

NAME (Print): \_\_\_\_\_

Chemistry 310N  
Dr. Brent Iverson  
2nd Midterm  
March 29, 2007

SIGNATURE: \_\_\_\_\_

Please print the  
first three letters  
of your last name  
in the three boxes

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**Please Note:** This test may be a bit long, but there is a reason. I would like to give you a lot of little questions, so you can find ones you can answer and show me what you know, rather than just a few questions that may be testing the one thing you forgot. **I recommend you look the exam over and answer the questions you are sure of first**, then go back and try to figure out the rest. Also make sure to **look at the point totals** on the questions as a guide to help budget your time.

*For synthesis problems GO FOR PARTIAL CREDIT EVEN IF YOU DO NOT KNOW THE ENTIRE ANSWER!! WRITE DOWN WHAT YOU DO KNOW IN THE REACTION SEQUENCE SOMEWHERE. YOU WILL GET PARTIAL CREDIT IF IT IS CORRECT*

**Note: You must have your answers written in pen if you want a regrade!!!!**

| Page               | Points       |
|--------------------|--------------|
| <b>1</b>           | <b>(26)</b>  |
| <b>2</b>           | <b>(34)</b>  |
| <b>3</b>           | <b>(19)</b>  |
| <b>4</b>           | <b>(18)</b>  |
| <b>5</b>           | <b>(29)</b>  |
| <b>6</b>           | <b>(19)</b>  |
| <b>7</b>           | <b>(19)</b>  |
| <b>8</b>           | <b>(25)</b>  |
| <b>9</b>           | <b>(17)</b>  |
| <b>10</b>          | <b>(21)</b>  |
| <b>11</b>          | <b>(14)</b>  |
| <b>12</b>          | <b>(7)</b>   |
| <b>13</b>          | <b>(16)</b>  |
| <b>14</b>          | <b>(16)</b>  |
| <b>15</b>          | <b>(18)</b>  |
| <b>16</b>          | <b>(6)</b>   |
| <b>Total</b>       | <b>(304)</b> |
| <b>HW</b>          |              |
| <b>T<br/>Score</b> |              |

## Honor Code

The core values of the University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

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(Your signature)

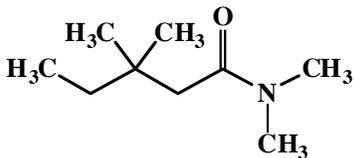
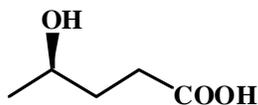
| Compound           |  | pK <sub>a</sub> |
|--------------------|--|-----------------|
| Hydrochloric acid  | $\underline{\text{H}}\text{-Cl}$   | -7              |
| Protonated alcohol | $\text{RCH}_2\text{O}\overset{\oplus}{\text{H}}_2$   | -2              |
| Hydronium ion      | $\overset{\oplus}{\text{H}}_3\text{O}$   | -1.7            |
| Carboxylic acids   | $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\underline{\text{H}}$  | 3-5             |
| Ammonium ion       | $\overset{\oplus}{\text{H}}_4\text{N}$   | 9.2             |
| β-Dicarbonyls      | $\overset{\text{O}}{\parallel}{\text{RC}}-\underline{\text{CH}}_2-\overset{\text{O}}{\parallel}{\text{CR}'}$   | 10              |
| β-Ketoesters       | $\overset{\text{O}}{\parallel}{\text{RC}}-\underline{\text{CH}}_2-\overset{\text{O}}{\parallel}{\text{COR}'}$  | 11              |
| β-Diesters         | $\overset{\text{O}}{\parallel}{\text{ROC}}-\underline{\text{CH}}_2-\overset{\text{O}}{\parallel}{\text{COR}'}$ | 13              |
| Water              | $\text{HO}\underline{\text{H}}$  | 15.7            |
| Alcohols           | $\text{RCH}_2\text{O}\underline{\text{H}}$   | 15-19           |
| Acid chlorides     | $\text{RCH}_2-\overset{\text{O}}{\parallel}{\text{CCl}}$   | 16              |
| Aldehydes          | $\text{RCH}_2-\overset{\text{O}}{\parallel}{\text{CH}}$  | 18-20           |
| Ketones            | $\text{RCH}_2-\overset{\text{O}}{\parallel}{\text{CR}'}$   | 18-20           |
| Esters             | $\text{RCH}_2-\overset{\text{O}}{\parallel}{\text{COR}'}$  | 23-25           |
| Terminal alkynes   | $\text{RC}\equiv\text{C}-\underline{\text{H}}$   | 25              |
| LDA                | $\underline{\text{H}}\text{-N}(i\text{-C}_3\text{H}_7)_2$  | 40              |
| Terminal alkenes   | $\text{R}_2\text{C}=\underset{\text{H}}{\text{C}}-\underline{\text{H}}$  | 44              |
| Alkanes            | $\text{CH}_3\text{CH}_2-\underline{\text{H}}$  | 51              |

Signature \_\_\_\_\_

Pg 1 \_\_\_\_\_(26)

1. (14 points) Suppose a relative of yours is having an MRI. In no more than four sentences, explain to them what is happening when they have the MRI scan. We will be looking for a minimum of 7 key points here.

