

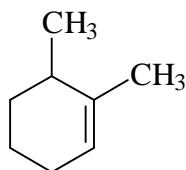
Part 1: (In case of multiple questions, circle only **ONE** answer!)

1. Given the molecular formula of  $C_4H_6OCl_2$ , The compound can contain:

- (A) two double bonds.
- (B) one double bond and one ring.
- (C) two triple bonds.
- (D) one double bond and one triple bond.
- (E) one double bond or one ring but not both.

Know how to calculate element of unsaturation and its definition.

2. Provide an acceptable IUPAC name for the alkene shown below.

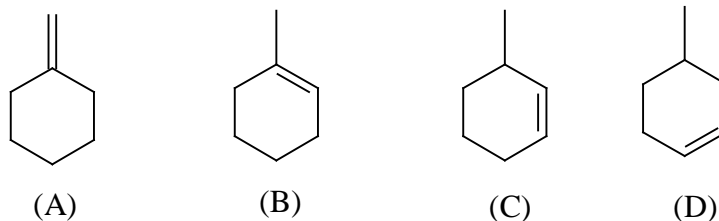


**(E)-1,6-dimethylcyclohexene** (the double bonded carbons have to be numbered in consecutive order.)

3. Draw a valid structure for (E)-2-chloro-4-ethyl-2-hexene.

**The double bond must have E configuration which means two higher prioritized groups lie on the opposite side of the double bond.**

4. Which of the following compounds is expected to released the least amount of heat upon hydrogenation with one mole of  $H_2$ ?



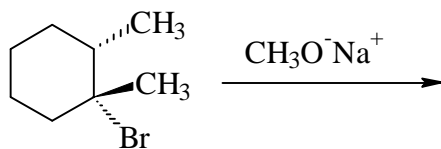
(E) They all contain one double bond and are equally stable.

**Most stable double releases less heat. More substituted C=C is more stable. (B)**

5. Which of the following statement is NOT true for ethylene ( $CH_2=CH_2$ ) molecule ?

- (A) Both carbons are  $sp^2$  hybridized.
- (B) C=C bond length is shorter than the C-C length in ethane.
- (C) The two bonds in C=C are equally strong. (one is pi and the other is sigma)**
- (D) The entire molecule has a planar geometry.
- (E) The molecule has a dipole moment of zero.

6. Draw the major organic product of the following reaction (Hint: first determine what type of reaction mechanism it should follow). How would the rate of this reaction change with the concentration of the halide or sodium methoxide? What would happen to the rate if Br is changed to Cl? What additional product may be possible if the CH<sub>3</sub> attached to the carbon bearing Br was changed to H?

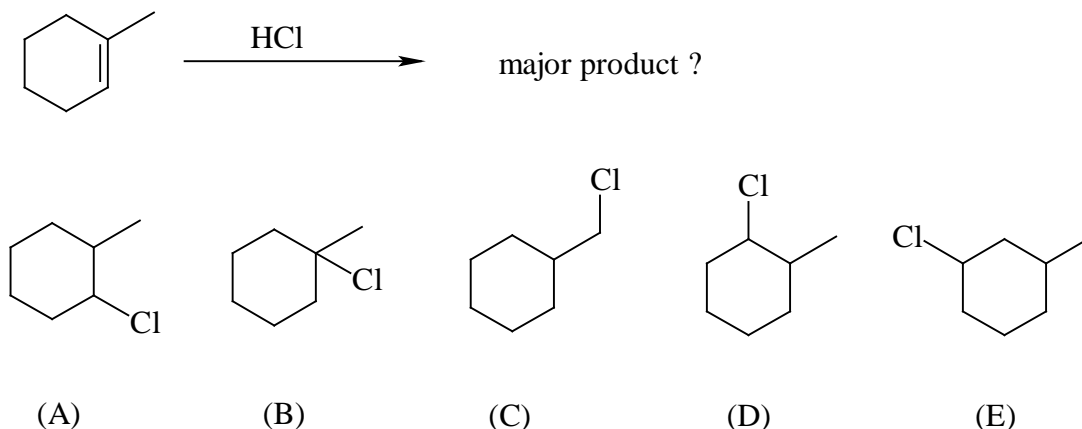


It is going to follow E2 (strong base/nucleophile and hindered halide carbon). There are two possible E2 product, but the more stable one is the more substituted. (both types of beta hydrogen is anti, coplanar to leaving group Br). Since it's E2, the rate will be first order on each reactant. Changing a better L.G. Br to Cl slows down the reaction. The carbon bearing Br is secondary, then SN2 product is also possible (show the structure)

7. If the above reaction is run in CH<sub>3</sub>OH but without CH<sub>3</sub>ONa, what products are possible? (draw them all) Would the rate of this reaction be affected by doubling the amount of the halide? And by doubling the amount of methanol?

The reaction without a good nucleophile would proceed through SN1 (in this case, solvolysis) and E1. Two SN1 products are possible, three E1 products are also possible. The rate will only depend on the halide conc. but not methanol.

