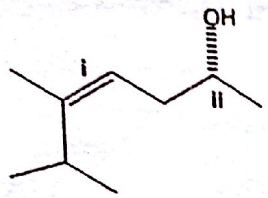
~~MIDTERM~~ CHM138 TTH2 2011-12 Prof. Quinlan

Part 1 (*20 marks*) – Multiple Choice Questions (*2 marks each*)

1. What is the degree of unsaturation of niacin, $C_6H_6N_2O$?

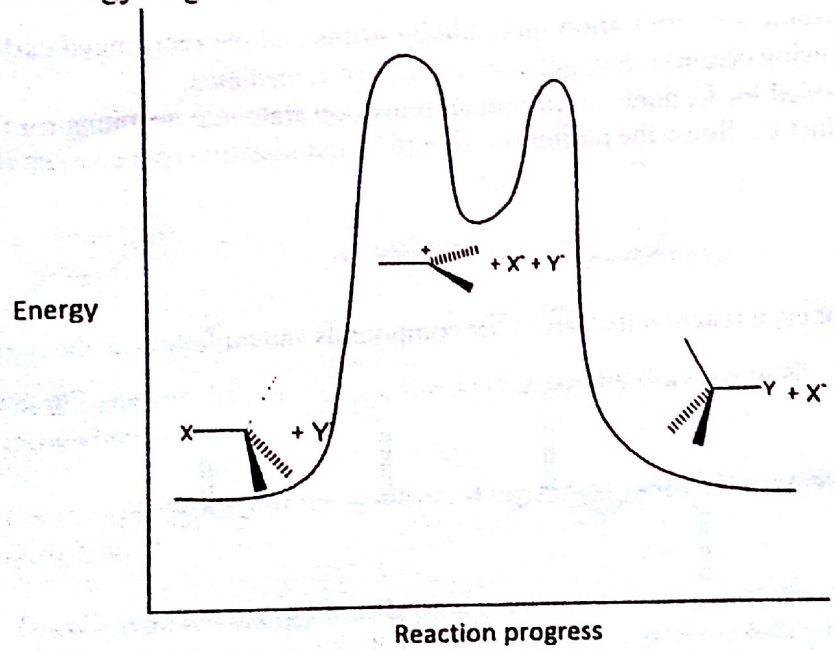
a) 2 b) 3 c) 4 d) 5 e) 6

2. What are the stereochemical descriptors of **i** and **ii** in the molecule shown below?



a) **i** *E* **ii** *R*
b) **i** *Z* **ii** *R*
c) **i** *E* **ii** *S*
d) **i** *Z* **ii** *S*

3. The energy diagram below describes a substitution reaction.

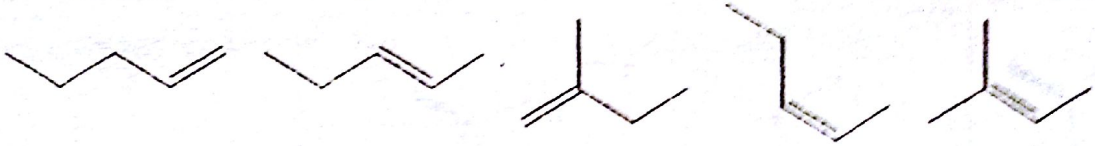


According to the above diagram, which of the following statements is **false?**

i) In the first transition state, the C-X bond is mostly broken.
ii) The concentrations of the reactants and products are approximately the same when the reaction comes to equilibrium.
iii) The reaction is exergonic.

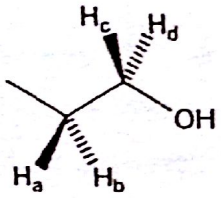
a) i only b) ii only (c) iii only (d) i and ii only (e) i and iii only (f) i, ii and iii

4. Which of the following alkenes releases the most heat on hydrogenation?



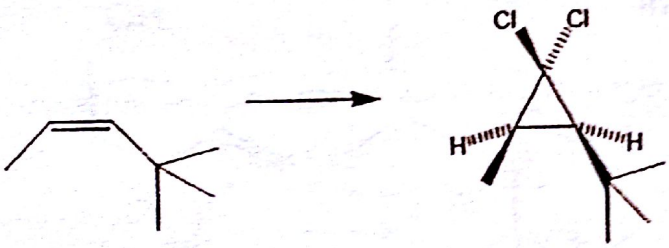
a) b) c) d) e)

5. What are the *pro-R* and *pro-S* designations for the hydrogen atoms labeled a, b, c and d in 1-propanol shown below?



a) H_a *pro-R*, H_b *pro-S*, H_c *pro-R*, H_d *pro-S*
b) H_a *pro-S*, H_b *pro-R*, H_c *pro-R*, H_d *pro-S*
c) H_a *pro-R*, H_b *pro-S*, H_c *pro-S*, H_d *pro-R*
d) H_a *pro-S*, H_b *pro-R*, H_c *pro-S*, H_d *pro-R*

6. One of the cyclopropyl products formed in an alkene addition reaction is shown below.



Which of the following reactions is true for this reaction?