2. (4 pts each) In the space provided, write the IUPAC name (including stereochemistry where appropriate) for the following two molecules:

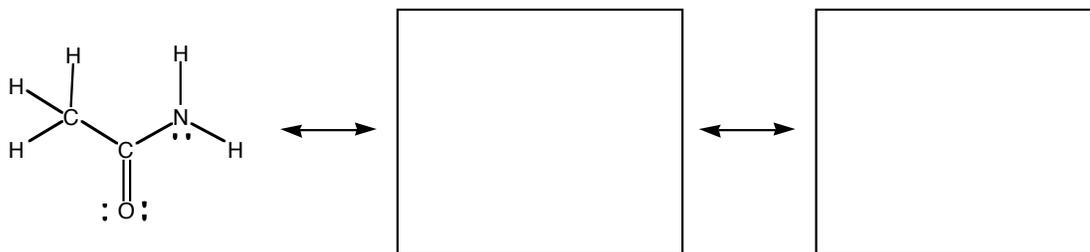


3. (4 pts) In the space provided, draw the following molecule:

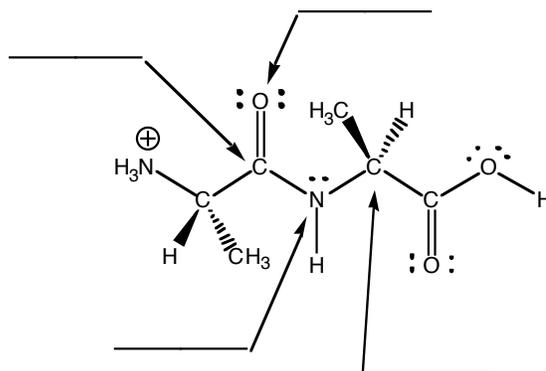
Diethyl cis-1,2-cyclohexanedicarboxylate



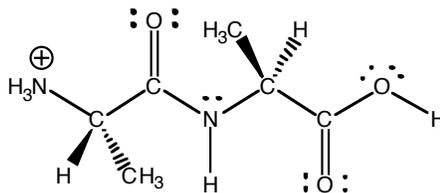
4. (8 points) Draw the two most important resonance contributing structures of the amide shown below. Be sure to show all lone pairs and formal charges. You do not have to draw arrows on this one.



5. (8 points) On the lines, indicate the hybridization state of each atom indicated by the arrows.



6. (14 points) On the following structure 1) Draw a box around all the atoms that are ALWAYS in the same plane as the amide carbonyl group ( $\text{C}=\text{O}$ ) and 2) circle all of the  $\text{C}-\text{N}$  bonds that DO NOT ROTATE.



- (4 pts) For the above structure, is this the appropriate protonation state for pH 2.0, 7.0, or 10.0?

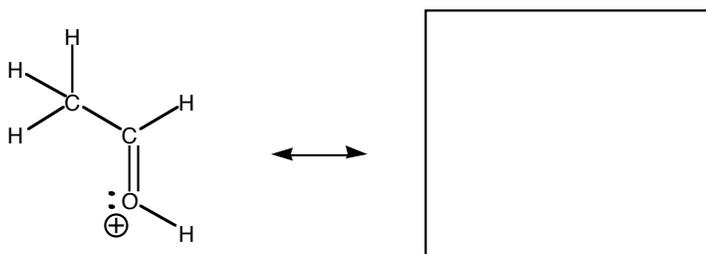
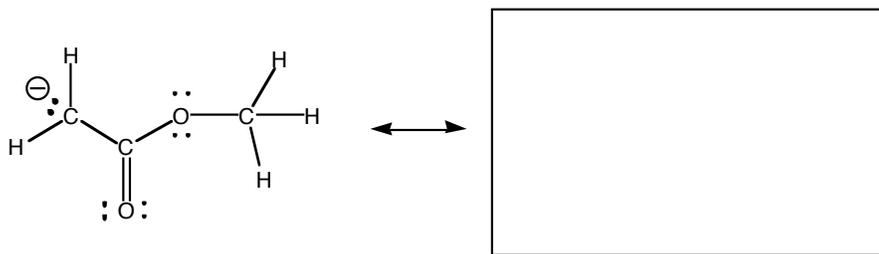
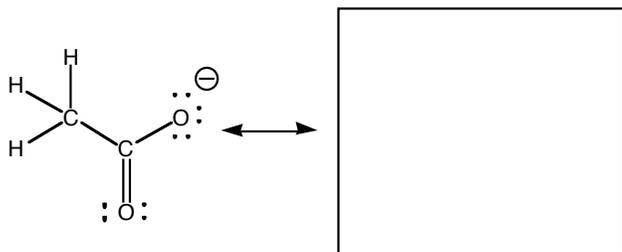
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⇐ Notice This

