

CHEM 3311-200, Fall 2005

## Final Exam

December 13, 2005

Professor Rebecca Hoenigman

I pledge to uphold the CU Honor Code:

Signature\_\_\_\_\_

Name (printed)\_\_\_\_\_

Last four digits of your student ID number\_\_\_\_\_

Recitation TA\_\_\_\_\_

Recitation number, day, and time\_\_\_\_\_

**You have 2.5 hours to complete this exam.**

**Exams will be collected at 4:00 pm.**

**No model kits or calculators allowed.**

Periodic table and scratch paper are attached.

DO NOT TURN PAGE UNTIL INSTRUCTED TO DO SO.

**Put your name on ALL pages of the exam**

### Recitation Sections:

Number	Day	Time	TA
211	Monday	8 am	Kate
251	Monday	2 pm	Kate
291	Monday	5 pm	Xin
252	Tuesday	12 pm	Matt
293	Tuesday	5 pm	Jon
212	Wednesday	8 am	Greg
253	Wednesday	1 pm	Greg
292	Wednesday	5 pm	Jon
213	Friday	8 am	Xin

Name: \_\_\_\_\_

1. (5 pts) Draw the structure of anthracene.

2. (4 pts) Explain why cyclobutadiene is better represented as a rectangle, rather than a square.

3. (6 pts) In class, we used heats of hydrogenation to explain the stability of dienes. Another way in which energies of isomers may be compared is by their heats of combustion ( $\Delta H_{\text{comb}}$ ). Match the  $\Delta H_{\text{comb}}$  values given below with the appropriate isomer by writing the  $\Delta H_{\text{comb}}$  value on the line next to the diene name.  $\Delta H_{\text{comb}} = 3186 \text{ kJ/mol}$ ,  $3217 \text{ kJ/mol}$ ,  $3251 \text{ kJ/mol}$

1,2-pentadiene:  $\Delta H_{\text{comb}} =$  \_\_\_\_\_

(*E*)-1,3-pentadiene:  $\Delta H_{\text{comb}} =$  \_\_\_\_\_

1,4-pentadiene:  $\Delta H_{\text{comb}} =$  \_\_\_\_\_

Name: \_\_\_\_\_

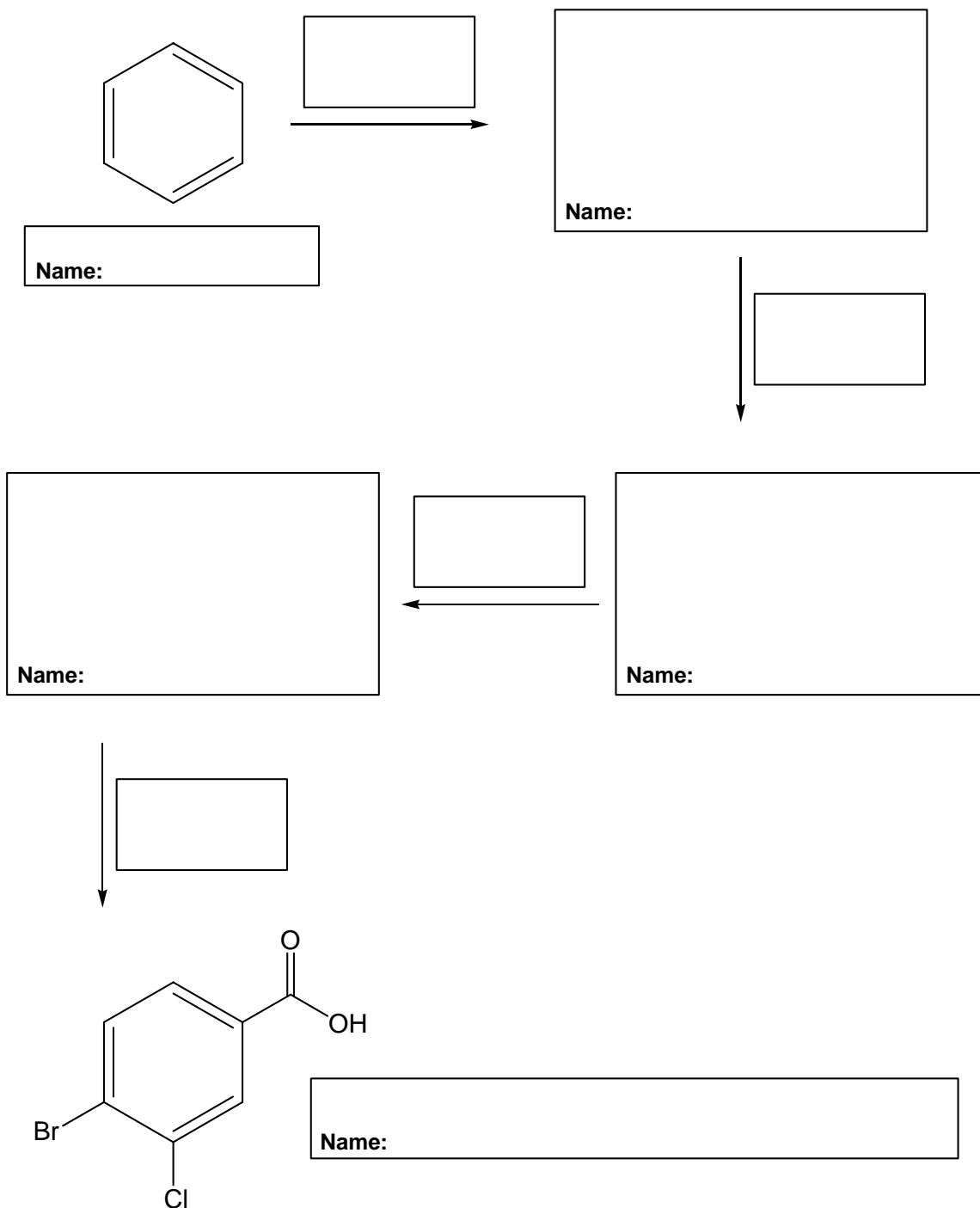
4. (20 pts) When benzaldehyde is allowed to react with nitric acid and sulfuric acid the major product is *m*-nitrobenzaldehyde.

