Cheatography

Organic Chemistry Exam 1 Cheat Sheet

by teganski via cheatography.com/211266/cs/45736/

Starting Material → Alkene

Name	Reagents	Regiochemistry	Stereochemistry	Functional Outcome	Mechanism
Hydrohalogenation (HX Addition)	HX $^{(HCl, HBr, HI)}$	Markovnikov (X attaches to more substituted carbon)	Racemic	Alkyl Halide	*
Hydrodrohalogenation (HX Addition with Peroxide)	HBr, ROOR $^{(peroxide)}$	Anti-Markovnikov (X attaches to less substituted carbon)	Racemic	Aklyl Halide	*
Acid-Catalyzed Hydration	H_2SO_4, H_2O (or H_3O^+)	Markovnikov	Racemic	Alcohol	
Oxymercuration-Demurcuration	1. $Hg(OAc)_2$, H_2O 2. $NaBH_4$	Markovnikov	Anti-Addition	Alcohol	
Hydroboration-Oxidation	1. BH_3, THF 2. H_2O, NaOH	Anti-Markovnikov	Syn-Addition	Alcohol	

Starting Material → Alkene (cont)

Halogenation (X_2 Addition)	X_2 $^{(Br_2,\ Cl_2)}$	None	Anti-Addition	Vicinal Dihalide
Halohydrin Formation	X_2, H_2O	Markovnikov	Anti-Addition	Halohydrin
Hydrogenation	H_2, Pt/Pd/Ni	None	Syn-Addition	Alkane
Dihydroxylation (Syn)	OsO_4 or $KMnO_4$ (cold, dilute), $NaHSO_3$	None	Syn-Addition	Vicinal Diol
Dihydroxylation (Anti)	1. mCPBA 2. H_3O^+	None	Anti-Additino	Vicinal Diol
Ozonlysis	1. O_3 2. Me_2S (DMS) or Zn/H_2O	None	None	Aldehyde/Ketone

Ranking Radical Stability

1. Benzylic/Allylic Radicals **[MOST STABLE]**
2. Tertiary (3°) Radicals
3. Secondary (2°) Radicals
4. Primary (1°) Radicals
5. Methyl Radicals

Key Factors Affecting Stability:

Resonance Stabilization (Allylic & Benzylic > Non-resonance stablized)

Hyperconjugation (More alkyl groups donate electron density)

Inductive Effects (Electron-withdrawing groups destabilize)

Number of Unique Products

NBS (Allylic Bromination)	**Cl_2/hv** (Radical Chlorination)
Selective Only abstracts the **allylic hydrogen**	*Less selective* attacks **all possible C-H bonds**
Favors one major product due to resonance stabilization	**More radical products** due to no preference
Highly Selective → Major product at most stable radical site	Non-selective → Multiple products

Arrow Pushing in Radical Reactions

Fishhook Arrows → movement of 1 electron

Initiation → arrows depict homolytic cleavage

Propagation → 1 radical reacts to form another

Termination → 2 radicals combine to form a stable molecule

Terms to Know

Markovnikov's Rule → *addition reactions* proton added to the *carbon* with the **most** *hydrogen* atoms attached	**Geminal** → 2 atoms bonded to the *same side* of the carbon
Anti-Markovnivkov's Rule → *addition reactions* proton added to the *carbon* with the **least** *hydrogen* atoms attached	**Vicinal** → 2 atoms bonded to *same* carbon
Zaitsev's Rule → *elimination reaction*, major product is the **more stable** alkene with the **highly substituted** double bond	**Syn-Addition** → added to *same side* of compound

Terms to Know (cont)

E/Z System → Prioritize the 2 groups attached to each carbon relative to one another. *Higher* priority groups are: **cis/same side** → Z **trans/opposite sides** → E	**Anti-Addition** → added to *different sides* of compounds

Oxidation State of Carbons

C-H bond → carbon gains **-1** per hydrogen

C-C bond → no change **(0)**

C-X bond → carbon loses **+1** per electronegative atom

The **oxidation state** of a carbon atom depends on its **bonds** to atoms of different electronegativities

NMR

^{1}H NMR	**^{13}C NMR**
Chemical Shift Trends	*Chemical Shift Trends*
0-2 ppm → Alkane	**0-50 ppm** → Alkane
2-3 ppm → Allylic, benzylic, alkynyl	**50-100 ppm** → Alcohol, ether, alkynes
4-6 ppm → Alkene	**100-150 ppm** → Aromatic, alkene

NMR (cont)

6-8 ppm → Aromatic	**150-200 ppm** Carbonyl (ketone, aldehyde, carboxylic acid)
9-10 ppm → Aldehyde	
10-12 ppm → Carboxylic acid (broad)	

Splitting Patterns (n+1 rule)
Singlet → no adjacent protons
Doublet → 1 adjacent proton
Triplet → 2 adjacent protons

IR Spectroscopy

Key Peaks

O-H (Alcohol) → 3200-3600 cm^{-1} (broad)
C-H (Alkanes) → 2800-3000 cm^{-1}
C=O (Carbonyls) → ~1700 cm^{-1}
C=C (Alkene) → ~1650 cm^{-1}
C≡C, C≡N → ~2100-2200 cm^{-1}

Starting Material → Alkyne

Substitution Reactions

S_N1 (Unimolecular)	S_N2 (Bimolecular)
Mechanism → Two-step; carbocation formation, nucleophilic attack	**Mechanism** → One-step; backside attack

Substitution Reactions (cont)

Rate → Dependent *only* on substrate rate=k[R-X]	**Rate** → Dependent on *both* substrate & nucleophile rate=k[R-X][Nu-]
Stereochemistry → Racemic mixture	**Stereochemistry** → Inversion of configuration
Preferred Conditions → Weak nucleophile, polar protic solvent	**Preferred Conditions** → Strong nucleophile, polar aprotic solvent
Tertiary > Secondary > ~~*Primary*~~	Methyl > Primary > Secondary > ~~*Tertiary*~~

Elimination Reactions

E1 (Unimolecular)	**E2** (Bimolecular)
Mechanism → Two-step; carbocation intermediate, base deprotonates	**Mechanism** → One-step; concerted β-H abstraction
Rate → Dependent *only* on substrate	**Rate** → Dependent on *both* substrate and base

Elimination Reactions (cont)

Regiochemistry → Zaitsev's Rule (more substituted alkene favored)	**Regiochemistry** → Zaitsev's Rule (unless bulky base → Hofmann product)
Stereochemistry → Forms most stable alkene	**Stereochemistry** → Anti-periplanar elimination
Preferred Conditions → Weak base, polar protic solvent	**Preferred Conditions** → Strong base required
Tertiary > Secondary > ~~*Primary*~~	Primary > Secondary > Tertiary (as long as β-H is anti-periplanar)