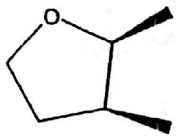
i) The carbene adds to the *re* face of C2.
ii) The carbene adds to the *si* face of C3.
iii) A suitable reagent for this transformation would be $CHCl_3$ in the presence of strong base.

a) i only b) ii only c) iii only d) i and iii only (e) ii and iii only (f) i, ii and iii

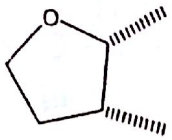
7. Which of the following compounds has a meso stereoisomer?

a) 2,3-dibromopentane
b) 1,5-dibromopentane
c) 1,1-dibromocyclopentane
d) 2,4-dibromopentane
e) 2-bromo-4-chloropentane

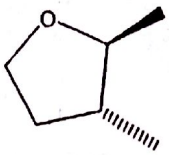
8. Which of the following molecules or mixtures of molecules will **NOT** rotate plane-polarized light?



(i)



(ii)



(iii)

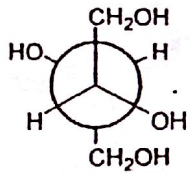
a) i
b) ii
c) iii
d) a mixture containing equal amounts of i and ii
e) a mixture containing equal amounts of ii and iii

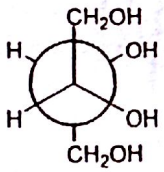
Questions 9 and 10 should be answered using one of the following 6 terms:

(a) constitutional isomers	(b) identical	(c) cis/trans or E/Z isomers
(d) enantiomers	(e) diastereomers	(f) not related (different)

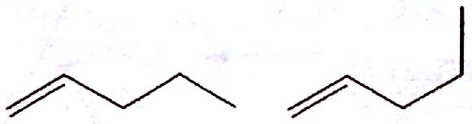
Which of these terms best describes the relationship of each pair of molecules below?

9.





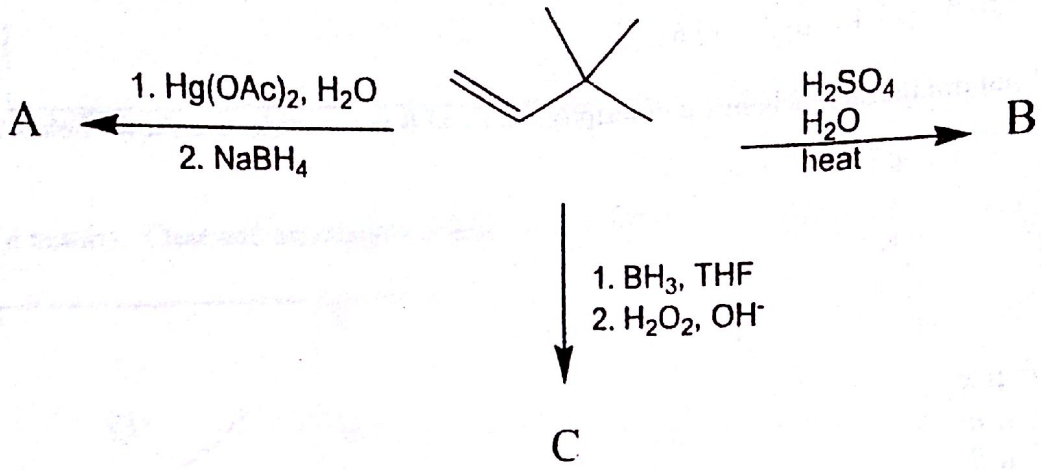
10.



END OF MULTIPLE CHOICE QUESTIONS

Part II (*50 marks*) Short Answer Questions

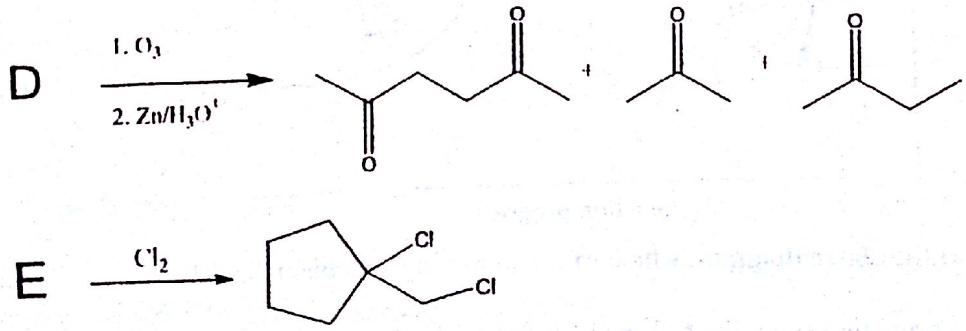
1. (*15 marks*) The three reactions shown below result in three different products.



