

Reactions Organized by Compound Families

Alkanes

1. Combustion
2. Halogenation

Alkenes and Alkynes

1. Additions: hydrogenation, halogenation & halohydrin formation*, hydrohalogenation, hydration
2. Polymerization
3. Hydroboration*
4. Oxidation (KMnO₄) and Ozonolysis (O₃)*
5. Free radicals
6. Epoxide synthesis

Aromatic Compounds

1. Substitutions: nitration, halogenation, sulfonation
2. Friedel Crafts Alkylation/Acylation *
3. Reduction w/ H₂ Rh/C at 100°C*

Alcohols

1. Elimination: dehydration
2. Oxidations
3. Ether synthesis: acid-catalyzed dehydration of ethanol*, Williamson Ether*, Alkoxymercuration-Demercuration*

Aldehydes and Ketones

1. Addition: Acetal/hemiacetal formation by alcohol addition (Reverse reaction: Acetal hydrolysis with acid), imine* & enamine formation*
2. Michael addition*
3. Oxidation and Reduction for aldehydes
(**Ketones go through reduction only*)
4. Wittig*
5. Grignard Reaction*

Amines

1. Acid-Base reactions
2. (Hoffman elimination: from amine to alkene)*
3. Gabriel Synthesis: primary alkyl halide-> primary amine*

Carboxylic Acids

1. Substitutions: esterification, amidation (Reverse reaction: ester hydrolysis with acid or base, amide hydrolysis with acid or base)
2. Acid-base reactions
3. Decarboxylation of β keto acids*

Epoxides

1. Nucleophilic ring-opening*
2. Acid-catalyzed ring-opening*

Pericyclic Reactions

1. Cycloaddition*
2. Electrocyclic*
3. Sigmatropic*

Phosphoric acid and Phosphates

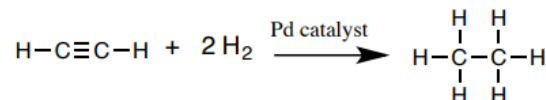
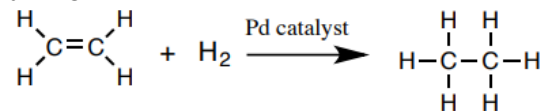
1. Phosphoric acid: Esterification with alcohol
2. Phosphates: Phosphorylation

Reactions Organized by Reaction Type

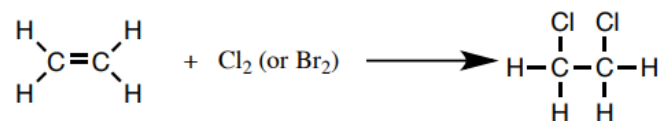
1. ADDITION

a. Alkenes and alkynes

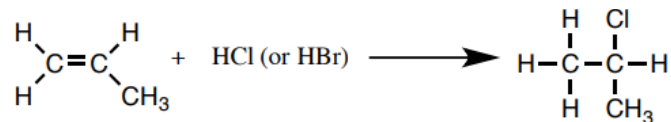
■ Hydrogenation



■ Halogenation

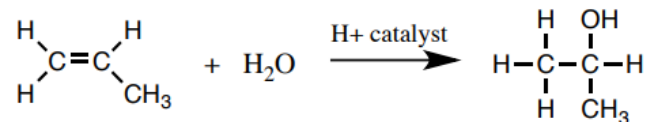


■ Hydrohalogenation



Markonikov's Rule
applies: H adds to C
with more Hs already.

■ Hydration

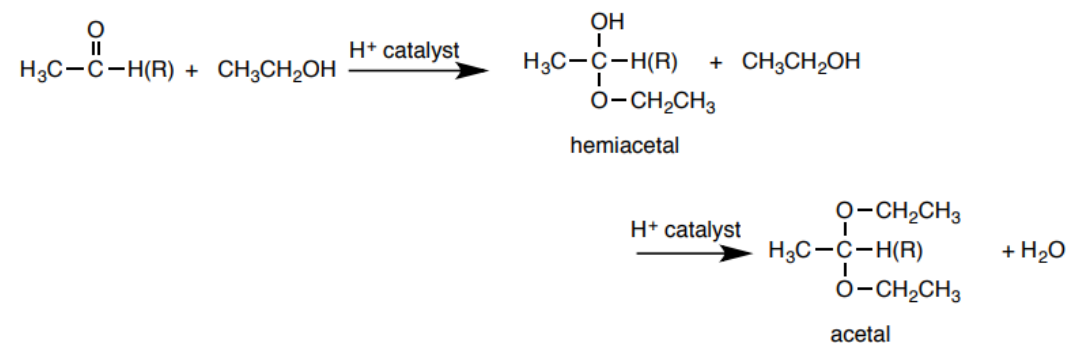


Markonikov's Rule
applies.

