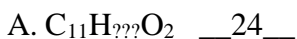
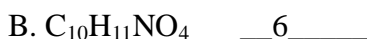


Exam # 3 – October 31, 2001  
Chemistry 2401

(4) I. Assuming that each of the following is a molecular formula for a compound with no rings and no double bonds, how many hydrogen atoms would each contain?



(6) II. How many degrees of unsaturation are present in compounds that have the following molecular formulas. Show your work in the space provided.



$$2 \times 7 + 2 = 16$$

$$2 \times 10 + 2 + 1 = 23$$

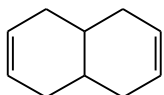
$$16 - 8 = 8$$

$$23 - 11 = 12$$

$$8/2 = 4$$

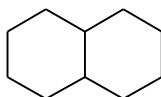
$$12/2 = 6$$

(6) III. A compound named Charlie had a formula of  $C_{10}H_{14}$ . When Charlie was allowed to react with  $H_2/Pd$  under conditions similar to those we used in lab, he was converted to a new compound named Rocky that had a formula of  $C_{10}H_{18}$ . In the space below draw structural formulas for Charlie and Rocky that are consistent with this information.



2 rings / 2 double bonds

Charlie

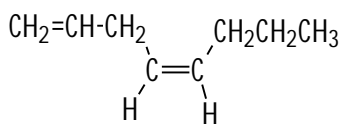


Charlie without the double bonds

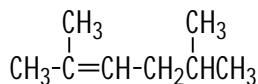
Rocky

(9) IV. Draw structural formulas for each of the following:

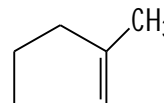
A. cis-1,4-octadiene



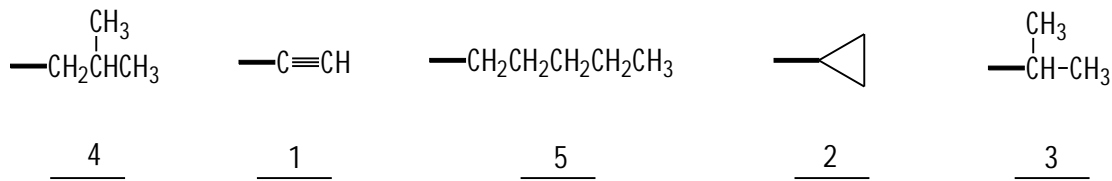
B. 2,5-dimethyl-2-hexene



C. 1-methylcyclopentene

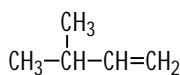
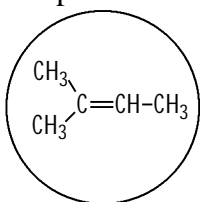


(5) V. Rank the following groups in terms of Cahn-Ingold-Prelog priority using 1 for the group with the highest priority.



(10) VI. We learned in chapter six that alkenes with more alkyl groups attached to the two double-bonded carbon atoms were lower in energy (more stable) than alkenes with fewer alkyl groups attached to these two carbon atoms.

A. Based on that principle circle the structure below that corresponds to the lower energy compound.



B. The explanation offered for this difference in energies was that  $\text{sp}^2 - \text{sp}^3$  carbon-carbon bonds are stronger. What experimental measurement was cited in support of this suggestion?

**The  $\text{sp}^2 - \text{sp}^3$  carbon-carbon bonds are shorter than the  $\text{sp}^3 - \text{sp}^3$  carbon-carbon bonds.**

C. Now bonds are formed by the overlap of orbitals and two different suggestions were made for how orbital interactions caused these bonds to be stronger. What were these two suggestions? Draw diagrams if they help.

- 1)  **$\text{sp}^2$  hybrid orbitals are simply shorter and therefore produce stronger sigma bonds.**
- 2) **Hyperconjugation: A type of pi bond involving overlap between an empty pi antibonding orbital on the double bond and the sigma bonding electrons in adjacent C-H bonds.**

