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# Organic Chemistry Reactions (Quick Study Academic)

**Quick Study ACADEMIC**

**ORGANIC CHEMISTRY REACTIONS**

**Features of an Organic Reaction**

- Mechanism:** Describes the overall reaction using a series of single steps.
- Stoichiometry:** Calculate reactant and product masses using the balanced equation and molar masses.
- Kinetics:** Study of the reaction rate and mechanism.
- Theoretical Yield:** Mass of product given by a complete reaction, % yield =  $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$ .
- Equilibrium:** Reaction does not proceed to completion. Instead, it reaches a balanced state of forward and reverse reactions.

**Major Reaction Types**

- Acid
- Base
- Oxidation-reduction
- Coordination
- Substitution ( $S_N1$ ,  $S_N2$ )
- Radical reaction
- Isomerization
- Elimination ( $E1$ ,  $E2$ )
- Cyclization
- Hydrolysis
- Addition
- Radical reaction

**Important Named Reactions**

- Diels-Alder:** Forms cyclic alkenes.
- Friedel-Crafts:** Add aryl or alkyl group.
- Grignard:** Add alkyl or aryl group.
- Wittig:** Convert aldehydes/ketones to alkenes.

**Organic Acid & Base**

**Acid**

- Electron-pair acceptor (Lewis acid)
- Proton donor (Brønsted-Lowry acid)
- EX:** Carboxylic acid

**Base**

- Electron-pair donor (Lewis base)
- Proton acceptor (Brønsted-Lowry base)
- EX:** Amine

**Factors Enhancing Acid Strength (H<sub>A</sub>)**

- Weaker H-A bond
- Greater electronegativity of "A"
- Inductive effect of substituent on "A" (electron-withdrawing enhances transfer)
- More "s" character in hybrid orbital (s-orbital is lower in energy than p-orbital)
- Resonance-stabilized conjugate base (A<sup>-</sup>)

**Factors Enhancing Base Strength**

- Reverse of acid strength guidelines
- A base is a nucleophile, electron-rich species which shift electron density to the atom with the lone pair increases base strength

**Alkene >C=C<**

**Properties**

- Similar to alkanes, non-polar, flammable

**Nomenclature**

- Add -ene to prefix, use 1 to denote C=C position
- Isotactic:  $C=C-C-C$
- Conformation:  $C=C-C-C$
- Polymers:  $C=C-C-C$  (e.g., polyethylene)
- Alkene: Adjacent C=C-C
- Vinyl Group:  $H_2C=CH-$
- Methylene Group:  $H_2C-$
- Allyl Group:  $H_2C=CH-CH_2-$
- Vinyl Halide: Halide replaces H on  $C=C$
- Conjugated: Alternate C=C and C-C (monomers)
- Alkadiene: 2 conjugated C=C (e.g., butadiene), cis and trans isomers about C=C bond
- Alkatriene: 3 conjugated C=C
- Aromatic: Conjugated monocyclic compound
- EX:** (a) benzene, (b) cyclopentadiene, (c) cycloheptatriene

**Isomers**

- No free rotation of C=C
- E/Z isomers (cis/trans) by atomic weight
- Z: Higher priority groups on the same side

**Reactions**

- Hydrogenation:**  $C=C + H_2 \rightarrow C-C$  (heat, catalyst)
- Hydrohalogenation:**  $C=C + HX \rightarrow C-C$  (Markovnikov)
- Hydroboration:**  $C=C + BH_3 \rightarrow C-C$  (anti-Markovnikov)
- Oxidation:**  $C=C + [O] \rightarrow C=O$  (KMnO<sub>4</sub>, heat)
- Epoxidation:**  $C=C + [O] \rightarrow C-O-C$  (mCPBA)
- Diels-Alder:**  $C=C + C=C \rightarrow C-C$  (heat)
- Wittig:**  $C=O + Ph_3P=CH_2 \rightarrow C=C$

**Kinetics & Reaction Mechanism**

**Transition State (TS):** Maximum on the reaction coordinate curve, the least stable intermediate.

**Activation Energy (E<sub>a</sub>):** Energy of the TS relative to the reactants. The change in enthalpy ( $\Delta H$ ) is  $\approx 0$  for exothermic reactions and  $\approx 0$  for endothermic reactions.

**Hammett-Laurer Plot:** The TS is more like the reactant or product that is closer in energy. The endothermic TS is like the product and the exothermic TS is like the reactant.

**Kinetic vs. Thermodynamic Control:**  $\Delta G$  and  $\Delta H$  describe thermodynamic stability. If  $\Delta G$  is large and negative (exergonic), the product formation is likely controlled by "thermodynamics." A large  $E_{a,TS}$  corresponds to a large amount of product relative to reactant. A large  $E_{a,TS}$  may give rise to "kinetic" control, the energy of the TS controls the reaction, instead of the product-reaction thermodynamics.

**Solvent Effects:** A solvent may stabilize an intermediate, decreasing the  $E_{a,TS}$  and increasing the rate of the reaction. Charged complexes are stabilized by polar solvents.



## Synopsis

Quick Reference for the core essentials of a subject and class that is challenging at best and that many students struggle with. In 6 laminated pages our experienced chemistry author and professor gathered key elements organized and designed to use along with your text and lectures, as a review before testing, or as a memory companion that keeps key answers always at your fingertips. As many students have said "a must have" • study tool. Suggested uses:

- Quick Reference " instead of digging into the textbook to find a core answer you need while studying, use the guide to reinforce quickly and repeatedly
- Memory " refreshing your memory repeatedly is a foundation of studying, have the core answers handy so you can focus on understanding the concepts
- Test Prep " no student should be cramming, but if you are, there is no better tool for that final review

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