b. Aldehydes and ketones

■ Addition of alcohol to get hemiacetals or acetals

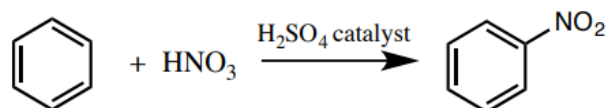
Organic Chemistry Reaction Sheet



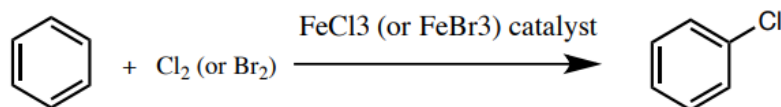
2. SUBSTITUTION

a. Aromatic compounds

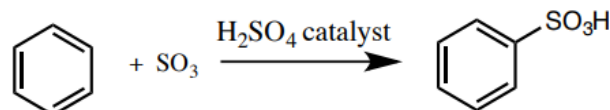
■ Nitration



■ Halogenation

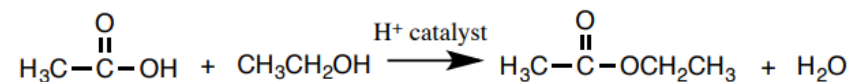


■ Sulfonation

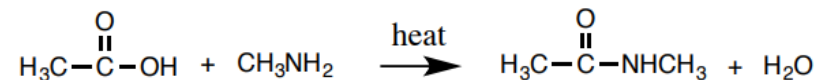


b. Carboxylic acids

■ Esterification with alcohol



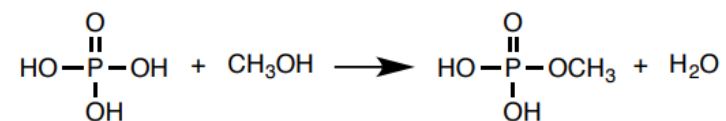
■ Amidation with amine



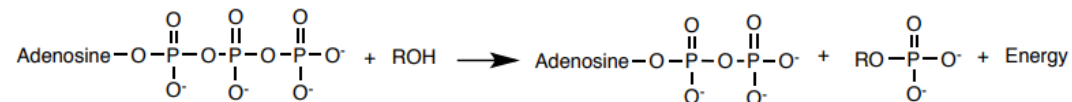
c. Phosphoric acid and phosphates

Organic Chemistry Reaction Sheet

- Phosphoric acid: Esterification with alcohol



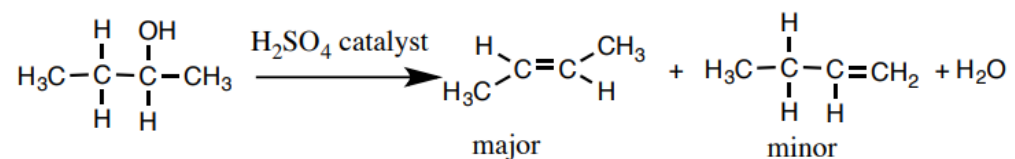
- Phosphates: Phosphorylation



3. ELIMINATION

a. Alcohols

- Dehydration

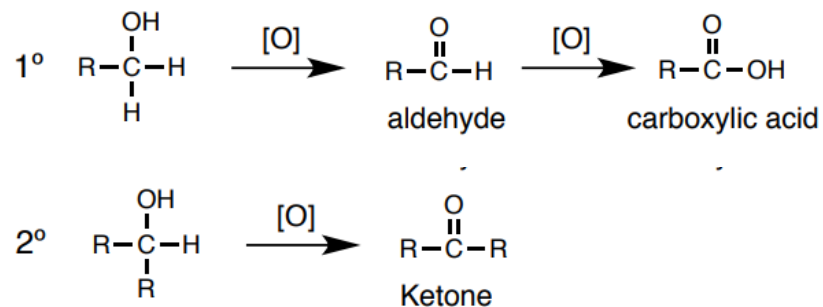


Zaitsev's Rule applies: More highly substituted alkene is major product.

