JOHN ABBOTT COLLEGE

CHEMISTRY DEPARTMENT

202-DCP-05

Organic Chemistry I

Winter 2020

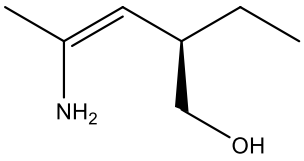
FINAL EXAM

Monday May 25, 2020

10:00 – 13:00

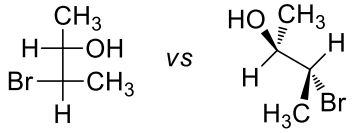
- Please note the exam was written at home due to the unusual Winter 2020 semester- COVID-19 shutdown on March 13 2020.
- There are 111 marks on this exam and 11 total pages. Marks for each question are indicated in parenthesis after the question.
- Some working spaces have been removed from this document for posting.

1. Provide an acceptable name for the following compound, with proper stereochemical designations where appropriate: (*5 marks*)

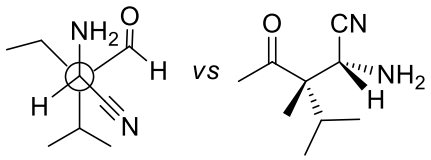


2. For each pair of compounds (1 vs 2 and 3 vs 4):

Give the relationship between the two compounds: Identical, structural/constitutional isomers, enantiomers, or diastereomers (*4 marks*)

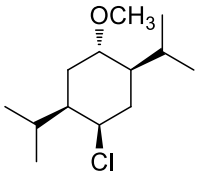


1 **2**



3 **4**

3. Consider the following substituted cyclohexane:

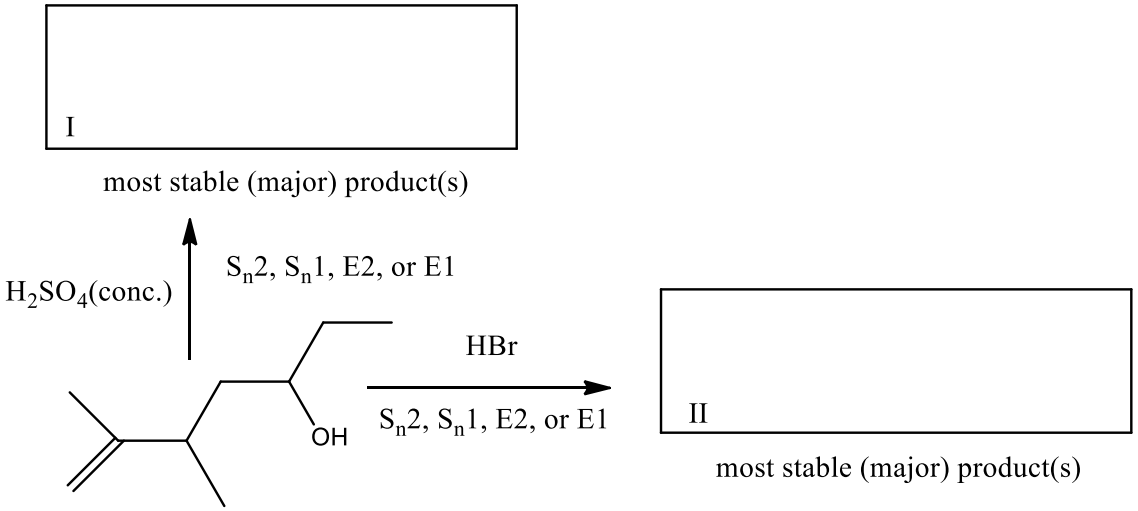


a) Provide the two chair-conformations for the above cyclohexane in as shown below. Place an equilibrium arrow between your conformers to indicate which conformer is more stable, and explain why this is the case. (*8 marks*)

Conformer A	Equilibrium Arrows	Conformer B

b) Which conformer, A or B, can undergo a second order (E2) elimination? Do you expect the reaction to be slow or fast? Briefly explain. (*4 marks*)

4. Observe the 2 separate reactions with the compound below:

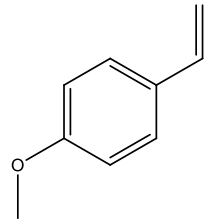


a) Identify the type of mechanism occurring in each reaction, and draw the major product(s) produced for both I and II. (*6 marks*)

