

# Chemistry 35

## Exam 3 – May 2, 2007

Put your name and SISD number on **EVERY PAGE** of the exam.

Write all answers on the exam.

There are several blank pages at the end of the exam for you to use as scratch paper.

1 H 1.00797						1 H 1.00797	2 He 4.0026
3 Li 6.939	4 Be 9.0122	5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183
11 Na 22.9898	12 Mg 24.312	13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948

1. (24 points) \_\_\_\_\_

2. (18 points) \_\_\_\_\_

3. (12 points) \_\_\_\_\_

4. (10 points) \_\_\_\_\_

5. (20 points) \_\_\_\_\_

6. (16 points) \_\_\_\_\_

Total (100 points) \_\_\_\_\_

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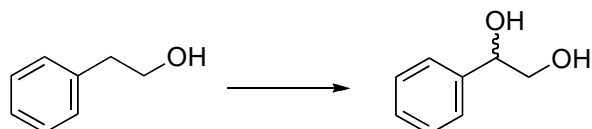
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*Problem 1.* (24 points) Synthesis: Propose a series of reactions (reagents and conditions) that convert the Starting Material into the Product. **You do NOT need to draw mechanisms for each reaction.**

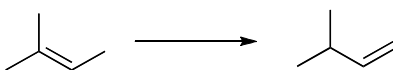
Structure your answer as follows:

Starting Material  $\xrightarrow{\text{Reagents-1}}$  Product 1  $\xrightarrow{\text{Reagents-2}}$  Product 2  $\rightarrow \rightarrow$  etc. as necessary

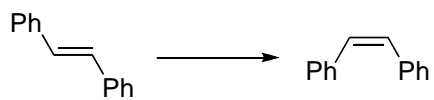
A) (6 points)



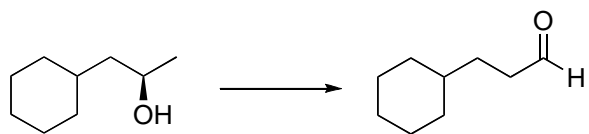
B) (6 points)



C) (6 points)



D) (6 points)



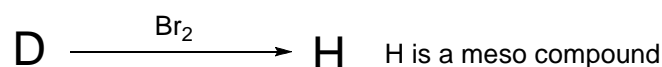
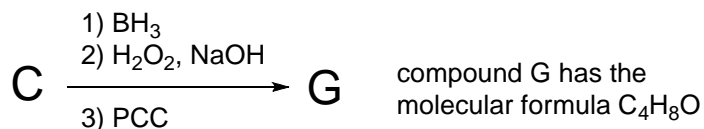
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*Problem 2.* (18 points)

A) (6 points) Draw out all of the isomers, including stereoisomers, that have the formula  $C_4H_8$ . Include only structures with complete octets and zero formal charges. There may be more or fewer boxes than isomers.


B) (12 points) Compounds A-D are four of the possible isomers or stereoisomers that have the formula  $C_4H_8$ . Compounds E-H are the major products from the reactions shown below.



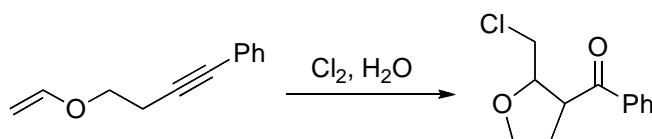
Based upon the information that you can infer from these reactions, and the other information that is provided, draw the correct structures for compounds A-H in the boxes provided below. Be sure to show stereochemistry where necessary.

A	B	C
D	E	F
G	H	

*Problem 3.* (12 points) Provide a detailed, step-by-step mechanism for the following reaction. In this question, we provide the reactants, products and reaction conditions. **YOUR JOB IS TO:**

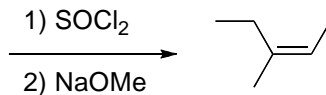
- 1) Show the individual chemical steps and all intermediates formed in the process of converting the reactant to the product.
- 2) Use curved arrows to show all changes in bonding and lone pair electrons.
- 3) Show all formal charges and all contributing resonance structures.

Remember, the sequence of steps you propose must convert the reactant into the product using only the starting material and reagents provided. You may not use additional acids or bases, since they are not present in the reaction mixture.

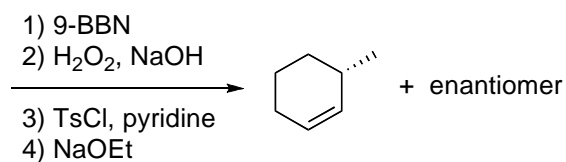


*Problem 4.* (10 points) Provide the structure of the starting material for each of the following reaction sequences. Your starting material must yield the indicated product as the **major product** from the transformations.

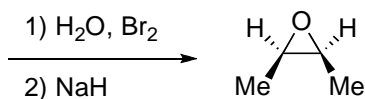
A) (3 points)



