First Practice Exam
CHEM 255 – Organic Chemistry I
Prof. Bastin
Summer 2011

Name _____

Provide clear, concise answers using unambiquous, carefully drawn structures (where appropriate) for all of the questions. Good luck and enjoy!

1) _____/8 pts

2) _____/8 pts

3) _____/10 pts

4) _____/4 pts **Total: _____/100 pts**

5) _____/4 pts

6) _____/8 pts

7) _____/10 pts

8) _____/8 pts

9) _____/10 pts

10) _____/10 pts

11) _____/4 pts

12) _____/10 pts

13) _____/4 pts

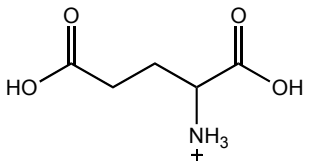
1) (8 pts) Cyanic acid, HOCN, and isocyanic acid, HNCO, dissolve in water to yield the same anion after loss of H^+.

   a. Write a Lewis structure for cyanic acid.

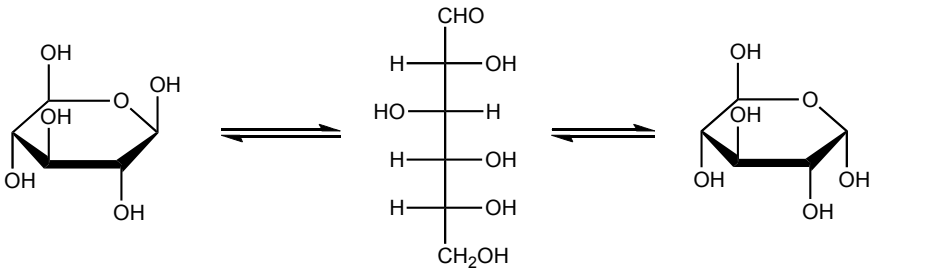
   b. Write a Lewis structure for isocyanic acid.

   c. Account for the fact that each acid gives the same anion on loss of H^+. Be sure to draw structures that **clearly** explain this observation.

2) (8 pts) Glutamic acid (shown below) is one of the 20 amino acids found in proteins. Glutamic acid has two carboxyl groups, one with a pK_a of 2.10 and the other with a pK_a of 4.07. Which carboxyl group has which pK_a? Why is one carboxyl group a considerably stronger acid than the other?



3) (10 pts) In aqueous solutions, three forms of glucose are present in the solution (shown below). Given the following equilibrium ratios at, calculate the relative energies of the three isomers at 25°C and sketch a reaction coordinate diagram. Is the transformation of β-D-Glucose into α-D-Glucose exothermic or endothermic?



β-D-Glucose (64.005%) D-Glucose (0.003%) *α*-D-Glucose (36.002%)

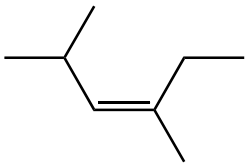
4) (4 pts) Provide structures for the following compounds.

(a) *(Z)*-1-chloropropene

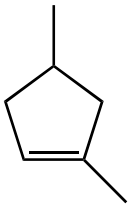
(b) (*E*)-2,6-dimethyl-2,6-octadiene

5) (4 pts) Provide either common or IUPAC names for the following compounds.

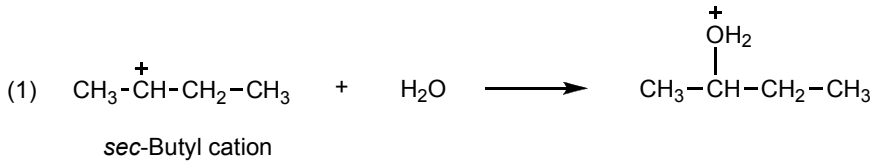
(a)

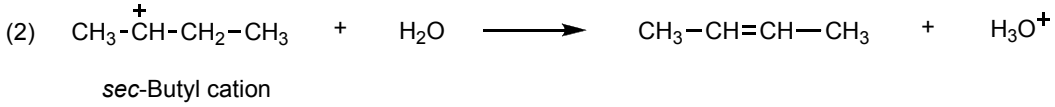


(b)



6) (8 pts) The *sec*-butyl cation can react as both a Brønsted-Lowry acid and a Lewis acid in the presence of a water-sulfuric acid mixture. In each case, however, the product is different. The two reactions are:



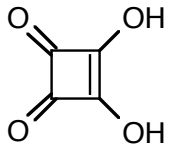


1. In which reaction(s) does this cation react as a Lewis acid?

2. In which reaction(s) does this cation react as a Brønsted-Lowry acid?

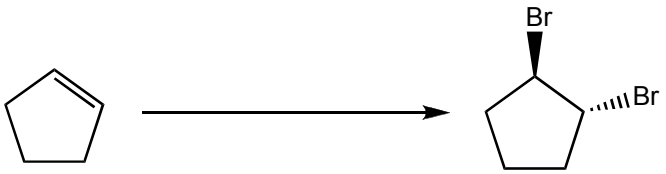
3. Draw curved arrow mechanisms to show the movement of electrons in the above reactions. Electron dots are deliberately left out of the reagents and products. Be sure to start by adding **ALL** the lone pairs to the structures.