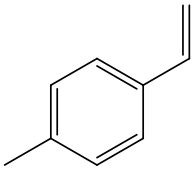
b) Provide the mechanism for the formation of ***either*** I or II using arrow formalism (arrow pushing) and include all the intermediates formed in the reaction. (*4 marks*)

c) Draw an energy (reaction coordinate) diagram for your chosen mechanism in part b). Assume that the reaction is endothermic. (*4 marks*)

5. Observe the two molecules below:



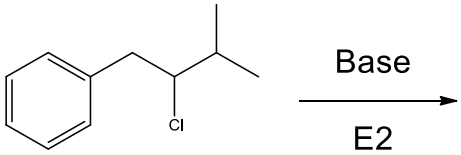
A



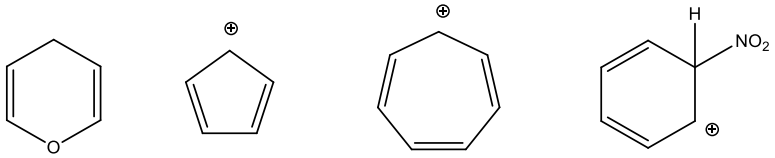
B

Which molecule would react with HBr faster in an electrophilic addition reaction? Identify the molecule that reacts faster and explain your answer based on the mechanism of the reaction. (*6 marks*)

6. For the following reaction, predict the major product and 1 minor product produced: (*4 marks*)



7. a) Identify each chemical species below as aromatic, anti-aromatic, or non-aromatic: (*4 marks*)

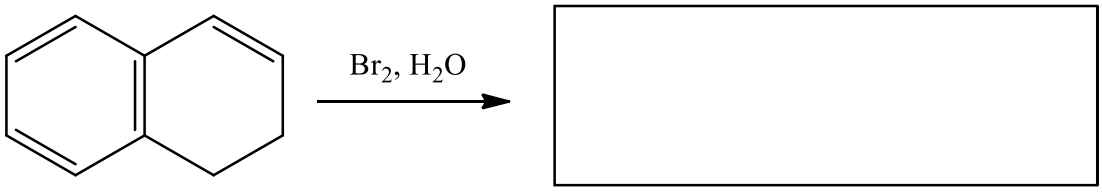


A B C D

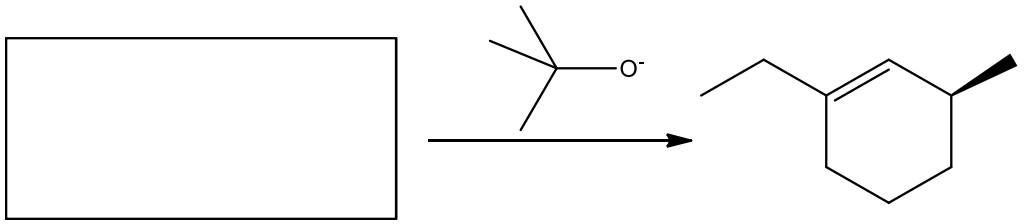
b) Between the 2 molecules below, identify the most acidic H's (a or b). Illustrate and briefly explain your answer. Your explanation must include the drawing(s) of the conjugate base(s). (*4 marks*)

8. Fill in the missing information for the reactions below. Pay attention to stereochemistry when applicable. (*8 marks*)

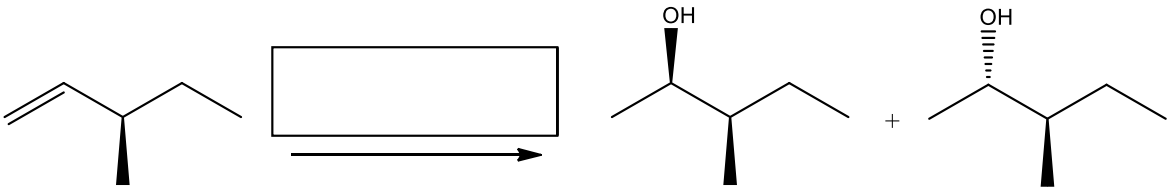
a)



