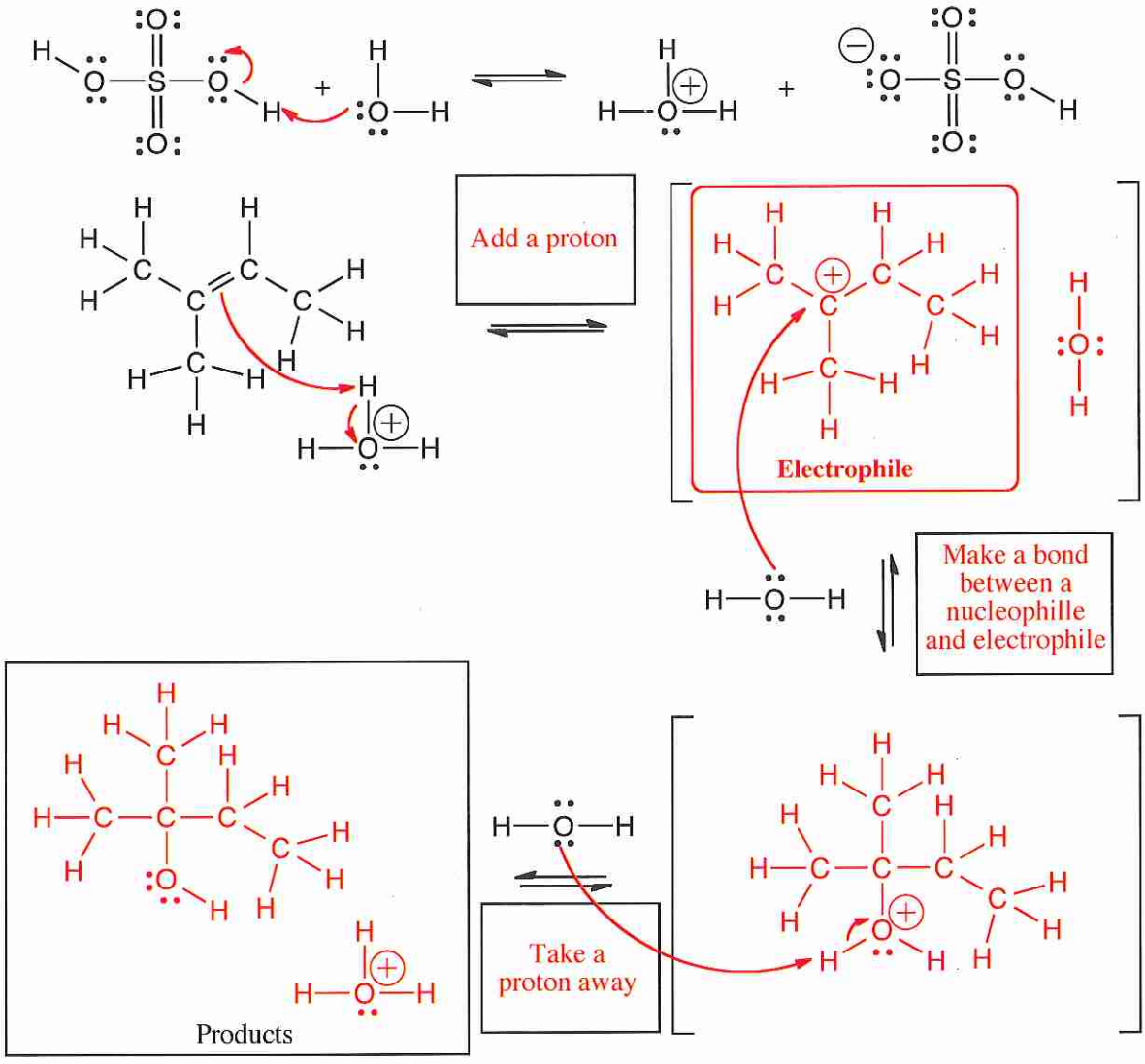
13. (16 pts.) Read these directions carefully. Read these directions carefully. (It was worth repeating) **For the reaction of an alkene with water and a small amount of sulfuric acid shown below, fill in the details of the mechanism. Draw the appropriate chemical structures and use an arrow to show how pairs of electrons are moved to** make and break bonds during the reaction. **For this question, you must draw all molecules produced in each step (yes, these equations need to be balanced!). Finally, fill in the boxes adjacent to the arrows with the type of step involved, such as "Make a bond" or Take a proton away". MAKE SURE TO NOTICE THE QUESTIONS AT THE BOTTOM. If an intermediate or product is chiral, you only need to draw one enantiomer for this problem.**

