Ch. 7 Structure and Synthesis of Alkenes

7.1,2 Review

Bond Strength	
C-C σ Bond	83 kcal/mol
C=C π Bond	63 kcal/mol

- π Bonds are much weaker
- π Bonds are thus more breakable and more reactive

Double Bonds can't rotate

7.3 Elements of Unsaturation ("EU")

- **"Saturated Alkane"**: C_NH_{2N+2}
- **Unsaturated** Formula: Has less than the maximum 2N+2 number of hydrogens

1. "**Element of Unsaturation**": Something that reduces the hydrogen count by two
   a. Double bond
   b. Ring
2. Each element of unsaturation reduces the hydrogen count by two
3. A molecule may well have several elements of unsaturation, each one progressively reducing it's hydrogen count by two.

4. Knowing how many elements of unsaturation are present helps to classify, and helps in isomer problems.

5. Calculating EU

General Concept

$$EU = \frac{\text{Theory \# H's} - \text{Actual \# H's}}{2}$$

For Formulas With Nothing Other than C, H, or O

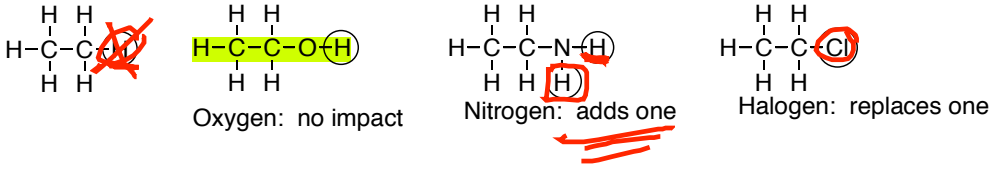
$$EU = \frac{(2C + 2) - H}{2}$$

C = # C's
H = # H's
N = # N's
X - # halogens

For Formulas That May Include Nitrogen or Halogens

$$EU = \frac{(2C + 2 + N) - (H + X)}{2}$$

6. Heteroatom Effect:
   - Oxygens: No effect
   - Nitrogen: each nitrogen increases the theory # H's by 1
   - Halogen: each halogen takes the place of a hydrogen and reduces the theory # H's by 1.



Calculate how many elements of unsaturation are in the following formulas:

2. C_5H_{12} Theory: $(5\times2)+2=12$ Actual: 12 EU $= \frac{12-12}{2} = \frac{0}{2} = 0$

3. C_4H_8 $\frac{10-8}{2} = \frac{2H \text{ short}}{2} =$ 1 EU

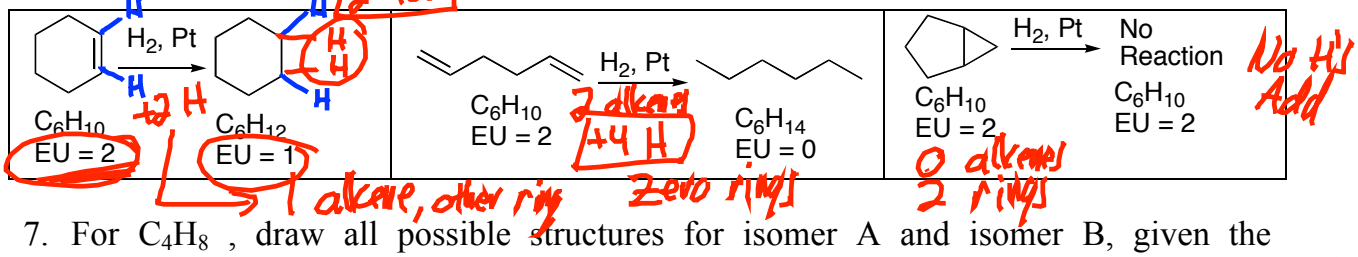
or 4. C_3H_4O $\frac{8-4}{2} = \frac{4H \text{ short}}{2} \Rightarrow$ 2 EU

hal 5. C_5H_9Cl $\frac{12-(9+1)}{2} =$ 1 EU

Nit 6. $C_4H_{11}N$ $(10+1)-11 =$ 0 EU

Distinguishing Rings from Double Bonds by H_2/Pt Hydrogenation

a. H_2/Pt will "saturate" **all** C=C double bonds by adding H_2 across each one.
b. However, rings will not add hydrogen upon treatment with H_2/Pt
c. Thus you can count how many of your EU's are rings versus double bonds
d. Note: 2H's add per 1 double bond