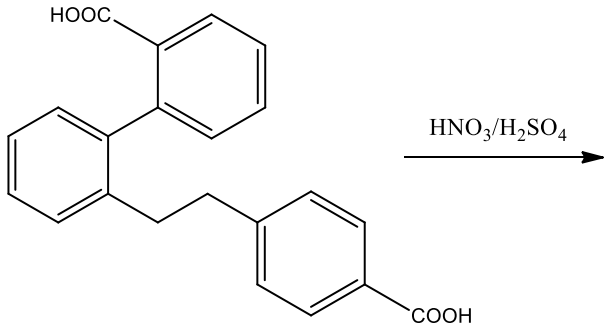
b)



c)

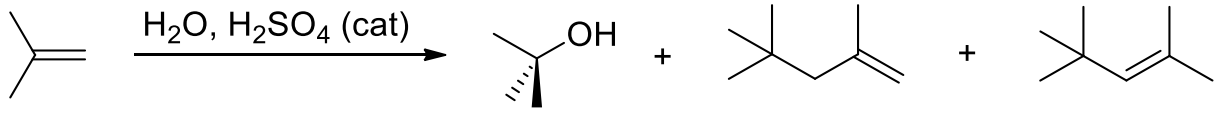


9. Observe the following compound consisting of multiple benzene rings, reacting with the chemical reagents shown.



Draw the final ***mono-substituted*** major product that is obtained from the reaction. Explain your reasoning for the position of the substituent. (*5 marks*)

10. Although 2-methylpropene undergoes acid catalyzed hydration in dilute sulfuric acid to form tert-butyl alcohol **1** as the major product, unwanted side-reactions could also occur to yield dimers **2** and **3**. Provide the mechanism for the transformation of 2-methylpropene into products **2**, and **3**. Use the curved arrow formalism (arrow pushing). Draw the structures of each intermediate. (*7 marks*)

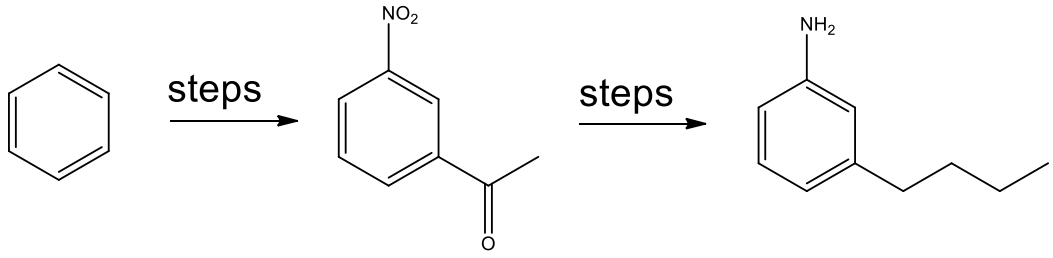


1 **2** **3**

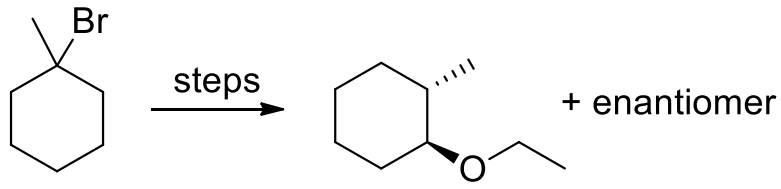
11. Provide the reagents (and conditions, if necessary) required to complete the following syntheses. Take the following requirements into consideration: (*12 marks*)

- Carbon-containing molecules to be incorporated into the structure must contain a maximum of 2-carbon atoms and 1 functional group.
- Show the product after each transformation (synthesis step).
- Pay attention to stereochemistry when applicable.

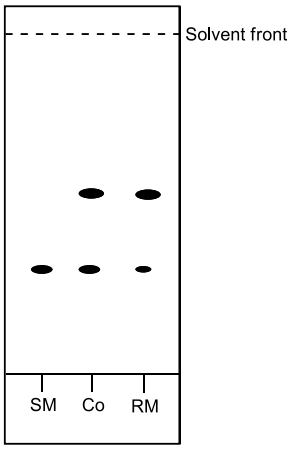
a)



b)