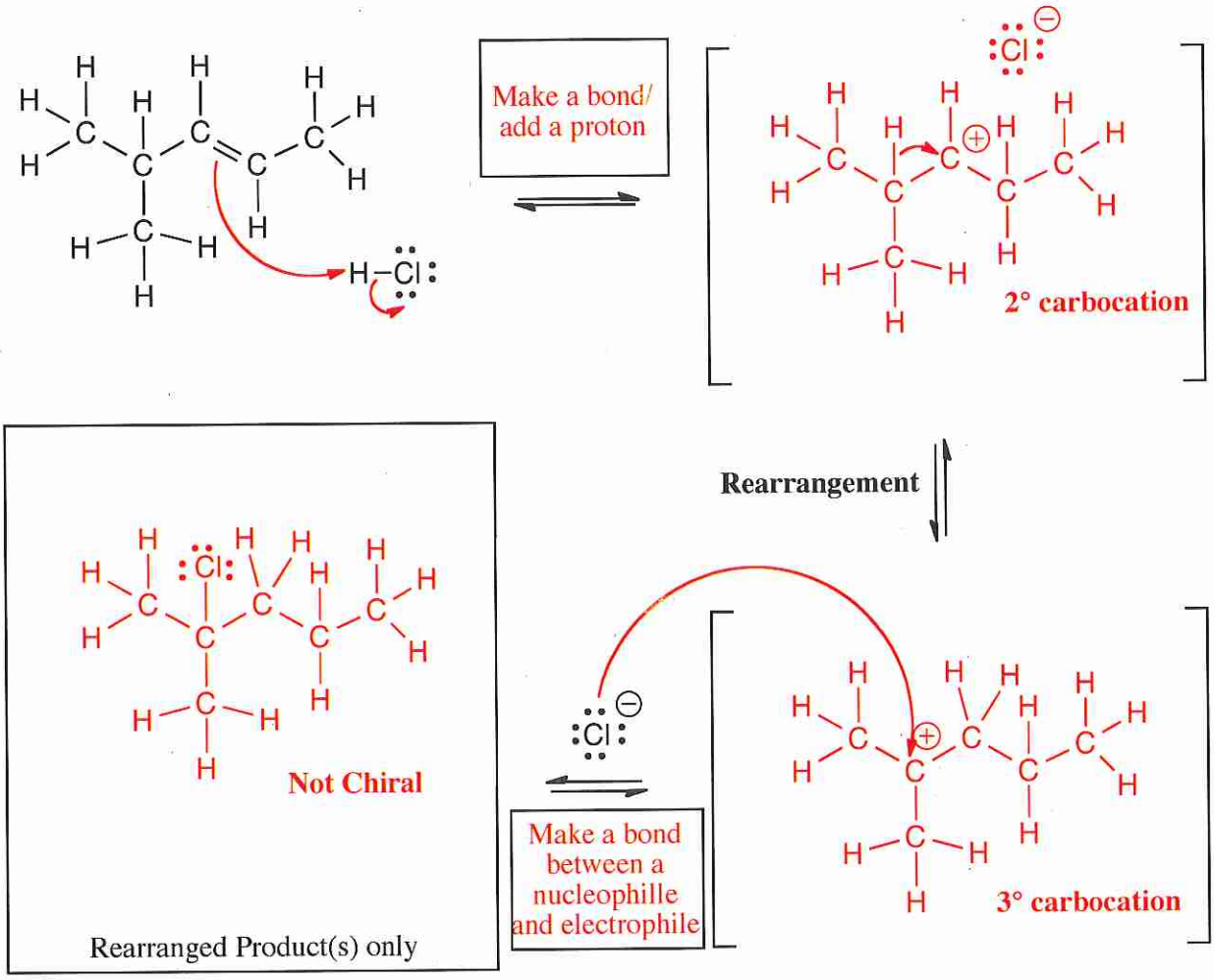


(2 pts) During the reaction described by the above mechanism, what happens to the pH of the solution The pH stays the same because just as much acid is made as is used.