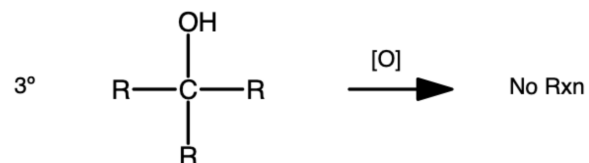
4. OXIDATION/REDUCTION

a. Alcohols

- Oxidation

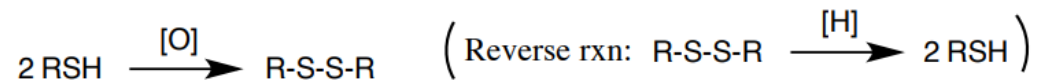


Organic Chemistry Reaction Sheet



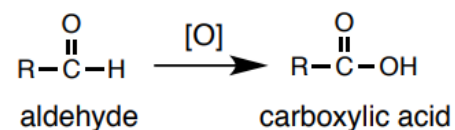
b. Thiols

■ Oxidation

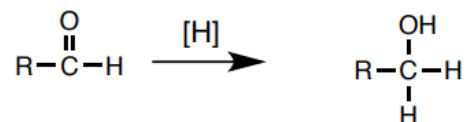


c. Aldehydes

■ Oxidation

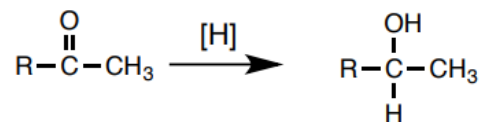


■ Reduction (also addition)



d. Ketones

■ Reduction (also addition)



5. ACID-BASE

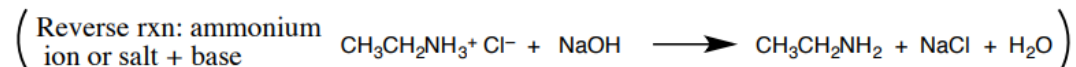
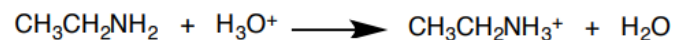
a. Amines (basic)

■ Reaction with water



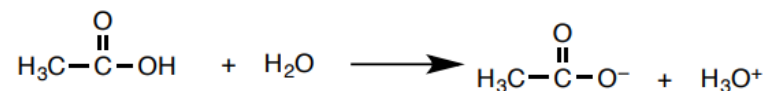
■ Neutralization with strong acid to get ammonium ion or salt

Organic Chemistry Reaction Sheet

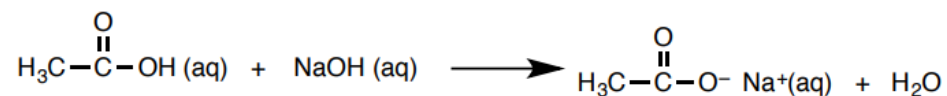


b. Carboxylic acids (acidic)

- Rxn with water



- Neutralization with a strong base to get carboxylic acid salt



c. Phenols (very weakly acidic)

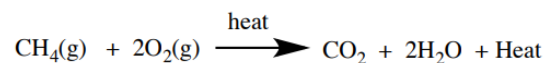
- Neutralization with a strong base to get salt



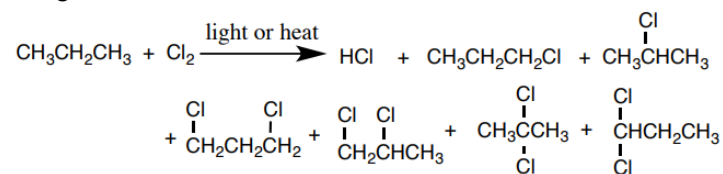
6. RADICAL REACTIONS

a. Alkanes

- Combustion (also oxidation/reduction reaction)



- Halogenation

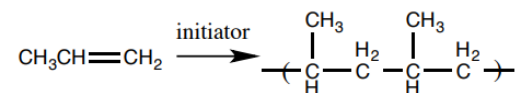


Mixed products

b. Alkenes

Organic Chemistry Reaction Sheet

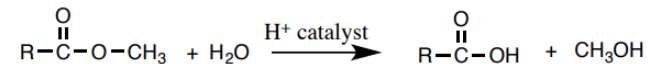
■ Polymerization



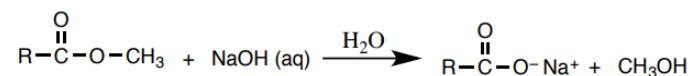
7. HYDROLYSIS

a. Esters (reverse reactions of carboxylic acid esterification)

