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Organic Chemistry Reactions (Quick Study Academic)

ORGANIC CHEMISTRY REACTIONS

Features of an Organic Reaction

- Mechanism:** Describes the overall reaction using a series of simple 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
- Condensation
- Substitution (S_N1 , S_N2)
- 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 aldehyde/ketone to alkene

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_A)

- Weak H-A bond
- Greater electronegativity of "A"
- Inductive effect of substituent on "A" (electron-withdrawing enhances transfer)
- Misc "A" character in hybrid orbital (s-orbital is lower in energy than p-orbital)
- Resonance-stabilized conjugate base (A⁻)

Factors Enhancing Base Strength

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

Alkane

Properties

- Hydrocarbon
- Weak intermolecular forces
- Non-Cyclic: General formula C_nH_{2n+2}
- Tetrahydral: $C-C-C$ (109°)

Isomerism

- Add "ane" to prefix
- Locate substituent by position #
- Halohalkane:** Substrate halide for $SN2$

Cycloalkane (C_nH_{2n})

- Bicyclic: Two fused or bridged rings
- Cyclopropane: $n = 3$ (highly strained)
- Cyclobutane: $n = 4$ (some flexibility)
- Cyclopentane: $n = 5$ (slight puckering)
- Cyclohexane: $n = 6$ (two strains)

Chair Conformation: Stable conformer

- Equatorial Position:** Perpendicular to ring
- Axial Position:** In ring plane
- See H_a and H_e in chair diagram below
- Cis:** Two substituents in the up position
- Trans:** One substituent up and one down

Reaction

- Combustion:** Alkane + $O_2 \rightarrow CO_2 + H_2O$
- Halogenation:** Alkane + Cl_2 (hv, light or heat)

Alkene

Properties

- Similar to alkane, non-polar, flammable
- Add "ene" to prefix, use # to denote C=C position
- Isolated:** $C=C-C-C=C$
- Conjugated:** $C=C-C=C$
- Polysubstituted Fatty Acid:** 2 or more C=C
- Alkene:** Adjacent C=C
- Vinyl Group:** $H_2C=CH-$
- Methylene Group:** CH_2
- Allyl Group:** $H_2C=CH-CH_2-$
- Vinyl Halide:** Halide replaces H on "C=C"
- Conjugated:** Alternate C=C and C-C (isomeric)
- 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:** (i) benzene + benzene
- Aromatic Cyclic Ions:** Cyclopentadienyl anion, cycloheptatrienyl cation (6 electrons)

Isomers

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

Reaction

- Hydration:** H_2O (acid catalyst)
- Hydrohalogenation:** HX (acid catalyst)
- Hydroboration:** BH_3 (acid catalyst)
- Hydrogenation:** H_2 (Pt catalyst)
- Wittig:** Aldehyde/ketone + phosphonium ylide



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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