Date:

NAME:

Reactions Of Alkenes And Alkynes

Date:

Reactions of Alkenes

1. Why is addition a characteristic reaction of Alkenes?
Alkenes are _____ hydrocarbons, therefore…

{Alkene + X-Y → Alkane}

2. **What is Markovnikov's Rule? How can I apply it to predict a reaction product?**

Markovnikov's Rule

1. Reviewing the reaction between Ethylene and HCl

Ethylene + HCl → carbocation intermediate → chloraethane

2. Addition of HI to 1-Pentene

Orientation of addition-Markovnikov's rule:

i. In addition of HX to a double bond, H attaches to the carbon with fewer substituents, and X attaches to the carbon with more substituents.

OR

In addition of HX to a double bond, the more highly substituted carbocation intermediate is formed.

Example: 1-methylcyclohexene + HCl →

ii. If the carbons have the same number of substituents, a mixture of products results.

Example: 2-Pentene + HBr →

Do 4.1, 4.2

Date:

Carbocation Structure and Stability:

EQ: Explain how Markovnikov's Rule works with respect to carbocation structure and stability.

1. Carbocation Structure:

- **Carbocations are _____**
- **Positively charged carbon atom is _____ hybridized**
- **The 3 substituents bonded to it are oriented to the corners of an _____**
- **_____ orbital is vacant**

2. Stability: Stability increases with increasing alkyl substituents.

Try 4.3

E.Q.: How do I predict the reaction product(s) for the following:

1. **Hydrohalogenation of alkenes (**addition of HX to a double bond)

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Example:

Date:

Naming Alkylhalides

Refer to page 212-213 (Section 7.1)

Do 7.1, 7.2 on page 213

Date:

2. **Hydration of alkenes**
   a. Water adds to alkenes to yield alcohols in the presence of a strong acid catalyst.
   b. Although this reaction is important industrially, reaction conditions are too severe for most molecules.

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Example:

Naming Alcohols

Refer to page 244 – 246 (Section 8.1)

Do 8.1(a,c,d), 8.2, 8.3 (a-d) on page 246

Date:

Mechanism

Try 4.4, 4.5

Date:

3. Halogenation of Alkenes (Addition of halogens)

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Example:

Try 4.6, 4.7

Date:

Mechanism: Bromination

a. Br_2 and Cl_2 react with alkenes to yield 1, 2-dihaloalkanes.

b. Reaction occurs with anti sterochemistry-both bromines come from opposite sides of the molecule.

c. The reaction intermediate is a cyclic bromonium intermediate that is formed in a single step by interaction of an alkene with Br^+.

Date:

4. Hydrogenation of alkenes

a. Catalytic hydrogenation reduces alkenes to saturated hydrocarbons.

b. Catalytic hydrogenation is a heterogeneous process that takes place on the surface of the catalyst.

c. Hydrogenation occurs with syn stereochemistry.

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Example:

Try 4.8

Date:

5. Oxidation of alkenes

A. Hydroxylation: Takes place in Basic medium

Hydroxylation: two –OH groups are added to the double bond when an alkene reacts with $KMnO_4$ under basic conditions.

*The reaction occurs with syn stereochemistry and yields a diol.

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Example:

B. Cleavage: takes place in Acidic medium

b. Cleavage occurs when an alkene is treated with acidic $KMnO_4$.

*The products may be ketones, carboxylic acids or CO_2.

Reaction Name:	
What are the reactants?	
What (if any) is the solvent/catalyst/pH of reactants?	
What does it yield?	

Date:

Degree of C	Product	Name of product

Example:

Try 4.9, 4.10

Date:

Naming Aldehydes, Ketones, Carboxylic Acids

Read Page 279-281 (Section 9.2)
Answer: 9.2 (a, c, d, e, f), 9.3 (a, b, c, e, f)

Read Page 306-309 (Section 10.1)
Answer: 10.1 (a-e), 10.2 (a, b, d)

Date:

Complete the following:
Textbook problems: 4.21, 4.23, 4.27, 4.28, 4.29, 4.32, 4.33, 4.35(i), 4.39, 4.41, 4.42, 4.51

Date:

Biological addition reactions of alkenes
What are enzymes-catalyzed reactions?

Alkene polymers

What are polymers and how do they affect our daily lives?

1. Many types of polymers can be formed by radical polymerization of alkene monomers.

2. There are 3 steps in a polymerization reaction.

a. Initiation involves hemolytic cleavage of a weak bond to form a radical
*The radical adds to an alkene to generate an alkyl radical.

b. The alkyl radical adds to another alkene molecule to yield a second radical.
*This step is repeated many, many times (up to 100,000 times for some polymers).

c. Termination occurs when two radical fragments combine.