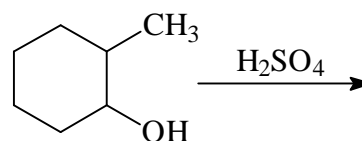
8. The major product for the following reaction is:



(B) Markovnikov rule (more stable carbocation intermediate)

8. Predict the major organic products of the following reaction:

E1 to give alkene, more substituted. (see last week lab)



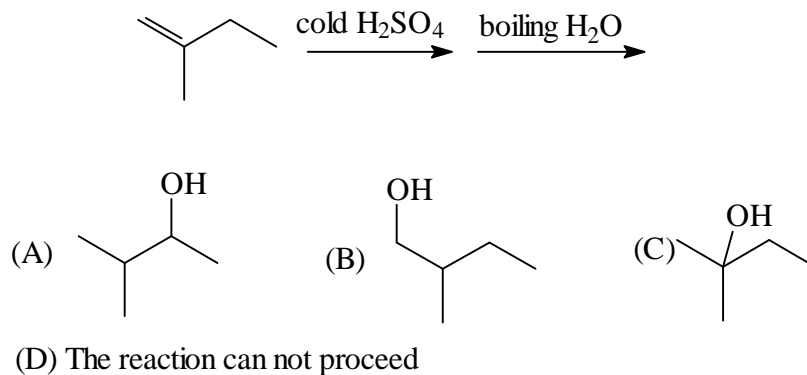
9. The above reaction fails to proceed without the acid. What is the function of  $\text{H}_2\text{SO}_4$ ?

The strong acid protonates the OH group so that it becomes a better leaving group,  $\text{H}_2\text{O}$ . From the mechanism, it is clear that it is a catalyst in this case.

10. Write a step-by-step mechanism to account for the product formation in 8.

(see the lab handout for "dehydration of 2-methylcyclohexanol" or textbook).

11. Predict the major product for the following reaction:

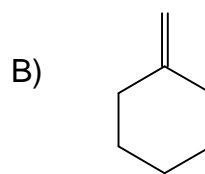


(C), indirect hydration which follows Markovnikov rule.

Part 2.

1.(10 points) What halides would undergo dehydrohalogenation to give the following pure alkenes? (Problem 7-31)

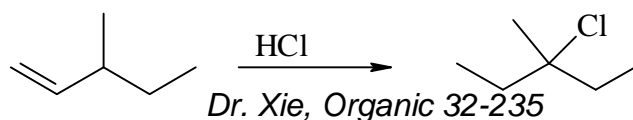
A) 1-butene



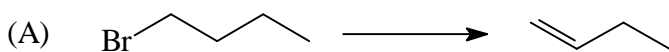
See Problem 7-31, the key is to find a halide that can undergo E2 elimination to give the product. Note SN2 may compete and should be kept to the minimum.

2.(14 points) The following shows the reaction between an alkene and HCl to give the halide product. Propose a step-by-step mechanism to account for the product formation. Use proper electron arrow pushing.

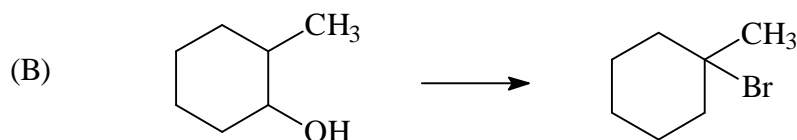
Chapter 7, two step mechanism starts with adding the positive end of the reagent to the  $\text{C}=\text{C}$  first, creating a carbocation. Note the carbocation can then rearrange to a more stable one which gives the final product.



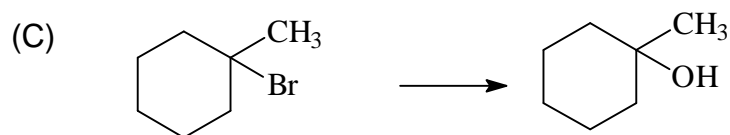
3. (24 points) Show how you would accomplish the following synthetic conversions. Each synthesis may involve one or more steps. Specify reagents needed in each step. (Problem 8-5)



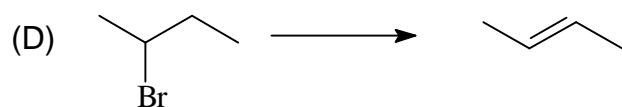
Reaction is best done with E2, therefore needs a bulky base potassium t-butoxide (which reduces the chance of SN2)



Dehydration of alcohol to give alkene using H<sub>2</sub>SO<sub>4</sub> or H<sub>3</sub>PO<sub>4</sub>/heat. Then add HBr to the C=C in Markovnikov way.



The best way is to do a dehydrohalogenation yielding C=C. Then use acid-catalyzed hydration (or sulfuric acid followed by water, or oxymercuration-demercuration) to complete the addition of water to C=C in Markovnikov way.



Do an E2 to give the most stable alkene (Saytzeff rule) (SN2 may compete somewhat)