12. A TLC was taken after 30 minutes of reaction time to assess the progress of an ether synthesis.

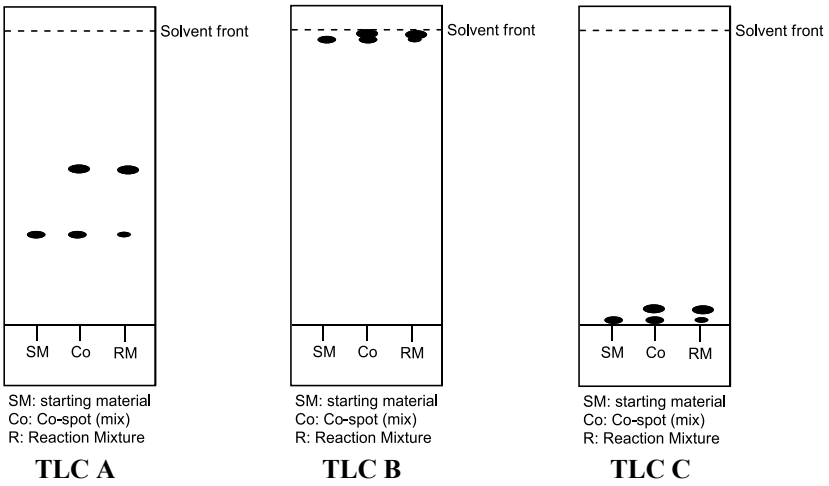


SM: starting material
Co: Co-spot (mix)
R: Reaction Mixture

a) Which compound is more polar, the starting material or the new product? Briefly explain how you know. (*2 marks*)

b) What useful information about the reaction can you get from these TLC results? (*2 marks*)

c) Match the following TLC plates with the following developing solvents/eluents: (*3 marks*)

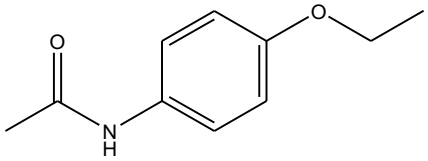


50% Ethyl acetate in Hexanes : _____

5% Ethyl acetate in Hexanes : _____

100 % Ethyl acetate : _____

13. The following structure is that of the compound phenacetin:



You would like to recrystallize phenacetin in the lab but don't know what solvent to use. You conduct a solubility test and obtain the following tabulated results:

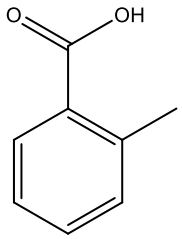
Table 1: Phenacetin solubility in different solvents at different temperatures.

	Water	Ethanol	Chloroform
Phenacetin solubility at room temp	Insoluble	Soluble	Soluble
Phenacetin solubility at boiling point	Insoluble	Soluble	Soluble
Phenacetin recrystallizes upon cooling	Not applicable	No	No

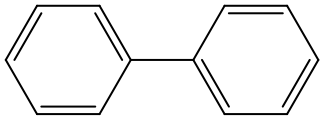
a) Explain why none of the 3 solvents are adequate for recrystallization of phenacetin, and describe what characteristics an ideal solvent should have. (*4 marks*)

b) However, a proper recrystallization solvent can be created by mixing 2 appropriate solvents together. Water is miscible with ethanol, but water is not miscible with chloroform. Ethanol and chloroform are miscible with each other. Which of the three following solvent systems would be most suitable for the recrystallization of phenacetin; water-chloroform, water-ethanol or chloroform-ethanol? Explain your reasoning. (*4 marks*)

14. Observe the following 2 compounds: both are white solid crystals and highly insoluble in water.



o-methylbenzoic acid
$pK_a = 4.21$



biphenyl
$pK_a = 43$

About 1 g of each of the two solid compounds are mixed together intimately.

You have access to any glassware you might need and also have the following solutions and solvents available: deionized water, aqueous sodium chloride, aqueous sodium hydroxide, aqueous sodium bicarbonate, aqueous ammonium chloride, aqueous hydrochloric acid, and t-butyl methyl ether.

a) Explain how these two compounds could be separated from each other using a common lab procedure using the following template below: (*8 marks*)

Step 1: Dissolve the mixed solids using _____ as the solvent.

Step 2: Pour the dissolved mixture into a _____ (name the glassware)

Step 3: Add _____ solution into the glassware and _____ (state the physical technique)

Step 4: Isolate the _____ solution fraction/layer which contains

(draw structure)

Step 5: The remaining fraction/layer contains (draw compound structure)

Step 6: To the collected fraction/layer in Step 4 add _____ solution to recover the compound from solution.

b) Explain why adding the solution you chose in step 3 allows for one compound to separate from the other (step 4). (*3 marks*)