CHEM 347 – Organic Chemistry II (for Majors)

Instructor: Paul J. Bracher

Quiz #4

Due in Monsanto Hall 103 by:

Friday, April 4th, 2014, 7:00 p.m.

Student Name (Printed)	Solutions
Student Signature	N/A

Instructions & Scoring

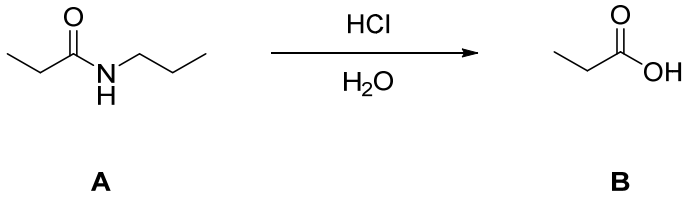
- This quiz must be turned in by the due date listed above.
- You are allowed access to any materials you wish and may discuss the questions with other students.
- Place your answers on the official answer sheet. If you print your own, please print it back-to-back on a single sheet of paper.
- Your quiz may be photocopied.

Problem	Points Earned	Points Available
I		24
II		25
III		21
IV		15
V		15
TOTAL		100

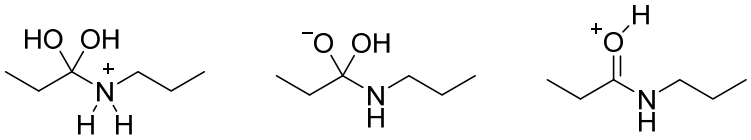
Original Problems, Required Answers, Supplemental Information

Problem I. Multiple choice (24 points total; +4 points for a correct answer, +1 points for an answer intentionally left blank, and 0 points for an incorrect answer.) For each question, select the best answer of the choices given. Write the answer, legibly, in the space provided on the answer sheet.

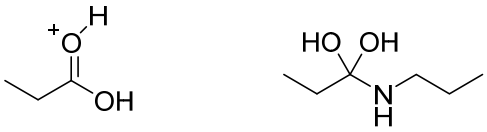
(1) B Which of the following species is <u>not</u> an intermediate in the mechanism for the formation of **B** from **A** in methanol with hydrochloric acid?



A **B**



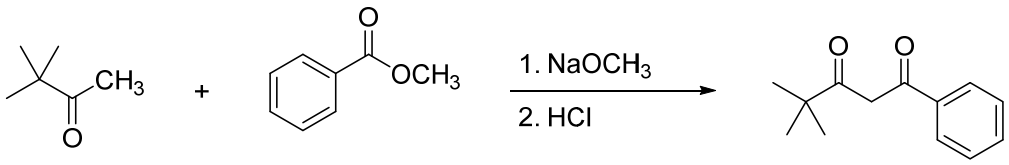
(a) (b) (c)



(d) (e)

- In acidic conditions, reactions typically proceed by protonation of the carbonyl group (to make it a better electrophile) followed by attack by a neutral nucleophile. Amines and alcohols typically leave as neutral molecules in substitutions. In basic conditions, the carbonyl group is not protonated, and oxygen nucleophiles and leaving groups are usually deprotonated and negatively charged.

(2) B Which of the following statements best describes the following reaction?



(a) the reaction requires a catalytic amount of sodium methoxide
(b) methanol is produced as a byproduct
(c) CO_2 is produced as a byproduct
(d) Statements (a) and (b) are correct
(e) Statements (a), (b), and (c) are correct

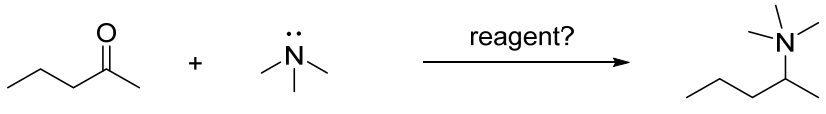
- This Claisen reaction involves the substitution of the methoxy group on the ester to generate methanol as a byproduct. While $NaOCH_3$ is regenerated after substitution of the carbonyl group, one equivalent of the base is consumed by the product, which has especially acidic hydrogen atoms located on the carbon atom between the two carbonyl groups. Since methoxide is consumed by each molecule of product, $NaOCH_3$ is not a catalyst.

(3) D Which of the following reactions would <u>not</u> produce phenol after workup with mildly acidic water?

(a) PhN_2^+ + water
(b) phenyl acetate + H_3O^+ + heat
(c) phenyl acetate + NaOH + heat
(d) phenylmagnesium bromide + water
(e) all of these reactions will produce phenol after workup

- Phenylmagnesium bromide, a Grignard reagent, will react with a proton to form benzene.