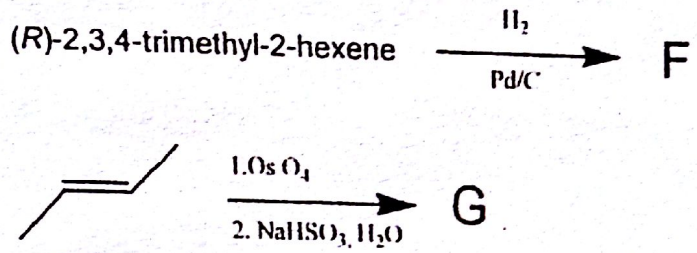
a) In the boxes provided (**A-C**), draw the major organic product of the reactions with each reagent. If more than one enantiomer is formed, you only need to draw one of the enantiomers.
b) For product **B**, draw the carbocation that initially forms and the rearranged carbocation with an arrow showing electron flow between the two intermediates.
c) In the box provided for **C**, draw the important transition state that accounts for the formation of product **C**. Show the partial positive (δ+) and negative (δ-) charges if applicable.

2. (*6 marks*)

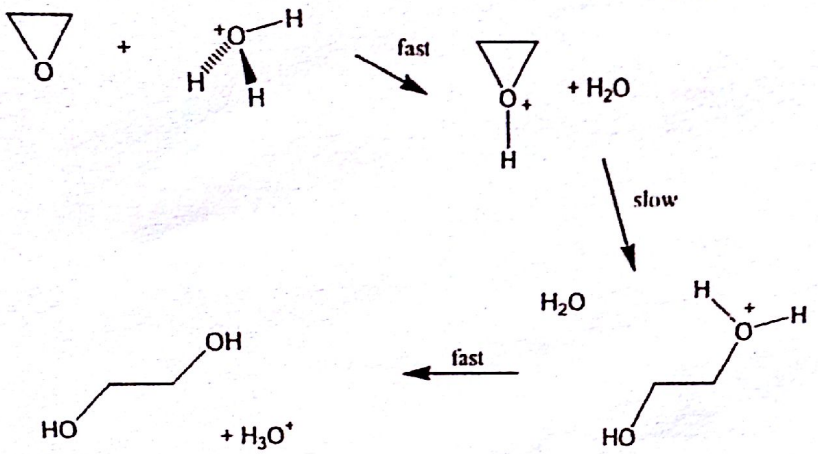
Draw an alkene for each reaction that gives the compounds shown below as the major products.



3. (*15 marks*) Draw the products, **F** and **G**, for the following reactions. If multiple stereoisomers are formed in the reaction, draw all of the stereoisomers. For **G**, draw the stereoisomer(s) formed in the reaction using as many Fischer projection templates as needed. Is the product or product mixture formed in each reaction best described as achiral, meso, optically active or racemic? (Check the appropriate box on the answer sheet).



4. (*14 marks*) A partial mechanism for the acid-catalyzed epoxide ring opening is shown below (this is NOT a reaction studied in class).



a) On the answer sheet, complete the mechanism by drawing in all of the curved arrows, to show electron flow.

b) For the second step of the reaction, write E next to the electrophile and N next to the nucleophile.

c) Draw a reaction energy profile on the answer sheet to show the energy changes that occur from reactants to products for this reaction. Label the following on the diagram with the letters below:

i) I for any intermediate(s)
ii) TS for any transition state(s)
iii) $\Delta G_{reaction}$
iv) $\Delta G^{\ddagger}$ for the rate-determining step

END OF TEST

CHM 138H Term Test 2 Answer Sheet

NAME: **MODEL ANSWERS** Student #: _____ Tutorial Gp.: ___

Students: do not write in this box. It is for grading purposes only.