(2 pts) Is this reaction catalytic in acid? Yes

(2 pts) One of the above steps involves making a bond between a nucleophile and an electrophile. Draw a circle around the electrophile.

14. (13 pts.) Read these directions carefully. Read these directions carefully. (It was worth repeating) **For the reaction of an alkene with HCl shown below, fill in the details of the mechanism FOR THE REARRANGEMENT REACTION ONLY. OTHER PRODUCTS WILL FORM, BUT WE ARE CONCERNED WITH THE REARRANGEMENT MECHANISM AND PRODUCT(S) ONLY. Draw the appropriate chemical structures and use an arrow to show how pairs of electrons are moved to** make and break bonds during the reaction. **For this question, you must draw all molecules produced in each step (yes, these equations need to be balanced!). Finally, fill in the boxes adjacent to the arrows with the type of step involved, such as "Make a bond" or Take a proton away". MAKE SURE TO NOTICE THE QUESTIONS AT THE BOTTOM. If an intermediate or product is chiral, you only need to draw one enantiomer for this problem. For the product, you must draw both enantiomers and write "racemic" if appropriate.**

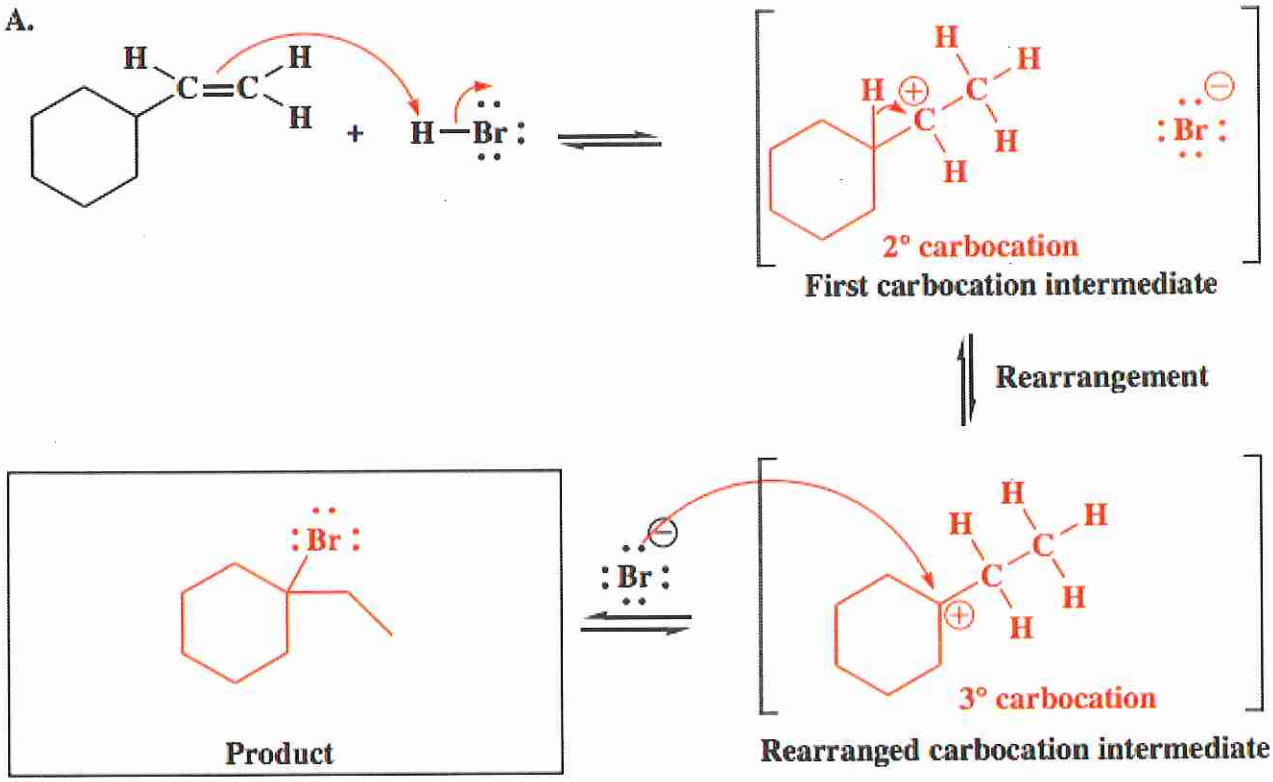


(2 pts) During the reaction described by the above mechanism, say what happens to the pH of the solution The pH increases because acid (HCl) is consumed