■ Acid hydrolysis to get carboxylic acid and alcohol

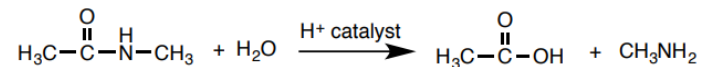


■ Saponification: Base hydrolysis to get carboxylic acid salt and alcohol

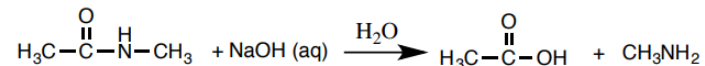


b. Amides (Reverse reactions of carboxylic acid amidation)

■ Acid hydrolysis to get amine

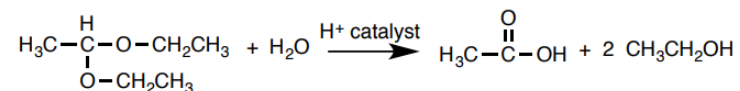


■ Base hydrolysis to get amine



c. Acetals (Reverse reaction of acetal formation from aldehydes/ketones)

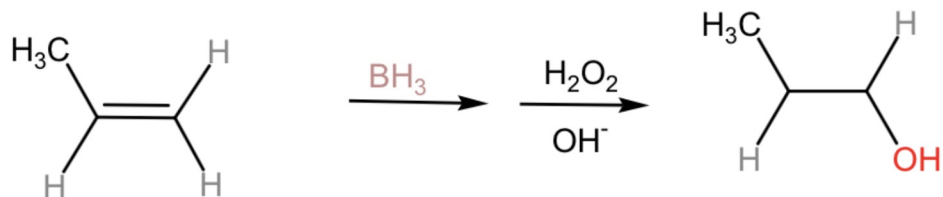
■ Acid hydrolysis to get aldehydes of ketones (reverse of acetal formation)



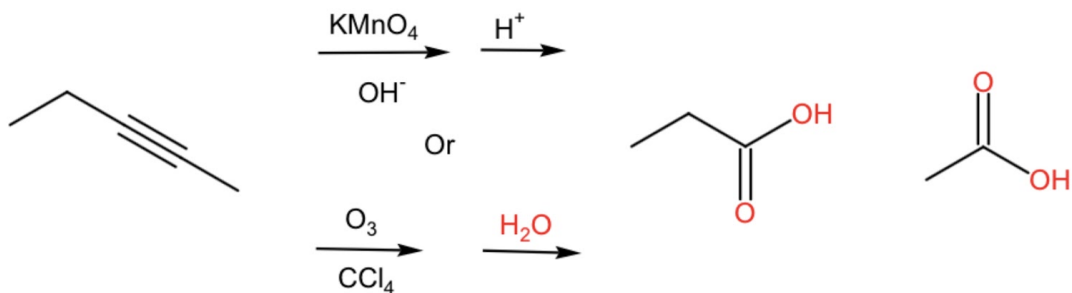
Other Reaction Types

Additional Reactions for consideration

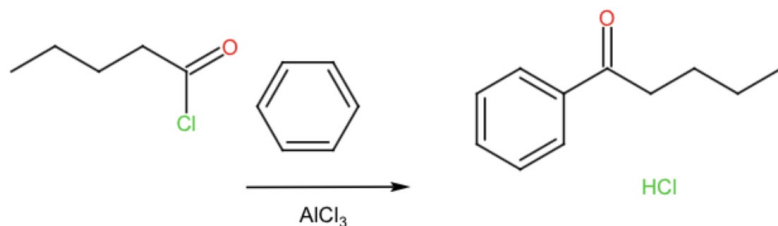
1. Hydroboration Reaction: reduction of an alkene (syn addition of OH)/alkyne (produces cis-alkene)



