

Week 2

Families of Carbon Compounds / Acids and Bases

2.1 Families of Carbon Compounds

10/7:

- Hydrocarbons:
 - Alkanes (C_nH_{2n+2}) and cycloalkanes C_nH_{2n} .
 - Alkenes (C_nH_{2n}).
 - Alkynes (C_nH_{2n-2}).
- Aromatic:
 - Contains a benzene ring.
 - All bonds ~ 140 Å.
 - All carbons sp^2 .
 - Planar.
 - π electrons above and below the ring.
 - Special stabilization.
- Covers drawing dipoles.
- Polar and nonpolar molecules:
 - Dipole = distance \times change between charges.
 - $\mu = r \times Q$
 - $1 \text{ D} = 3.336 \times 10^{-30} \text{ C m}$.
 - Analyzes molecules by drawing a Lewis structure, drawing a dipole along each bond, and drawing and labeling a net dipole, if applicable.
 - Goes through a number of examples.
 - Acetonitrile is a strong polar solvent.
- **Functional group:** A common arrangement that determines shape, bonding physical and reactivity of organic compounds.
- Families of carbon compounds:
 - Hydrocarbons: Aliphatic, aromatic.
 - Methyl, ethyl, propyl, R = alkyl groups.

- Phenyl: Ph- or ϕ -.
- Benzyl: Ph-CH₂-, C₆H₅CH₂-, Bn-
- Compounds with R-Z where Z is a heteroatom.
 - If Z is a halogen X, then the halogroup makes it an alkyl halide or haloalkane.
- Alkenyl halide: X- =.
- Aryl halide: Ph-X.
- Alcohols or phenols: R-OH.
- Ether: R-O-R'.
- Amines: NH₂R, NHR', NRR'R''.
- Thiols or mercaptols: R-SH.
- Carbonyl group: R-CO-R'.
- Aldehyde: R-COH.
- Ketone: R-CO-R'.
- Carboxylic acid derivatives:
 - Acid: R-COOH.
 - Ester: R-COOR'.
 - Acid chloride: R-COCl.
 - Acid halide: R-COX.
 - Amide: R-CONH₂.
 - Acid anhydride: R-COOCO-R'.
- Nitrile: R-C≡N.
- Acrylonitrile: $\text{--C}\equiv\text{N}$.

2.2 Discussion Section

- ACS in-text citations should be in superscripts as a list of number with no brackets or parentheses.
- Molecular formulas are C₂H₆O, not C₂H₅OH or CH₃CH₂OH.
- Make a table if you have a lot of data to put in (make it readable!).
- Distillation:
 - We need a boiling chip and stir bar inside the flask.
 - Vapor comes up from a round-bottomed flask, encounters a rubber stopper and gets diverted through a condenser instead.
 - Make use of countercurrent exchange and increase pressure by inflowing water in the gravitationally lower portion of the condenser.
 - Boiling chip is a coarse material with a lot of micropores inside.
 - The surface energy is reduced when the fluid is inside the micropores; within, it can more easily become a gas.
- As the mole fraction χ of a substance A increases...
- Raoult's law:
$$P_{\text{total}} = \frac{P_A \chi_A}{P_B \chi_B} = \frac{P_A \chi_A}{P_B (1 - \chi_A)}$$
- Dalton's law: The total pressure is equal to the sum of the partial pressures.

2.3 Intermolecular Forces and IR Spectroscopy

10/12:

- Intermolecular forces and physical properties.
- **Boiling point:** The temperature at which the vapor pressure is equal to the pressure of the atmosphere above.
 - The stronger the intermolecular forces, the higher the boiling point.
 - The higher the molecular weight, the higher the boiling point.
- **Melting point:** The temperature at which the crystalline solid and liquid are in equilibrium.
 - The stronger the intermolecular forces, the higher the melting point.
 - The more symmetrical, the higher the melting point.
- Solubility.
- Intermolecular forces.
 - All electrostatic attractions related to bond polarity.
 - 3 types: Dipole-dipole forces, hydrogen bonding, and dispersion forces.
- **Dipole-dipole forces:** Attraction between opposite poles (1 kcal/mol to 3 kcal/mol).
- **Hydrogen bonding:** Dipole-dipole interaction between H-atoms bonded to O, N, F (2 kcal/mol to 10 kcal/mol).
- **Dispersion forces:** Weak (< 1 kcal/mol). Momentary distortion of the electron cloud (temporary dipole). Induces dipoles in surrounding molecules. *Also known as London forces.*
 - Depends on relative polarizability, i.e., how far valence electrons are from the nucleus.
- IR spectroscopy: The frequencies absorbed vary based on the type. Higher stretching frequencies for lighter atoms and stronger bonds.