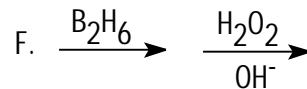
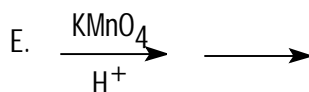
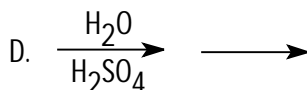
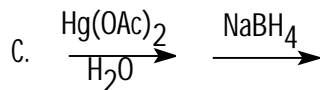
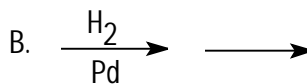
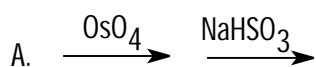
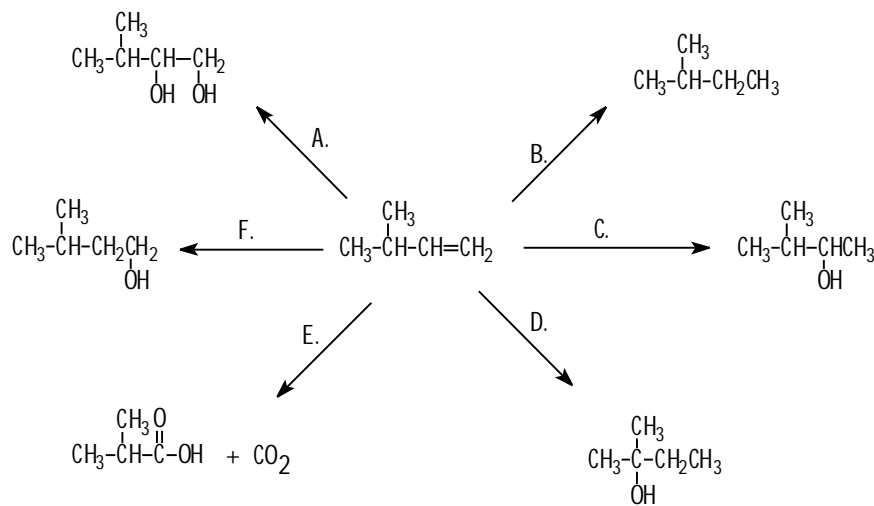
(4) VII. According to Hammond's postulate for what kind of chemical reaction step would the transition state look very much like the product that is being formed?

**Endergonic – one in which the product is higher in energy than the reactant.**

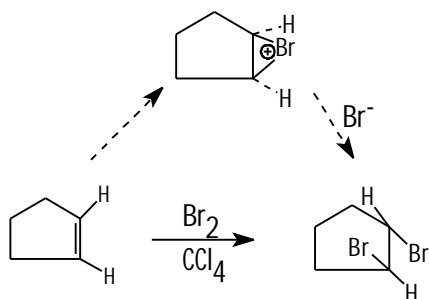
In such a reaction what is the relationship between the energy of the product and the rate at which it is produced by the reaction?

**The lower the energy of the product the faster it is formed because the transition state for the reaction looks like the product.**

(18) VII. Below is a diagram showing the conversion of 3-methyl-1-butene to a variety of different products. Identify the reagent(s) that produce each of the results indicated. I provided two arrows, but in some cases you may need to use only one.



(6) VIII. The reaction of bromine with cyclopentene yields 1,2-dibromocyclopentene that has exclusively the trans configuration. What causes this?

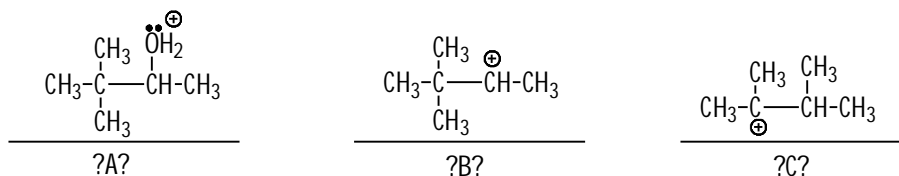
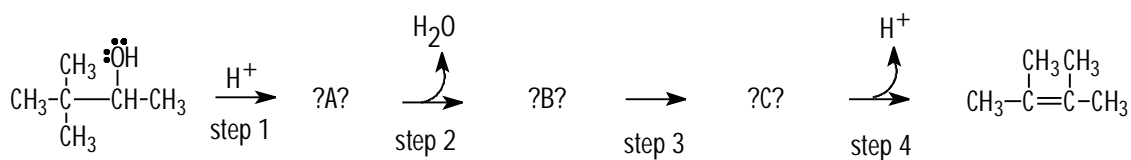


The three-membered bromonium ion intermediate can only be attacked by the bromide ion ( $\text{Br}^-$ ) from the side opposite the bromine that is already attached.

B. If you were conducting this reaction in the laboratory, what observation could you make that would indicate that the reaction was, in fact, taking place?

**The red color of the  $\text{Br}_2$  disappears as it reacts with the alkene.**

(12) IX. Draw structural formulas of the intermediates in the mechanism for the dehydration of 3,3-dimethyl-2-butanol shown below.

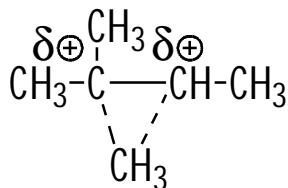


A. Which is the rate-determining step? STEP 2

B. Is step 3 endergonic or exergonic? Explain.

**Step 3 is exergonic since the 3° carbocation that is being produced is lower in energy than the initial 2° carbocation.**

C. Draw a structural formula representing the transition state for step 3.



**The transition state should look like the reactant in the process of turning into the product.**