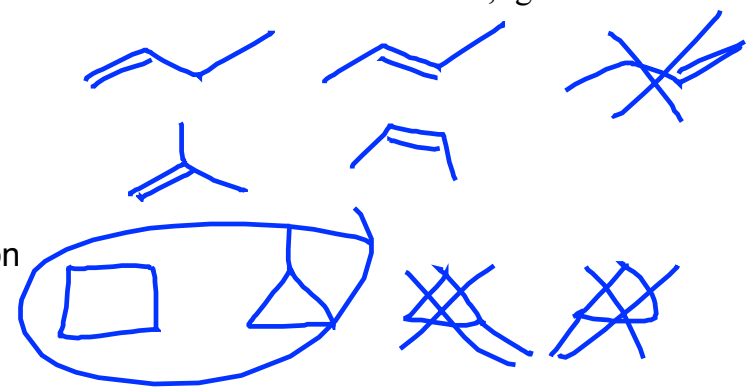


Total EU − alkenes = rings

7. For C_4H_8, draw all possible structures for isomer A and isomer B, given the following:

a. C_4H_8 (A) $\xrightarrow{H_2, Pt}$ C_4H_{10} $\frac{10-8}{2} = \frac{2H}{2} =$ 1 EU; +2 H ⇒ 1 alkene, 0 ring

b. C_4H_8 (B) $\xrightarrow{H_2, Pt}$ No reaction 1 EU; 0 H ⇒ no alkenes; ↳ 1 ring



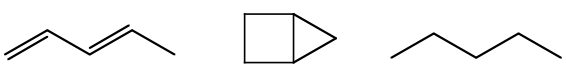
8. Which of the following is possible for structure C?

C_5H_8 (C) $\xrightarrow{H_2, Pt}$ C_5H_{10}

EU = 2 EU

12 − 8 = 4H short

+2 H ⇒ 1 alkene + 1 ring



total EU = # alkenes + # rings

Formulas, EU, and Hydrogenation Test: How to determine the number of alkenes versus rings:

Process

1. Determine EU from formula
2. Determine alkenes from H2/Pt test
   - 1 alkene per 2H added
3. Determine rings by the difference
   a. EU = alkenes + rings, therefore:
   b. rings = EU – alkenes

Q: Suppose a formula is C_7H_{10}, how many EU? 3 EU

16-10=6 H short

Given the following H_2/Pt results, how many alkenes and rings would have been in the original formula?

Product after H_2/Pt	# of H's Added	# of Alkenes	# of Rings
A. C_7H_{12}	+2	1	2
B. C_7H_{14}	+4	2	1
C. C_7H_{16}	+6	3	0
D. C_7H_{10}	+0	0	3

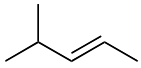
7.4,5 Alkene Nomenclature

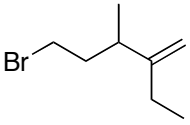
A. When the Alkene is in the Core Name (the priority functional group)

1. Number the longest continuous alkene-containing C-chain from the end nearest the alkene → core name = "alk-x-ene"
2. Designate the position of the alkene by using the lower-numbered of the two alkene carbons
3. Attach and number substituents
4. When alkene stereoisomer issues apply:
   - Designate stereochemistry as (E) or (Z)

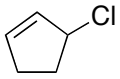
Give formal names for the following alkenes

Simple Acyclics

1. 

2. 

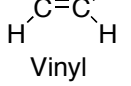
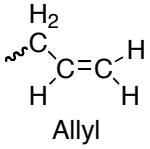
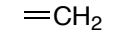
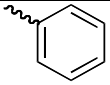
Rings

3. 

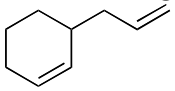
B. Alkenes as Substitutents

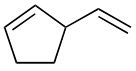
- Many functional groups have higher priority than alkenes, so that alkenes may need to be named as substituents rather than in the core name

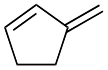
Four to Memorize:

 Vinyl	 Allyl	 Methylene	 Phenyl = "Ph"

Name the following:

1. 

2. 

3. 

4.