A. Using arrows to show the movement of electrons, write a mechanism for this reaction. Be sure to show how the electrophile is formed.

B. Using resonance structures, explain why *ortho* and *para* substitution does not occur in this reaction.

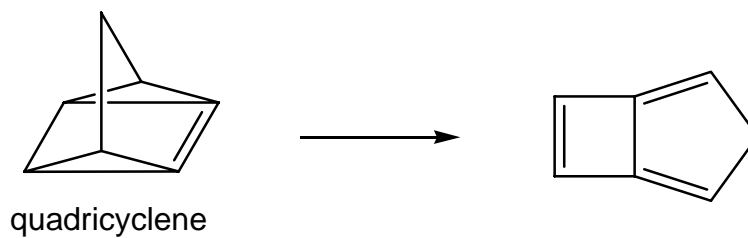
Name: \_\_\_\_\_

5. (16 pts) Fill in the missing reagents and intermediates for the multi-step synthesis below. If a reaction can produce two isomers, only show the isomer that is needed for the synthesis. Give the names for all of the aromatic compounds involved in this transformation.



Name: \_\_\_\_\_

6. (14 pts) The retro-Diels-Alder reaction of quadricyclene occurs readily.



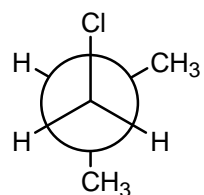
A. Briefly explain why this is a favorable reaction.

B. Using arrows to show the movement of electrons, give a mechanism to show how this reaction occurs. (Hint: the mechanism involves the concerted movement of 6 electrons.)

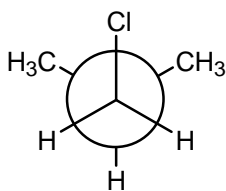
Name: \_\_\_\_\_

7. (30 pts) Circle the more stable compound in each of the following pairs and give the reason for your choice in the adjacent box.

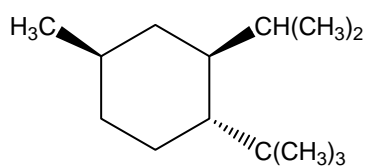
A.



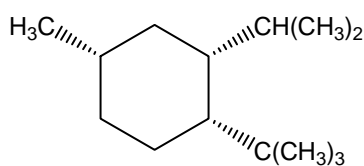
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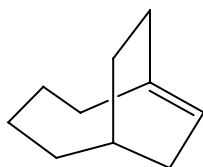
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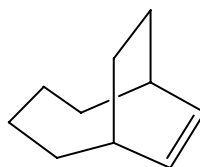
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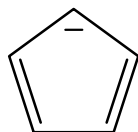
C.