(2 pts) Is this reaction catalytic in acid? No, acid is consumed

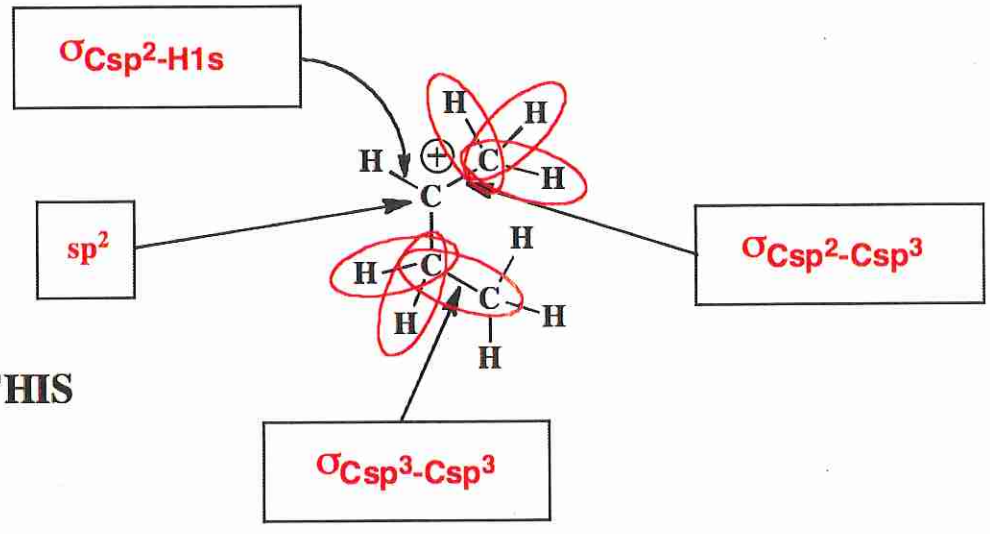
12. (14 pts) The following molecule undergoes a rearrangment. Draw the first carbocation intermediate in the first box, then the rearranged carbocation intermediate in the second, and finally the rearranged product of this reacation. For each step, include all prouducts, all lone pairs and formal charges. Use arrows to indicatethe flow of electrons involved in each step.

A.



7. For the following carbocation:
A) State the hybridization state of the indicated atom in the square box provided. In the rectangular boxes, describe the bonds indicated by the arrows in terms of overlap between hybrid orbitals (the valence bond approach). For example, answers might be $\sigma_{Csp^3\text{-}Csp^3}$ or $\pi_{C2p\text{-}C2p}$.
Note that this part of the question is NOT about hyperconjugation. We just want a valence bond description of the bonding in a carbocation structure.

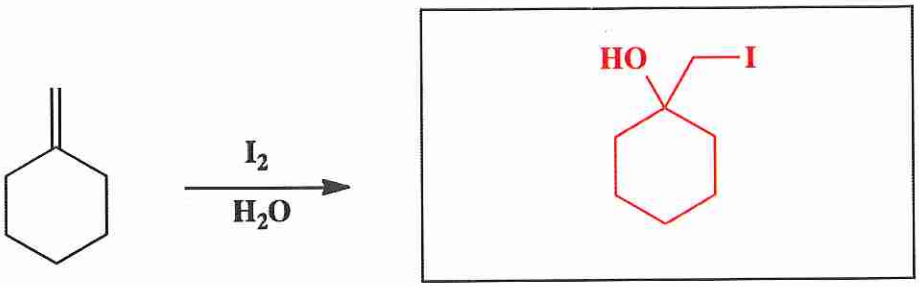
(2 pts. each)