2. Oxidation/Ozonolysis of Alkene/Alkynes

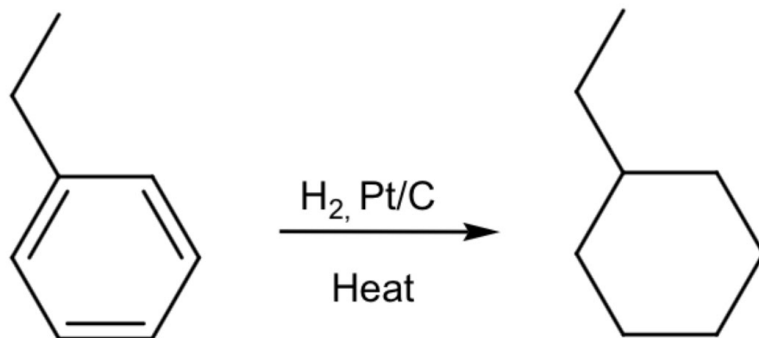


3. Friedel-Crafts Acylation (Part of Electrophilic Additions to Benzene)

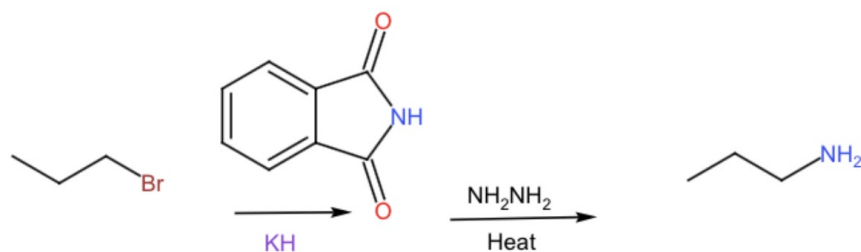


Organic Chemistry Reaction Sheet

4. Reduction of Aromatic Compound via H_2 and heat

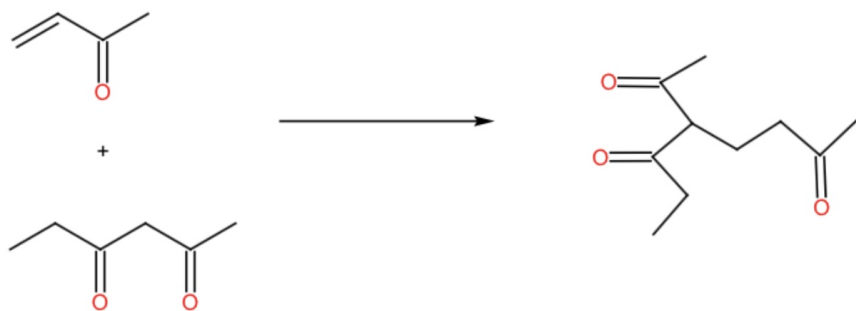


5. Gabriel Synthesis- the substitution of a primary acyl halide to a primary amine

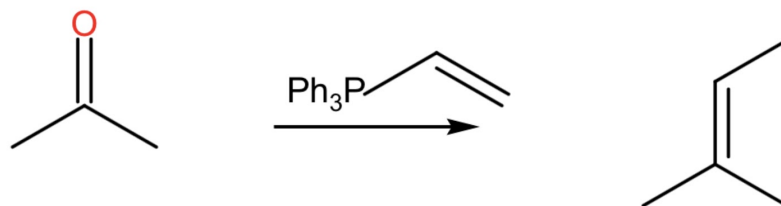


6. Michael Addition: addition to an enolate carbanion (formed with a strong base like LAH) of a carbonyl compound with a neighboring double bond