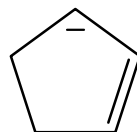
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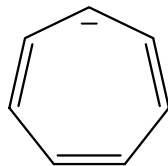
D.



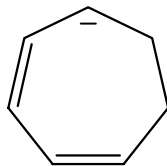
or



E.



or



F.

(E)-cycloheptene

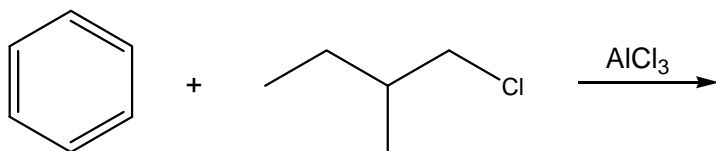
or

(Z)-cycloheptene

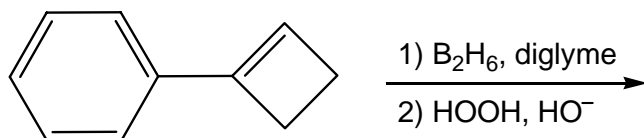
Name: \_\_\_\_\_

8. (40 pts) Give the organic products for the following reactions. If necessary, clearly label the stereochemistry of the products.

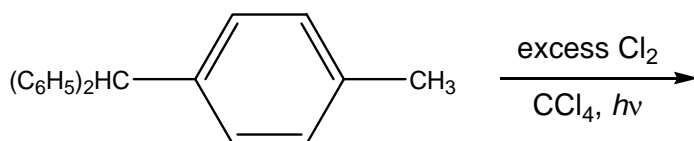
A.



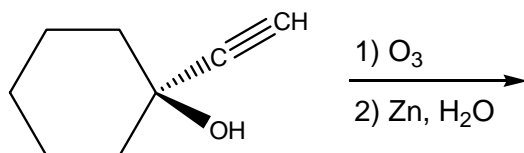
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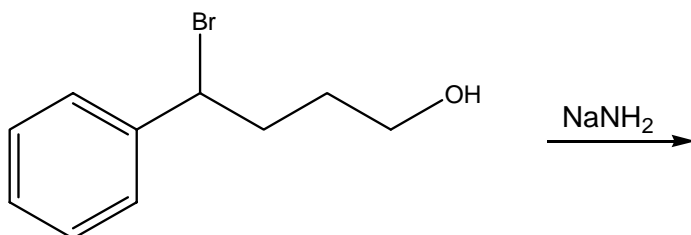
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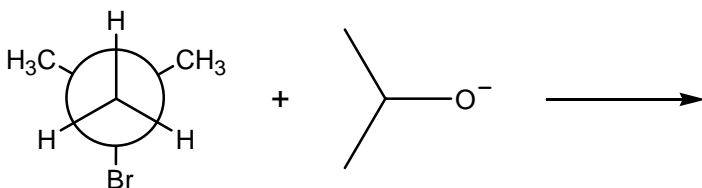
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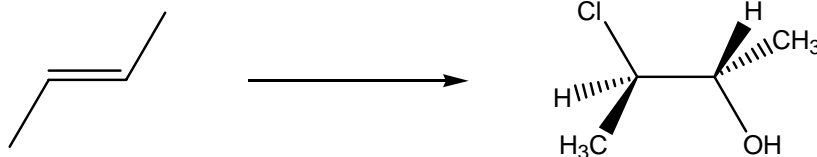
F.



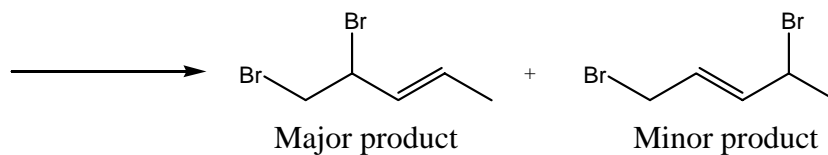
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9. (35 pts) Fill in the missing reactants and/or reagents for the following one step reactions. If necessary, clearly label the stereochemistry of the reactants.