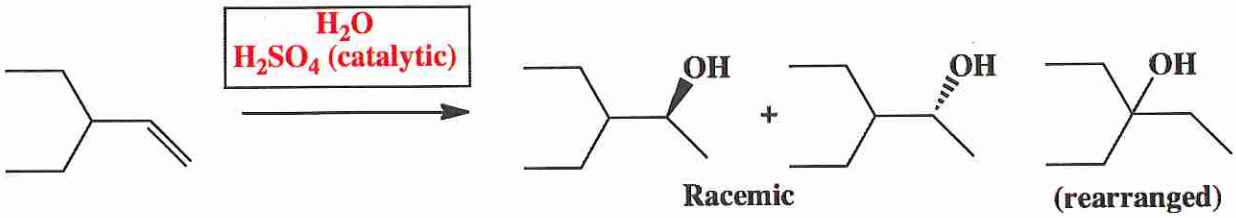


NOTICE THIS

B) (6 pts) This part refers to hyperconjugation. On the structure, **circle all of the sigma bonds that can take part in hyperconjugation with the carbocation.**

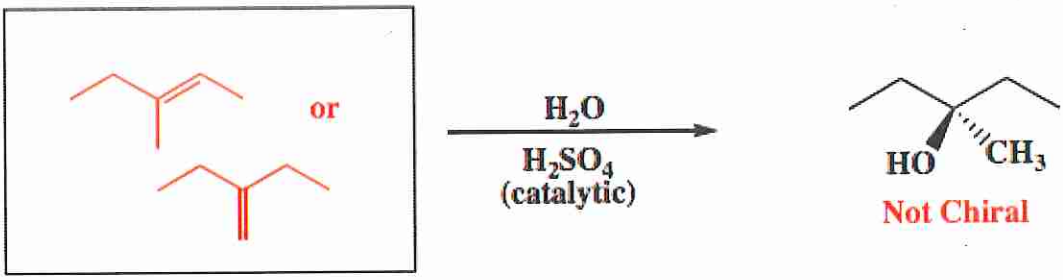
16. (3 or 5 pts each) The following problems are a different format. **In the space provided show the starting material, reagents or products to complete the scheme. If a pair of enantiomers are created, you must draw both and write "racemic" if appropriate.**



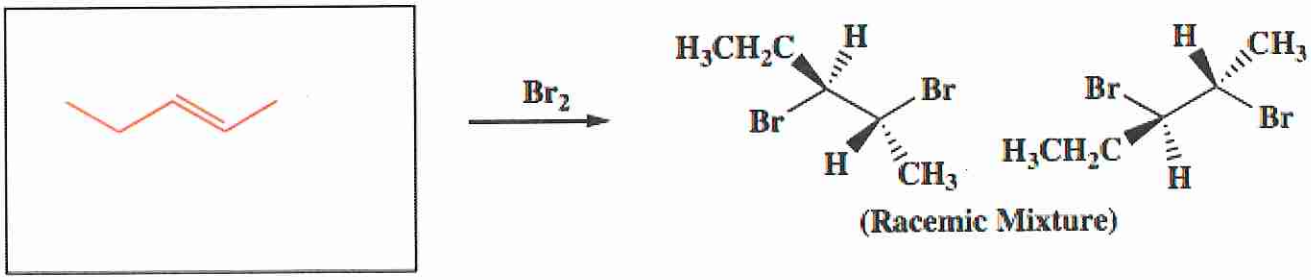


13. (4 or 6 pts each) The following problems are a new format. We turn the tables and give you the product. **In the space provided show the starting material required to make that product using the given reagents. When more than one starting material would work, you must draw both.**

A.

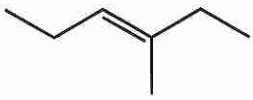


B.



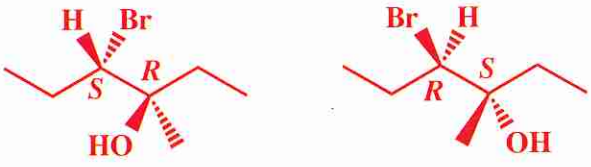
15 (cont.) (6 or 8 pts each) The following reactions all involve chemistry of alkenes. Fill in the box with the product(s) that are missing from the chemical reaction equations. **Draw only the predominant regioisomer product or products (i.e. Markovnikov or non-Markovnikov products)** and please remember that **you must draw the structures of all the product stereoisomers using wedges and dashes to indicate stereochemistry**. When a racemic mixture is formed, **you must write "racemic" under both structures EVEN THOUGH YOU DREW BOTH STRUCTURES.**

J.



