy matter changes from solid to liquid to gas.
- Chemical Reaction: the process of breaking chemical bonds, forming new bonds, or both
- Chemical Equation: an equation showing the products and reactants of a chemical reaction
  - Reactants → Products
- Energy and Chemical Reactions
  - Activation Energy: the amount of energy required for a chemical reaction to get started and to continue on its own
  - Exothermic Reaction: a reaction that has a net release of energy
  - Endothermic Reaction: a chemical reaction that involves a net consumption of energy
  - Intermediary Metabolism: a series of chemical reactions in which energy is released slowly in controlled amounts that will not damage cells