

Chemical Fundamentals I

- Biology is the study of living things
- All living matter is ultimately composed of chemical substances
- Matter is anything that has mass and takes up space

The Rutherford Model of the Atom

- The nucleus (core) is made up of protons and neutrons and is surrounded by rings of orbiting electrons
- Ex/ Draw diagram for carbon

- Atomic Number is the number of protons in the nucleus
- This # is written as a subscript to the left of the element symbol
- Ex/ ${}_2\text{He}$
- Mass Number or Atomic Weight is the number of protons AND neutrons in the nucleus
- Ex/ ${}^4\text{He}$

- Isotopes are atoms in which the number of neutrons may differ
- Ex/ ${}^{12}\text{C}$ (6p and 6n), ${}^{13}\text{C}$ (6p and 7n), or ${}^{14}\text{C}$ (6p and 8n)
- Atoms have different weights but react with other atoms in the same way
- Radioisotopes are radioactive (emit subatomic particles like alpha particles) isotopes that are unstable and tend to break apart (decay) into more stable atoms

Chemical Bonding

- Atomic Energy Levels
- Electrons are believed to be restricted to energy levels
- Electrons occupying lower energy levels have a low amount of energy but require high amounts of energy to be pulled free of the attraction of the nucleus
- The maximum number of electrons that can occupy any one level is $2n^2$
- This rule applies for the first 20 elements
- Ex/ Draw energy levels for potassium

- Orbitals are a region of space around the atoms nucleus in which electrons can be found at any moment
 - First shell: has one orbital that can have 1 or 2 electrons with the lowest energy level
 - Second shell: has up to 4 orbitals, so it can hold 8 electrons
 - See fig. 4 on p. 11

- A Chemical Bond is a union between electrons of atoms
- It is an energy relationship
- Atoms are stable when they are surrounded by 8 electrons in their outer valence shell, and will combine to achieve this "octet" stability.
- Ex/ He, Ne, and Ar are all chemically unreactive or inert
- Electrons can be knocked out of atoms, pulled away from them, added to them or shared between atoms

- Ionic Bonds are formed between two oppositely charged ions

- A cation is the positively charged ion and an anion is negatively charged
- Ex/ $\text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl}$ *A metal (Na) is bonded with a non-metal (Cl)*
- An electrostatic attraction exists between the Na^+ and the Cl^-
- An ionic compound (or salt) is formed with a crystalline structure that dissociates into the component ions when in solution
- Some important ions are Ca^{2+} (muscle contraction), Na^+ , K^+ (nerve and muscle function), Fe^{+2} and Fe^{+3} (hemoglobin components) and H^+ (HCl in stomach provides optimum pH for pepsin)

Covalent Bonds are formed when atoms share electrons in order to achieve stable electron configurations

- Ex/ Hydrogen gas (H-H) is formed when one pair of e^- are shared
- Ex/ Oxygen gas (O=O) is formed when two pairs of e^- are shared
- Bonds can be polar or non-polar

Non-Polar Covalent Bonds

- Both atoms exert the same pull on the shared electrons
- Occurs when the atoms are identical or have similar electronegativities

Polar Covalent Bonds

- Atoms of different elements (different # of protons) do not exert the same pull on the shared electrons
- The atoms with the end that is more attractive ends up with a slightly negative charge (electronegative)
- See Fig. 7 on p. 14
- Ex/ Water has 2 polar covalent bonds where the electrons are less attracted to the hydrogens than to the oxygen (has more protons)

Molecular Shape

- The Valence Shell Electron Pair Repulsion (VSEPR) theory is useful in determining the shape of a molecule
- Most biological molecules contain up to 4 valence electrons
- Table 5 on p. 15 shows the various shapes common to biological molecules

Molecular Polarity

- Symmetrical molecular structures typically produce non-polar molecules
- Asymmetrical molecular structures produce non-polar molecules only if the bonds are all non-polar, and produce polar molecules only if at least one bond is polar

Homework:

Read p. 8-10

p. 10 #1-7

p. 16 #8-9