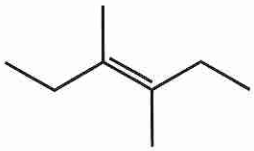
Br_2

H_2O



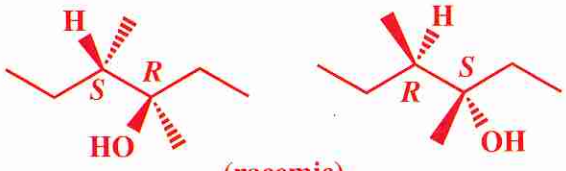
(racemic)

K.

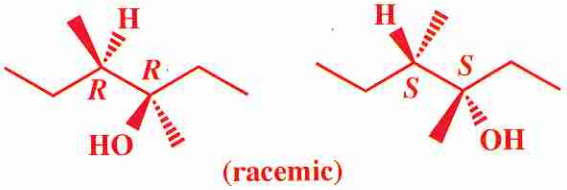


H_2O

H_2SO_4 (catalytic)



(racemic)

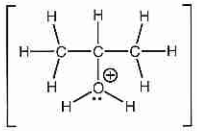


(racemic)

18. Here is an "apply what you know" problem in the format of an MCAT style passage. Circle the correct answers.

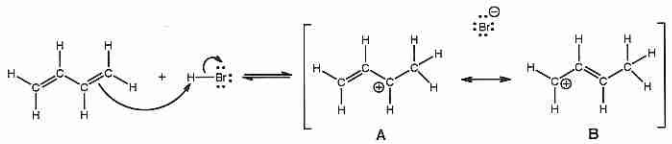
One of the more difficult things for new organic students to master is how to recognize an electrophile. One key piece of information is the charge you see on an atom. An atom with a full or partial positive charge is worth considering as an electrophile. However, not all atoms with a full or partial positive charge are electrophiles. To be an electrophile, an atom must be capable of acting as a "sink" for a mechanism arrow. In other words, it must be able to accept a new bond from an nucleophile. The best electrophile we have seen is a carbocation, capable of reaction with nucleophiles such as halide anions and water. As you continue your study of organic chemistry, you will encounter several other electrophiles. The following questions examine some of these. Although you have not seen all of them before, you are already familiar with all of the fundamental concepts you need to deduce the correct answers.

1. The following intermediate structure has a positive charge on the O atom.



A. The O atom is an electrophile because a nucleophile can add to it without causing the breaking of any of the other bonds to O.
B. The O atom is an electrophile because although it already has a filled valence, a proton (H^+) can depart as the new bond is made.
C. The O atom is not an electrophile because hyperconjugation stabilizes it.
D. The O atom is not an electrophile because it already has a filled valence and adding a new bond would require the creation of a very high energy species such as an H or C atom with a lone pair and thus negative charge.

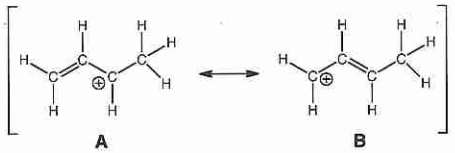
2. The following carbocation is encountered in a reaction you will study next semester.



A. The contributing structure A makes a larger contribution to the resonance hybrid.
B. The contributing structure B makes a larger contribution to the resonance hybrid.
C. The two contributing structures make equal contributions.
D. There is a third contributing structure that is not shown even though it makes the major contribution to the resonance hybrid.

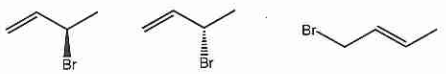
18. (cont.).

3. Here again is the same carbocation you saw in part 2.



A. This carbocation is stabilized because it has a "pi-way", that is a pi orbital that extends over more than two atoms.
B. This carbocation is stabilized by delocalization of the positive charge over more than one atom.
C. Both A and B.
D. This carbocation is less stable than an analogous carbocation that does not have an adjacent pi bond.

4. If the carbocation shown in parts 2 and 3 reacted with the bromide anion, one could imagine at least three different products that could form.



A. The product on the left is the only one that could form.
B. The product on the right is the only one that could form.
C. Only the product on the left and the product in the middle could form.
D. All three products could form.

5. Of the three products shown in part 4, which one(s) would you expect to be the most stable

A. The molecule on the left is the most stable
B. The molecule on the right is the most stable
C. The two molecules on the left have the same stability and they are both more stable than the molecule on the right.
D. All three molecules have the same stability