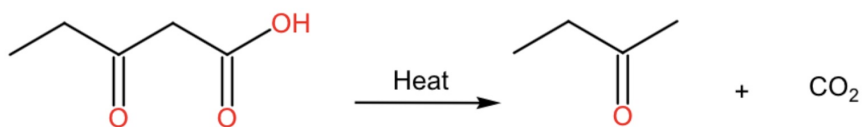
Organic Chemistry Reaction Sheet



7. Wittig Reaction: substitution of C=O double bond with C=C

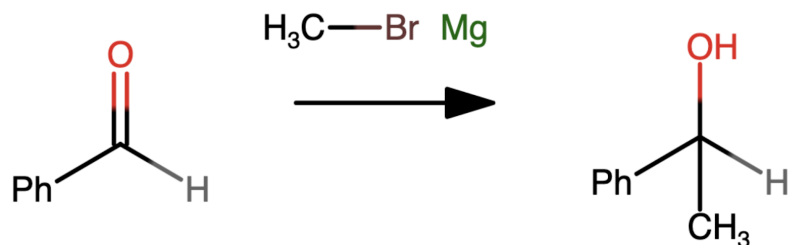


8. Decarboxylation of a beta keto acid: heat produces carbonyl compound + CO₂

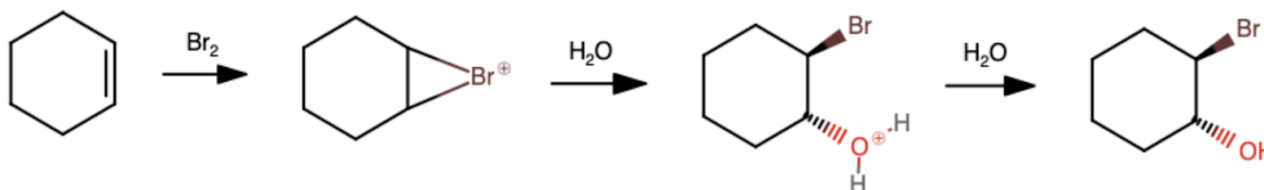


Organic Chemistry Reaction Sheet

9. Grignard Reaction: nucleophilic attack of Grignard reagent (RXMg) on a δ^+ carbonyl carbon to form an alcohol



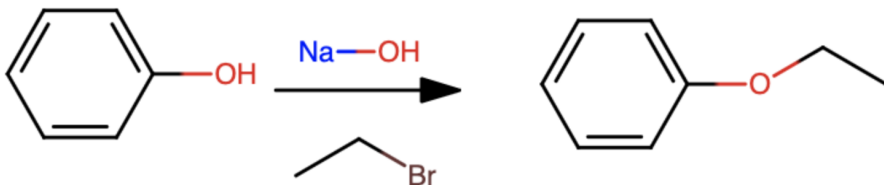
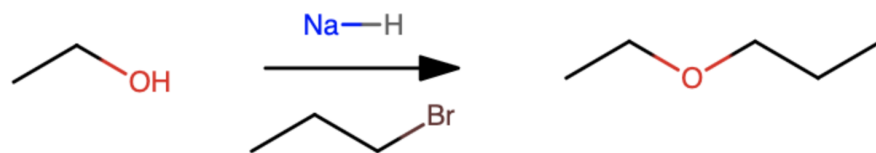
10. Halohydrin formation: halogenation reaction plus water, with anti-addition of an OH and halogen group to an alkene



11. Ether synthesis: acid-catalyzed dehydration of EtOH, AKA solvolysis or ethanolsis

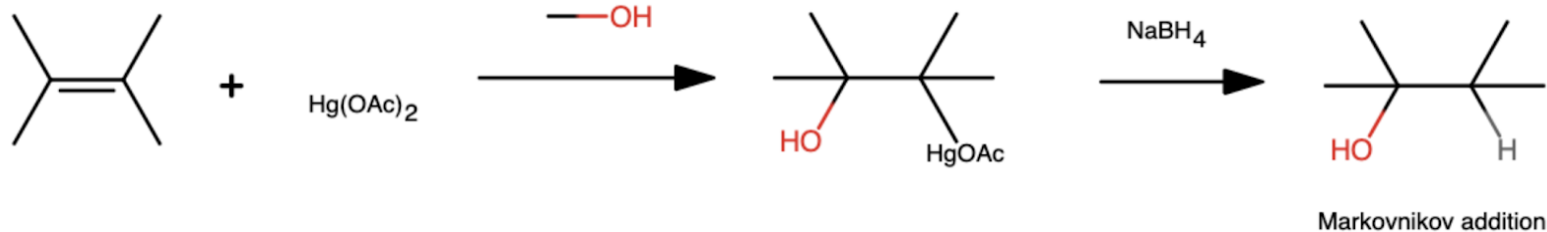


12. Williamson ether synthesis: formation of asymmetrical ethers using NaH or NaOH in acidic conditions and RX ; does not apply to 3° alkyl halides