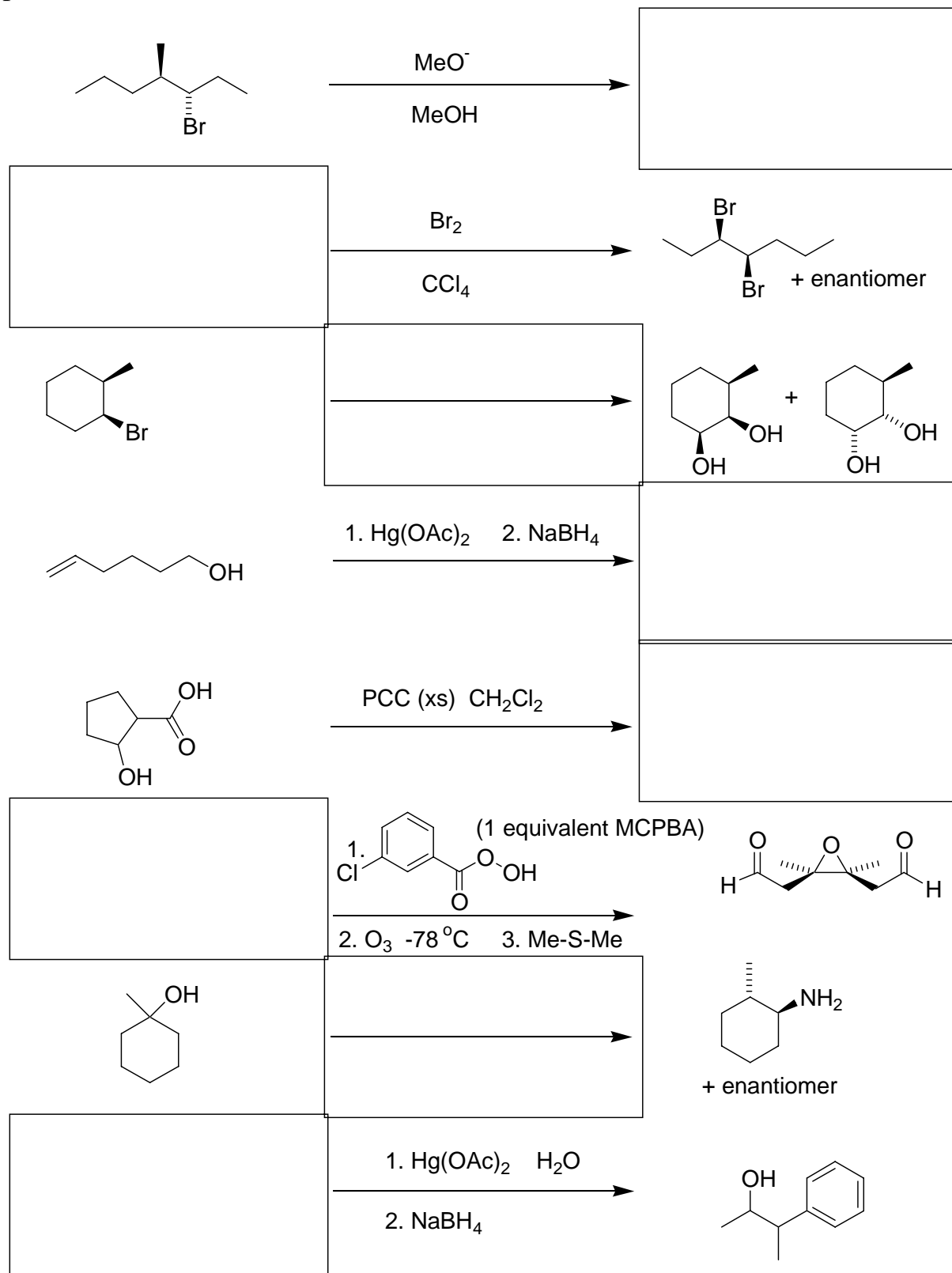
B) (4 points)



C) (3 points)



**Problem 5.** (20 points) Provide the missing starting material, reagent(s) or major product(s).

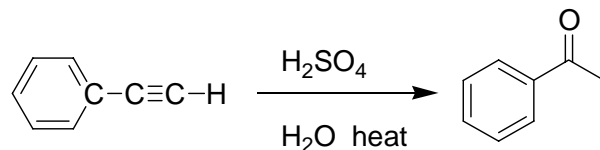




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*Problem 6.* (16 points) A vinyl carbocation is formed as an intermediate during the acid catalyzed electrophilic addition of water to an alkyne (shown below). While this reaction is often catalyzed by metals such as  $\text{HgSO}_4$  and  $\text{PtCl}_2$ , the reaction can also occur in the absence of metals at elevated temperatures.



A. (8 points) Provide a detailed, step-by-step mechanism for the reaction shown above. Do not use metals in your mechanism.

B. (6 points) The carbocation center of the vinyl cation formed as an intermediate in this reaction could be either  $sp$  or  $sp^2$  hybridized.

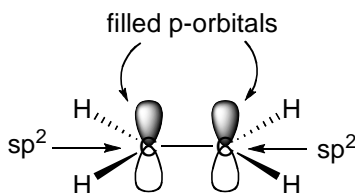
Provide 3D-sketches of the atomic / hybridized orbitals of the vinyl cation carbons indicated with a "C" in the alkyne (shown above part A) formed by protonation if you assume that

(a) the cationic carbon is  $sp$  hybridized, or (b) the cationic carbon is  $sp^2$  hybridized.

Your drawings should:

- Show all sigma bonds as lines between atoms.
- Draw in the orbitals for all pi-bonds, all p-orbitals, and all empty orbitals.
- Label each orbital as  $s$ ,  $sp$ ,  $sp^2$ ,  $sp^3$  or  $p$ . Also indicate if the orbital is empty or filled.
- Label the hybridization of the vinyl cation carbons indicated with a "C."
- Be sure that the geometry of your structure is clearly drawn.

We have provided a drawing of ethylene as an example of what your structure should look like.



(a) cationic carbon is  $sp$  hybridized

(b) cationic carbon is  $sp^2$  hybridized

C. (2 points) In reality, the vinyl cation carbon is  $sp$  hybridized. Briefly explain why the vinyl cation prefers  $sp$  hybridization over  $sp^2$  hybridization.

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