Date:

Common Polymers:

Polymer Name	Monomer Formula	Polymer
Polyethylene (PE)	**$CH_2=CH_2$**	
Polypropylene (PP)	**$CH_2=CHCH_3$**	
Polyvinyl chloride (PVC)	**$CH_2=CHCl$**	
Polystyrene (PS)	**$CH_2=CHC_6H_5$**	
Teflon	**$F_2C=CF_2$**	
Orlon or Acrilan	**$CH_2=CHCN$**	
Plexiglas or Lucite	**$CH_2=C(CO_2CH_3)(CH_3)$**	
Polyvinyl acetate	**$CH_2=CHOCOCH_3$**	

Try 4.11

Date:

Conjugated dienes and resonance

What are conjugated dienes?

What is the structural difference between conjugated and non-conjugated dienes?

1. In conjugated dienes, there is overlap of the π orbitals of the double bonds across the central single bond.
2. This overlap leads to formation of both 1,2 and 1,4 addition products.
3. Mechanism of 1,4-addition: allylic cations (Section 4.11)
   a. The reaction intermediate of addition to a diene is an allylic cation.
   b. An allylic cation is a resonance hybrid of two different forms.
   c. In general, the more resonance forms that can be drawn for a structure, the greater the stability.

Try 4.12

Drawing and interpreting resonance structures
1.Resonance forms are imaginary.
2. Resonance forms differ only in the placement of π or nonbonding electrons.
3. Different resonance forms of a structure don't have to be equivalent.
4. Resonance forms must be valid Lewis forms and must obey normal rules of valency.
5. Resonance leads to stability.

Try 4.13 – 4.15

Date:

Addition Reactions: Alkynes

1. Addition of HX:

In the addition of HX to alkyne, the more highly substituted carbocation intermediate is formed rather than the less highly substituted one. (Remember Markovnikov's Rule?)

a. $CH_3CH_2CH_2CH_2C{\equiv}CH + HBr \rightarrow$

b. $CH_3CH_2C{\equiv}CH + HCl \rightarrow$

2. Addition of H_2:

a. With *1 equivalents* of H_2

$$CH_3(CH_2)_3C{\equiv}C(CH_2)_3CH_3 \xrightarrow[\text{Pd/C}]{2H_2}$$

b. With 2 *equivalent* of H_2

$$CH_3(CH_2)_3C{\equiv}C(CH_2)_3CH_3 \xrightarrow[\text{Catatyst}]{\text{Lindlar}} H_2$$

3. Addition of X_2:

$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}C{\equiv}CH + Br_2 \rightarrow$

Date:

Hydration of alkynes

4. Addition of H_2O:

a. The –OH group adds to the more substituted carbon to give Markovnikov product.
b. The intermediate enol product tautomerizes to a ketone.
c. A mixture of products is formed from an internal alkyne, but a terminal alkyne yields a methyl ketone.

$$CH_3\,CH_2CH_2C{\equiv}CH + H_2O \xrightarrow[HgSO_4]{H_2SO_4}$$

$$CH_3CH_2C{\equiv}CCH_3 + H_2O \xrightarrow[HgSO_4]{H_2SO_4}$$

Date:

Try These: 4.17 – 4.19

Date:

Formation of acetylide anions

a. Terminal alkynes are weakly acidic (pK_a=25)
b. Very strong bases (-NH_2) Can deprotonate terminal alkynes.
c. Acetylide anions can react with haloalkanes to form substitution products.
   i. The nucleophilic acetylide anion attacks the electrophilic carbon of a haloalkane to produce a new alkyne.
   ii. This reaction is called an alkylation reaction.
d. Acetylide alkylations are limited to primary alkyl bromides and iodides.

Try 4.20

Date:

End of the Chapter 4 Problems:

4.25: §4.10 – §4.13
4.26: §4.10 – §4.13
4.27: §4.1 – §4.13
4.28: §4.13
4.29: §4.13
4.30: §4.10
4.31: §4.10 – §4.13
4.32: §4.1 – §4.7

4.33: §4.1 – §4.7
4.34: §4.7
4.35: §4.5
4.36: §4.1 – §4.6
4.37: §4.6 – §4.7
4.38: §4.7
4.39: §4.4
4.40: §4.13

4.41: §4.7
4.42: §4.13
4.43: §4.13
4.44: §4.1 – §4.13
4.45: §4.13
4.46: §4.13
4.47: §4.10 – §4.12

4.48: §4.10 – §4.12
4.49: §4.10 – §4.12
4.50: §4.10 – §4.12
4.51: §4.7
4.52: §4.9
4.53: §4.9
4.54: §4.1 – §4.6
4.55: §4.6 – §4.7
4.56: §4.6 – §4.7

4.57: §4.7
4.58: §4.13
4.59: §4.9
4.60: §4.1 – §4.3
4.61: §4.1 – §4.3
4.62: §4.10 – §4.13
4.63: §4.7
4.64: §4.7