Organic Chemistry Reaction Sheet

13. Alkoxymercuration-Demercuration: Markovnikov addition of an alcohol to an alkene, followed by NaBH₄ reduction

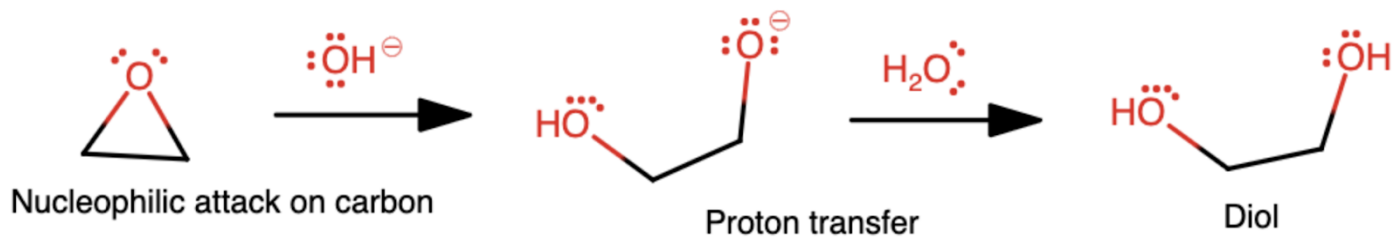


14. Free radical addition: ether reaction with O₂, AKA autooxidation, causes explosive hydroperoxide to form

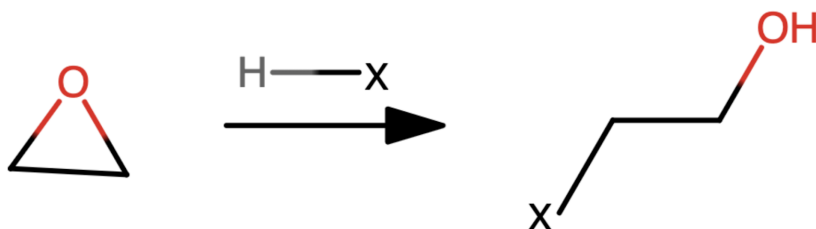


15. Epoxide ring openings:

a. Nucleophilic



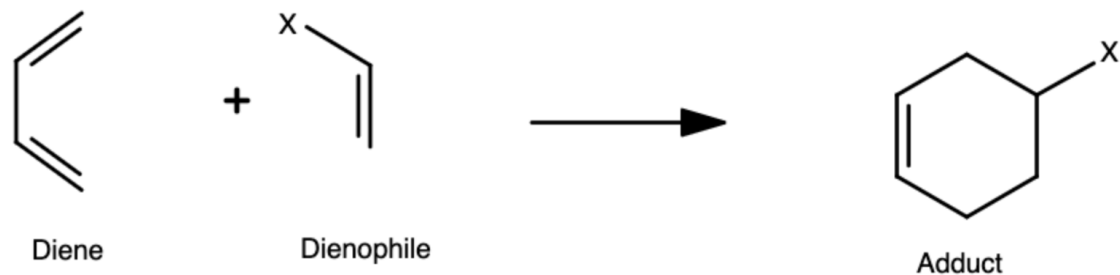
b. Acid-catalyzed



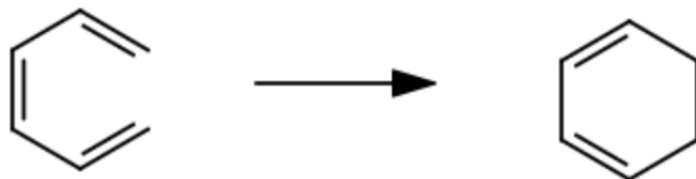
16. Pericyclic reactions

Organic Chemistry Reaction Sheet

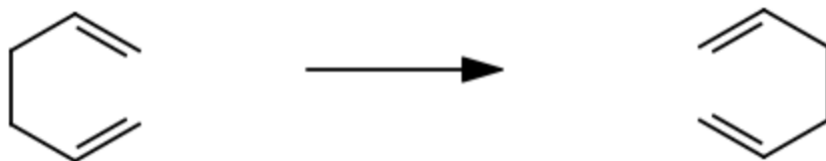
- a. Cycloaddition, AKA Diels-Alder reaction: addition of a diene to a monosubstituted double bond, creating a cyclic compound with the same number of bonds



- b. Electrocyclic addition: rearrangement of double bonds to create a cyclic compound



- c. Sigmatropic rearrangement: migration of sigma bonds around a conjugated system



Organic Chemistry Reaction Sheet

17. Imine/Enamine formation: aldehyde/ketone (R_2CO) reaction with a primary or secondary amine under acidic conditions, resulting in a carbon-nitrogen double bond or rearranged carbon-carbon double bond, respectively

