

Chemistry 506: Allied Health Chemistry 2

Chapter 11: Alkenes, Alkynes, and Aromatic Compounds

Hydrocarbons with Multiple Bonds

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11A Section(s) 11.1/2/4 Introduction and Nomenclature of Alkenes

- Ethene = (Ethylene), $\text{CH}_2=\text{CH}_2$

- IUPAC Rules
 - Start numbering from the end that gives the double bond the lowest number.
 - Indicate position of double bond(s) by numbers.
 - Use the **ene ending**
 - Indicated number of double bonds by prefixes (**ene, diene, triene, tetraene**, etc.)

- Examples

- Geometric Isomers
 - No free rotation (π -bonds)
 - Experimental observations

 - cis isomers vs. trans isomers

 - Examples

11B Section(s) 11.3 π -Bonds

- **Bonding:** sp^2 hybridization for 3 σ -bonds to the three atoms bonded to each carbon
- p_z orbital for π -bond
- Typical $C=C$ bond distance (i.e., 1.34 Å) shorter than $C-C$ bond distance (i.e., 1.54 Å)
- slightly shorter $C-H$ distance than alkanes

11C Section(s) 11.5 Physical Properties

- Almost identical to Alkanes of same MW
 - Van der Waals forces
- Slightly higher **Mp** and **Bp**
- **Smell** (turpentine like)
- **Density**
- **Solubility**

➤ Addition of HX ((HF) HCl, HBr (HI))

➤ Halide Influences

➤ Markovnikov Addition

➤ Addition of Water (Hydration)

➤ H⁺ Catalyst

➤ Markovnikov

11E Section(s) 11.7 Addition Polymers

- Definition of Addition **Polymers**
 - No loss of mass
 - Rapid **chain growth**
 - **π -bond opening**
 - “Generic” Synthesis Reaction
 - typical **monomers** are **$\text{CH}_2=\text{CH-R}$**

- Role of **Catalysts**
 - Speed reaction but aren't themselves consumed
 - Highly reactive species

- **Reversibility of Reactions**
 - **Polymerization** under low temperatures/high pressures
 - i.e., **monomer** (liquids or gasses) -> polymer (solids)
 - **Depolymerizations** (unraveling) at high temperatures
 - i.e., polymer -> monomer

- **Molecular Weights and Molecular Weight Distributions**
 - High average Molecular Weights
 - Distributions rather than discrete weights

- **Linear Chains vs. Branched Chains**

➤ Examples

➤ Polyethylene, PE, Synthesis



➤ Poly(vinyl chloride), PVC, Synthesis



➤ Polypropylene, PP, Synthesis



➤ Polystyrene, PS, Synthesis



➤ Poly(methyl methacrylate), PMMA, Synthesis



➤ Teflon Synthesis



➤ Rubber (Polyisoprene) Synthesis



11F Section(s) 11.8 Alkynes

- **Carbon-Carbon Triple Bonds**
 - **sp hybridized**
 - **Very Short C≡C Bond distance (i.e., 1.20 Å), much shorter than the C=C distance (i.e., 1.34 Å) and the C-C distance (i.e., 1.20 Å)**
 - **Bonding: 1 σ-bond and 2 π-bonds (p_x and p_y)**
 - **slightly shorter C-H distance than alkanes or even alkenes**
 - **Ethyne = Acetylene, H-C≡C-H**

- **Physical Properties**
 - **Almost identical to Alkanes/Alkenes of same MW**
 - **Van der Waals forces**
 - **Slightly higher Mp and Bp**
 - **Density**
 - **Solubility**

➤ Nomenclature

➤ yne ending

➤ yne > ene in priority of naming

➤ Examples

➤ Alkyne Reactions

➤ Generic Reaction

➤ Very like Alkenes

➤ Normally Double Addition

➤ Hydrogenation: Addition of H_2 or D_2 (Pt catalyst)

➤ Addition of X_2 (Cl_2 or Br_2)

➤ Addition of HX (most commonly HCl and HBr)

➤ Markovnikov Addition

➤ Addition of H_2O (H^+ catalyst)

➤ Markovnikov Addition

➤ Secondary elimination of water from diol

➤ gives carbonyl group (aldehyde or ketone)

11G Section(s) 11.9/10 Aromatic Hydrocarbons

- Sources
 - Coal Tar
 - Coke production
 - Direct separation
 - Start of industrial chemistry
 - Petroleum
 - multiple processing steps
- Uses
 - Octane enhancers in gasoline
 - Plastics
 - Pigments/Dyes
 - Pharmaceuticals
- Aromatic: Properties, Reactivity, C/H Ratios (cf. Alkane/Alkenes/Alkynes)

➤ **Substitution Reactions** not **Addition Reactions** (i.e., not like alkenes)

➤ **Bonding / Resonance Stabilization**

➤ **Common Names (IUPAC)**

➤ **Phenol** (Z = OH)

➤ **Aniline** (Z = NH₂)

➤ **Toluene** (Z = CH₃, methylbenzene)

➤ **Benzoic Acid** (Z = CO₂H)

11H Section(s) 18.2 Amino Acids having Simple Aromatic Side
Chains

➤ Generic AA = $\text{H}_2\text{N}-\text{CHR}-\text{CO}_2\text{H}$

➤ Phenyl Alanine (non-polar)

➤ R = $\text{CH}_2\text{C}_6\text{H}_5$

➤ PKU

➤ **Sulfonation** ($Z = \text{SO}_3\text{H}$, $\text{H}_2\text{SO}_4/\text{SO}_3$)

➤ **Halogenation** ($X = \text{Cl}$ or Br , Cl_2/Fe or Br_2/Fe)

11K Section(s) 11.13 Heterocyclics (Not covered in detail)

- Replace C-H by **Heteroatom Groups** such as: N, O, S, etc.

- Important in **Biomolecules**

- **Pyridine (C₅H₅N)**

Problems: All up to 11.50

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