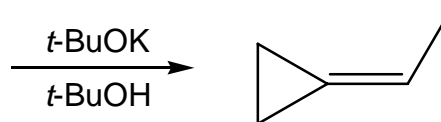
A.



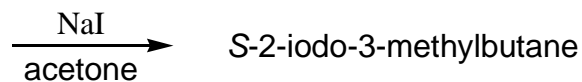
B.



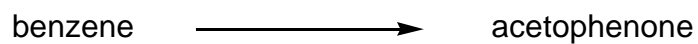
C.



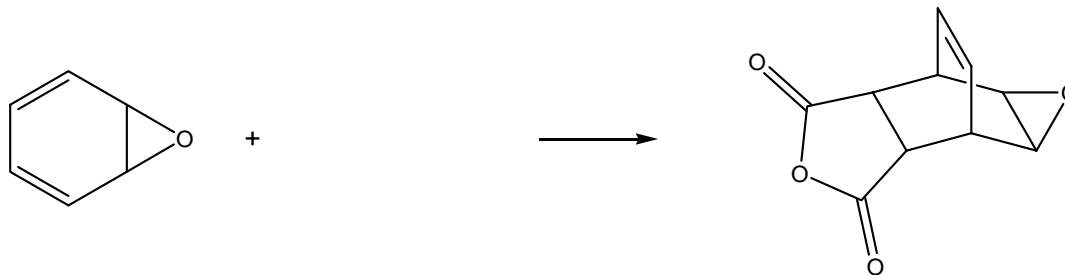
D.



E.



F.





Name: \_\_\_\_\_

10. (45 pts) Answer the following questions with examples that have the molecular formula **C<sub>2</sub>H<sub>2</sub>F<sub>2</sub>Br<sub>2</sub>**.

A. Draw a pair of enantiomers and clearly assign each carbon with the appropriate *R* or *S* configuration.

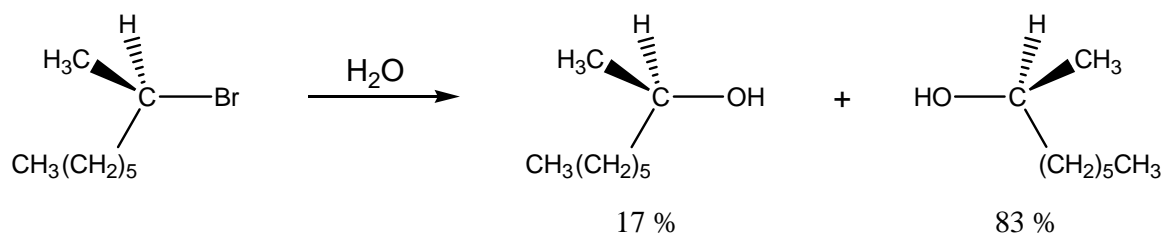
B. Draw a pair of diastereomers and clearly assign each carbon with the appropriate *R* or *S* configuration.

C. Draw a meso compound and clearly assign each carbon with the appropriate *R* or *S* configuration.

D. Draw a pair of constitutional isomers.

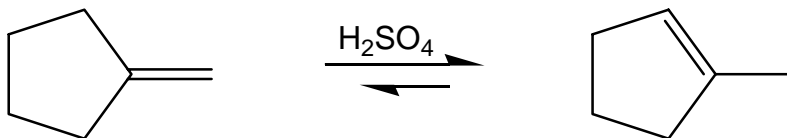
Name: \_\_\_\_\_

11. (10 pts) Explain why the following  $S_N1$  reaction does not give a racemic mixture.

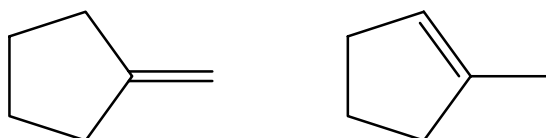


Name: \_\_\_\_\_

12. (25 pts) Methylene cyclopentane and 1-methylcyclopentene are equilibrated upon reaction with  $\text{H}_2\text{SO}_4$ . Answer the following questions about this reaction.