MC	1	2	3	4	Total
/20	/15	/6	/15	/14	/70

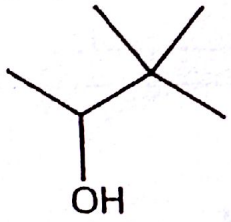
Part I. (*20 marks*) Multiple choice answers:

Question	1	2	3	4	5	6	7	8	9	10
Answer	d	b	c	a	b	d	d	d	e	b

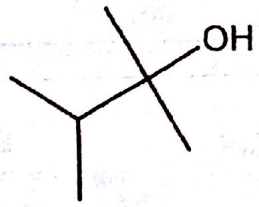
Part II. Short answers:

1. (*15 marks*)

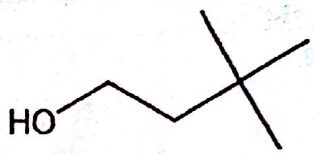
a) Product **A**



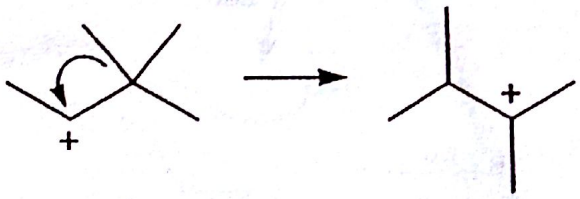
Product **B**



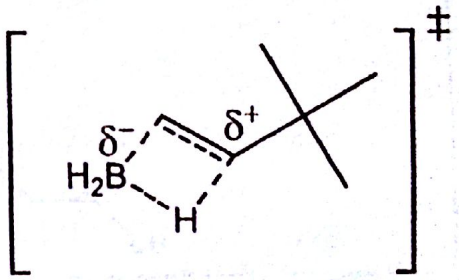
Product **C**



b) carbocation → rearranged carbocation with arrow

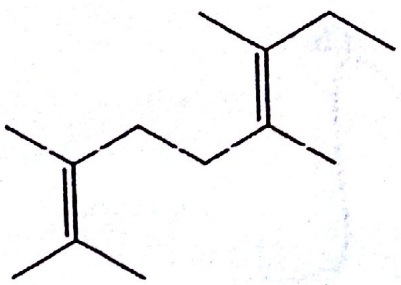


c) important transition state

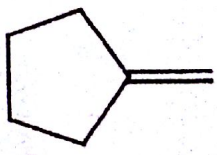


2. (*6 marks*)

Alkene **D**



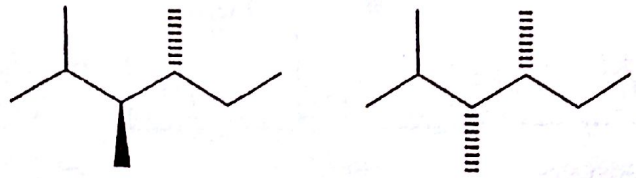
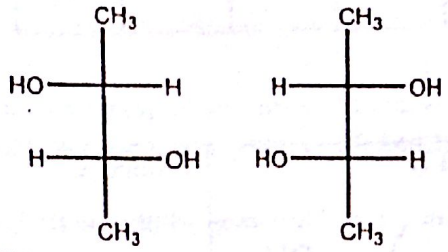
Alkene **E**



CHM 138H Term Test 2 Answer Sheet

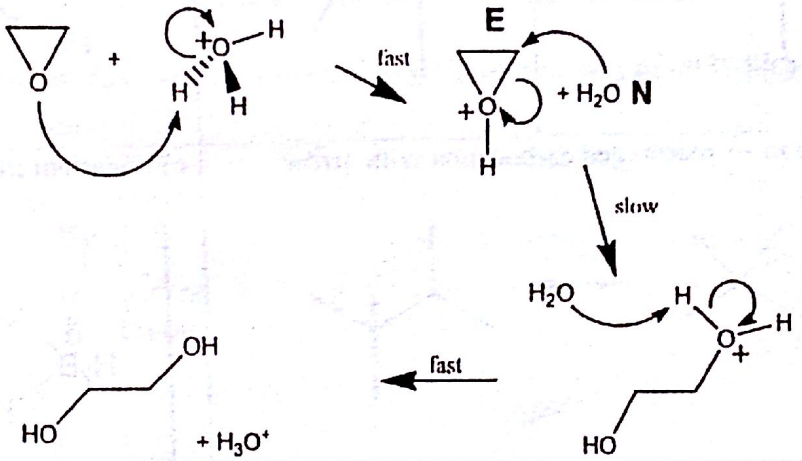
NAME: MODEL ANSWERS **Student #:** _____ **Tutorial Gp.:** ___

3. (*15 marks*)

F 	Product or product mixture is: [ ] achiral [ ] meso √ optically active [ ] racemic (Check one box.)
G 	Product or product mixture is: [ ] achiral [ ] meso [ ] optically active √ racemic (Check one box.)

4. (*14 marks*)

a)b)



c)