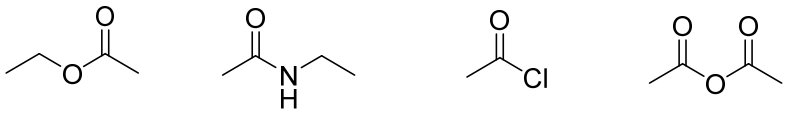
(4) E Which of the following reagents is the best choice for the following conversion?



(a) $LiAlH_4$
(b) H_2, Pd-C
(c) $NaBH_4$
(d) $NaBH_3CN$
(e) None of the above reagents will effect this conversion

- Even if the tertiary amine adds to the carbonyl group, the oxygen atom cannot leave as water because the presence of the quaternary ammonium would destabilize the carbocation. Reductive amination cannot be used to prepare quaternary amines from tertiary amines.

(5) B Rank the following molecules in order of <u>slowest-to-fastest</u> rate of reaction in hot acidic water to liberate acetic acid. The slowest-reacting compound is listed first in each answer choice.

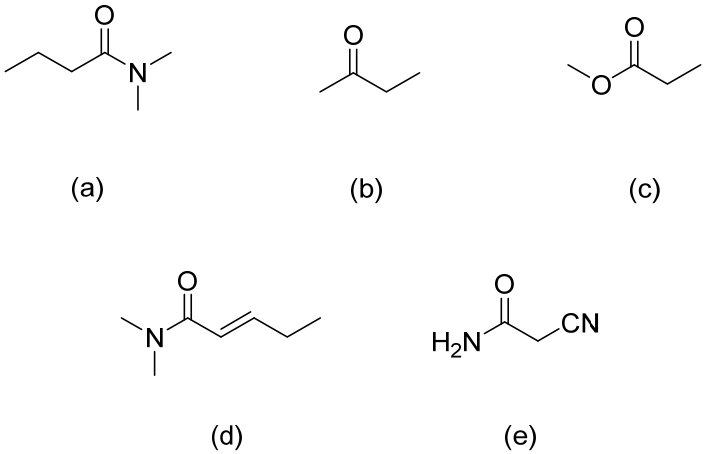


C **D** **E** **F**

(a) **C** < **D** < **E** < **F**
(b) **D** < **C** < **F** < **E**
(c) **E** < **F** < **C** < **D**
(d) **D** < **C** < **E** < **F**
(e) **D** < **F** < **C** < **E**

- Recall that acid chlorides are less stable than acid anhydrides, which are less stable than esters, which are less stable than amides.

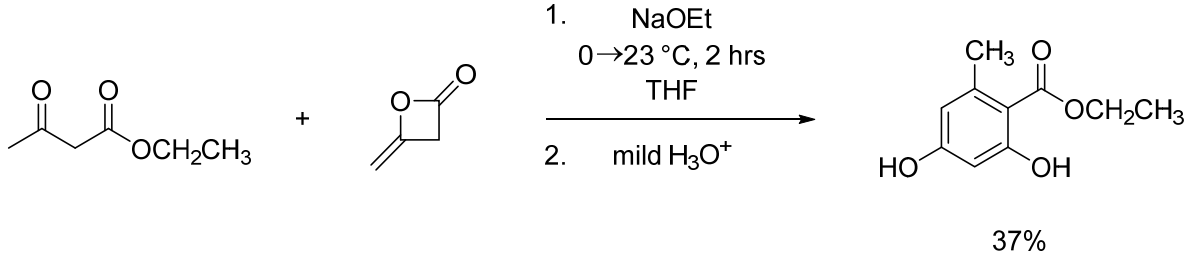
(6) A Which of the following compounds is the <u>weakest</u> acid (i.e., has the highest pK_a)?



- We can judge relative acidity among a set of related compounds based on the relative stability of the conjugate bases that would result from each compound losing a proton. Choice (e) is the most acidic, since the carbanion in the conjugate base can be delocalized into both a carbonyl group and the adjacent cyano group. In general, ketones are more acidic than esters, because the alkoxy substituent on the carbonyl group of an esters donates electorn density into the carbonyl group, making it less able to accept more electron density from a carbanion at the alpha position. Amino groups are better electron donating groups by this resonance effect, so in general, amides are less acidic than esters at the alpha position. Finally, we must distinguish between choices (a) and (d). If (d) is deprotonated on the CH_2 group to the right of the pi bond, the carbanion can be delocalized to both the alpha position and into the carbonyl group. This affords more extensive delocalization than simple deprotonation at the alpha position of (a), so (d) is more acidic than (a), which is the weakest acid present.

Problem II. Mechanism (25 points). Draw a sensible mechanism for the transformation shown below. Remember to use proper "curved arrow notation" to account for the movement of electrons in the making and breaking of bonds. Show all steps (i.e., draw all intermediates). For this problem, you only need to draw one resonance form for any intermediates with multiple resonance forms. (Ref: **Kato** and **Hozumi**. *Chem. Pharm. Bull.* **1972**, *20*, 1574-1578.)