7) (10 pts) The compound below has (for obvious reasons) been given the trivial name squaric acid. Squaric acid is a diprotic acid, with both protons being more acidic than acetic acid. In the dianion obtained after the loss of both protons, all of the carbon-carbon bonds are the same length as well as all of the carbon-oxygen bonds. Provide an explanation for **ALL** these observations.



8) (8 pts) Provide the reagents needed to bring about the following transformations.

a)



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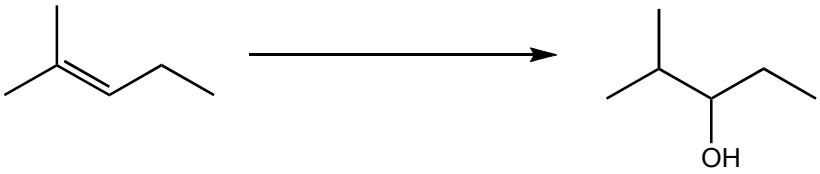

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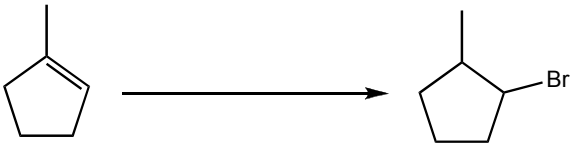

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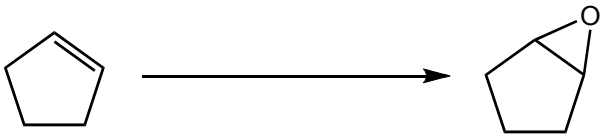
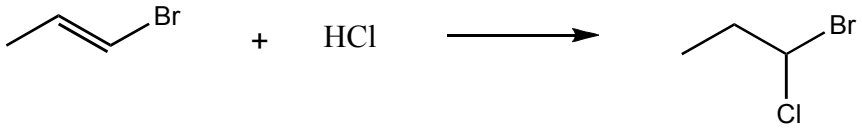


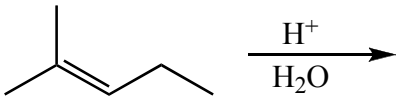
9) (10 pts) There are two dicarboxylic acids with the general formula $HO_2CCH=CHCO_2H$. One dicarboxylic acid is called maleic acid; the other is called fumaric acid. In 1880, Kekulé found that on treatment with cold dilute $KMnO_4$, maleic acid yields *meso*-tartaric acid and that fumaric acid yields (±)-tartaric acid. Show how this information allows one to write stereochemical formulas for maleic acid and fumaric acid.

10) (10 Pts) Using a curved-arrow mechanism, account for the fact that addition of HCl to 1-bromopropene gives exclusively 1-bromo-1-chloropropane.



11) (4 pts) Draw the product(s), if any, of the following reactions. Indicate stereochemistry where relevant.

a)



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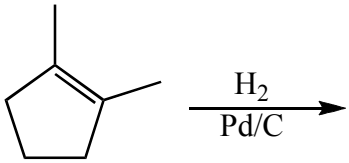
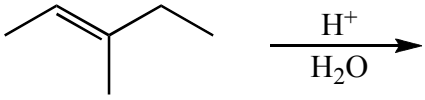
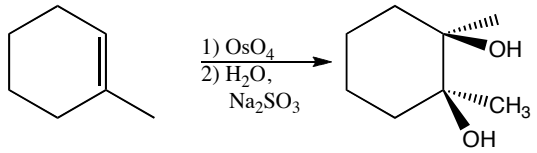


12) (10 pts) Draw the mechanism and depict all possible products (being sure to show how EACH product is formed, if more than 1 product is formed) for the following reaction.



13) (4 pts) Which of the following are true chemical statements? Place an **X** in the space provided if TRUE. If the reaction gives multiple products in detectable quantities, and the compound shown on the right is one of these, then the reaction is considered to be TRUE.



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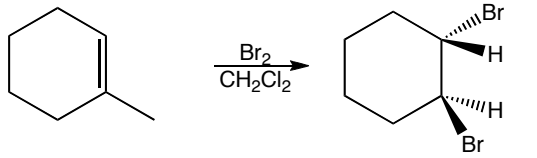

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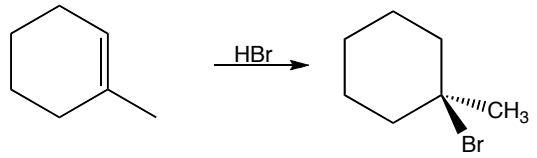

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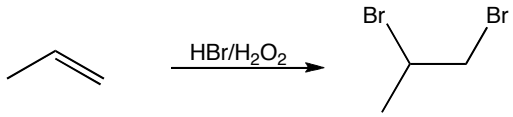

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