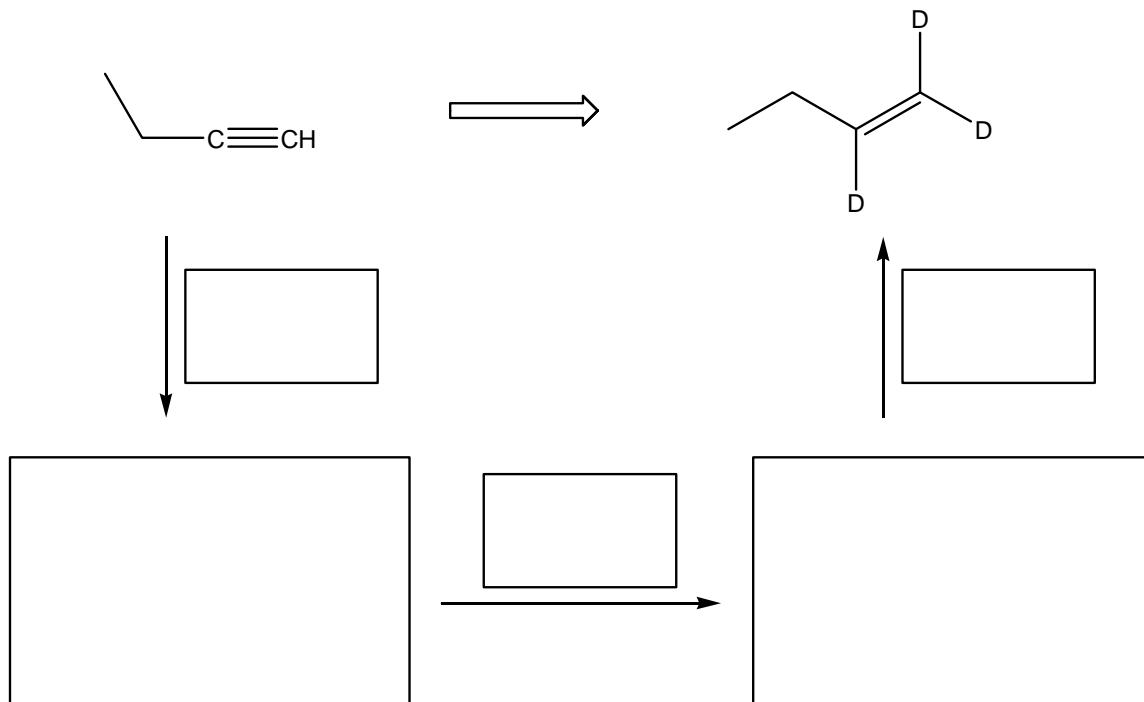
- A. Why is 1-methylcyclopentene favored at equilibrium?
- B. Give the IUPAC name of the product that would be formed if this reaction were carried out with  $\text{HCl}$ , rather than with  $\text{H}_2\text{SO}_4$ .
- C. Using arrows to show the movement of electrons, write a mechanism for the sulfuric acid catalyzed interconversion of these two alkenes. Be sure to show all intermediates that are involved.
- D. When this reaction is carried out with  $\text{D}_2\text{SO}_4$ , up to six atoms of deuterium are found in each of the products. Using the drawings below, circle all the carbons in each molecule where deuterium is found.



Name: \_\_\_\_\_

13. (40 pts) Each of the following transformations can be carried out in two or three steps. For each transformation, show in the boxes the necessary reagents and organic intermediates that are formed in the reactions.

A.



B.



Name: \_\_\_\_\_

14. (10 pts) The active ingredients in Gebauer's Pain Ease<sup>®</sup> are 1,1,1,3,3-pentafluoropropane and 1,1,1,2-tetrafluoroethane. The boiling points of these ingredients are 15.3 °C and -26.6 °C, respectively. For comparison, the boiling points of 1,1,1,2,3-pentachloropropane, 1,1,2,3,3-pentachloropropane, and 1,1,1,2-tetrachloroethane are 179 °C, 199 °C, and 138 °C, respectively.

A. Draw the active ingredients of Pain Ease<sup>®</sup>.

B. Explain why these fluorocarbons have such low boiling points.

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- No systemic toxicity.

**NEW GEBAUER'S PAIN EASE WORKS IN SECONDS**

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- Swab the area with antiseptic, spray Gebauer's Pain Ease for a few seconds, and perform procedure.
- Temporary numbing lasts up to one minute.
- Reapply as needed.

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Name: \_\_\_\_\_

**Score:**

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**Total** \_\_\_\_\_/300