(a) (20 points)



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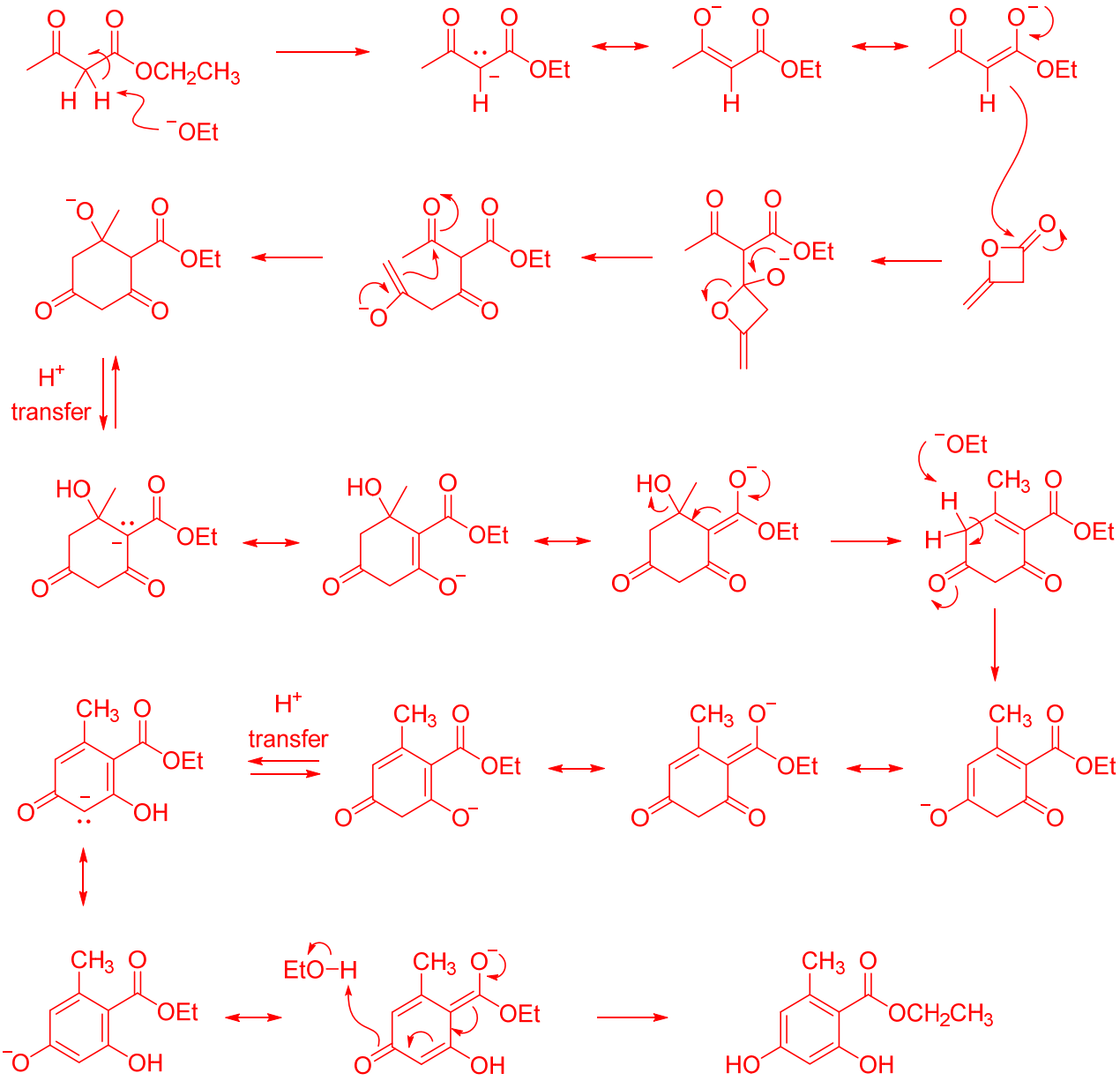


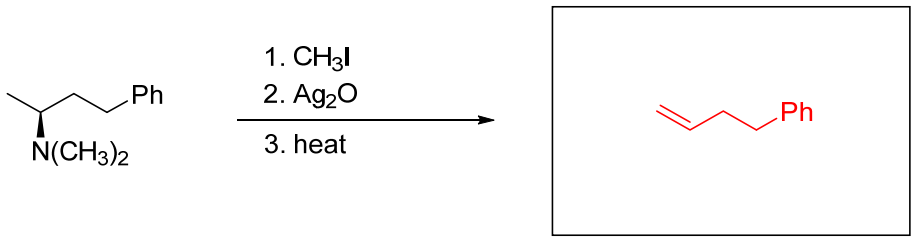
(b) (5 points)

The last step of the mechanism for the reaction above involves a tautomerization. Usually, keto tautomers are favored over enol tautomers. Explain what provides the driving force to favor the enol tautomer in this reaction.

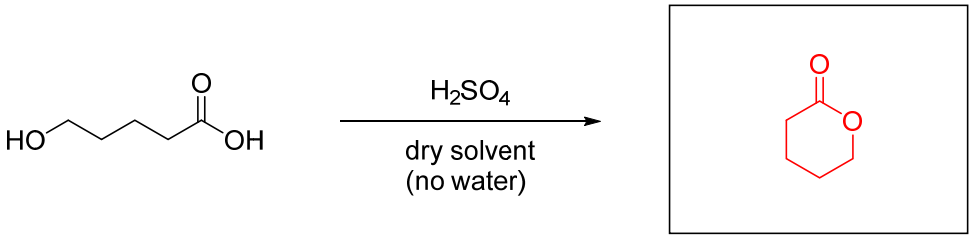
The tautomerization equilibrium favors the enol functional groups because this structure possesses an aromatic ring.

Problem III. Reactions (21 points). The following chemical reactions are missing their starting materials, products, or reagents. Write the missing compounds into the empty boxes below, as appropriate. For missing products, draw the single organic product that you expect to be produced in the highest yield among all of the possibilities. In some cases, there will be more than one correct answer that will merit full credit.

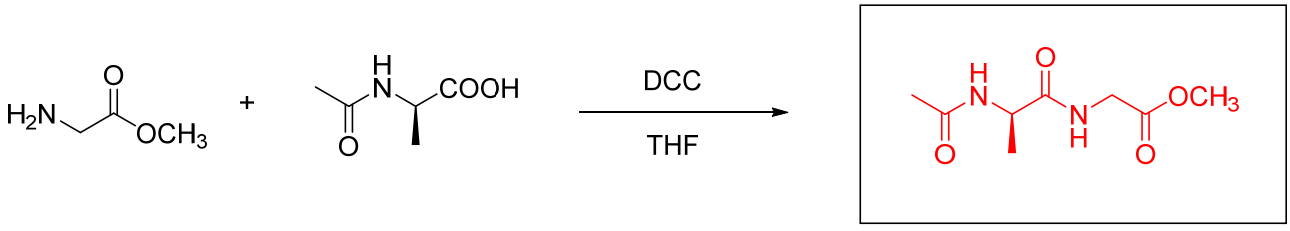
(1) (7 points)



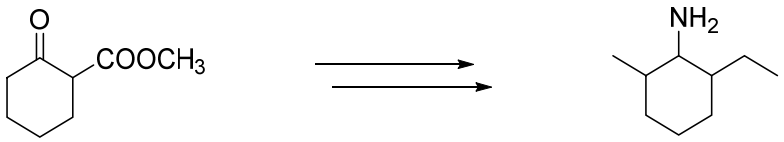
(2) (7 points)



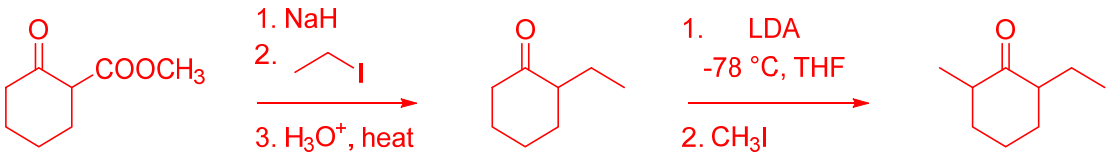
(3) (7 points)

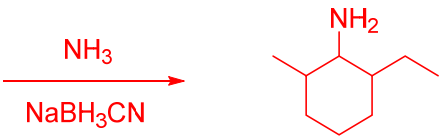


Problem IV. Synthesis (15 points). Design an efficient synthesis of compound **G** from the indicated starting material and any other reagents you wish.

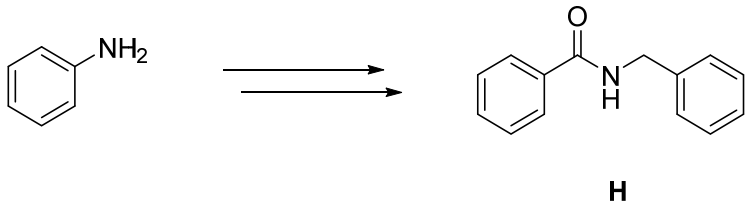


G





Problem V. Synthesis (15 points). Design an efficient synthesis of compound **H** using aniline and any compounds you wish with <u>three or fewer</u> carbon atoms as the <u>only</u> sources of carbon in the product. (Any reagents or solvents you use that have more than three carbon atoms can't contribute carbon atoms to the final product.)



H