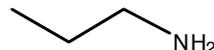
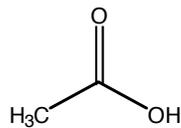
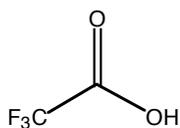
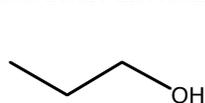
Signature \_\_\_\_\_

Pg 3 \_\_\_\_\_ (19)

7. (15 points) For each of the following molecules, draw the indicated number of MOST important resonance contributing structures. Be sure to show all lone pairs and formal charges. You do not have to draw arrows on this one.



8. (4 points) Rank the following in terms of relative acidity, with a 1 under the most acidic, and a 4 under the least acidic molecule.



\_\_\_\_\_

\_\_\_\_\_

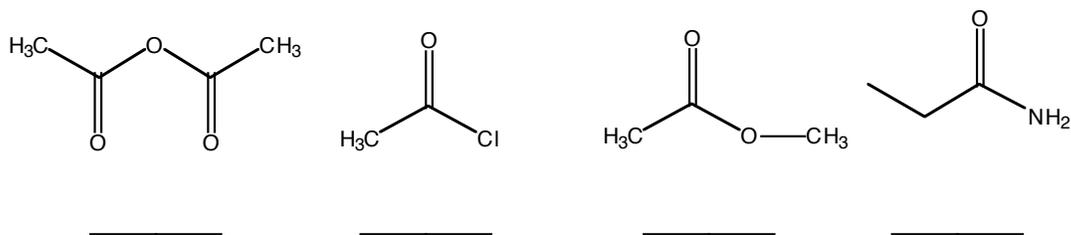
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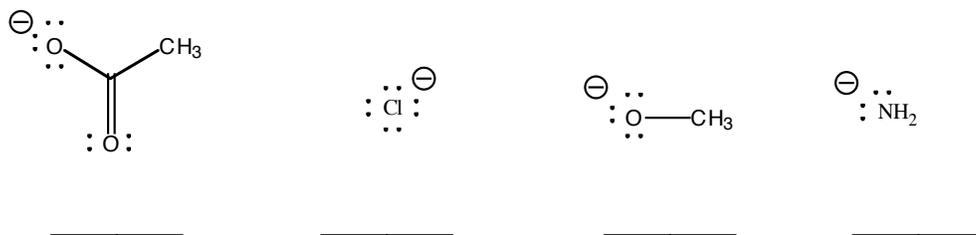
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Pg 4 \_\_\_\_\_ (18)

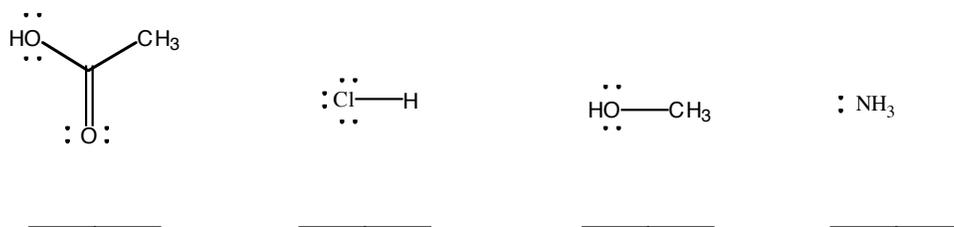
9. (4 points) Rank the following carboxylic acid derivatives with respect to reactivity with a nucleophile. Write a 1 under the most reactive, and a 4 under the least reactive derivative.



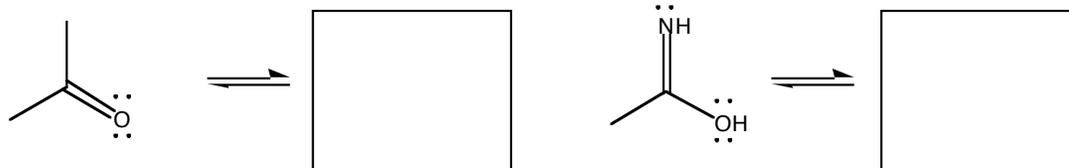
10. (4 points) Rank the following with respect to anion stability. Write a 1 under the most stable anion, and a 4 under the least stable anion.



11. (4 points) Rank the following in terms of relative acidity, with a 1 under the most acidic, and a 4 under the least acidic molecule.

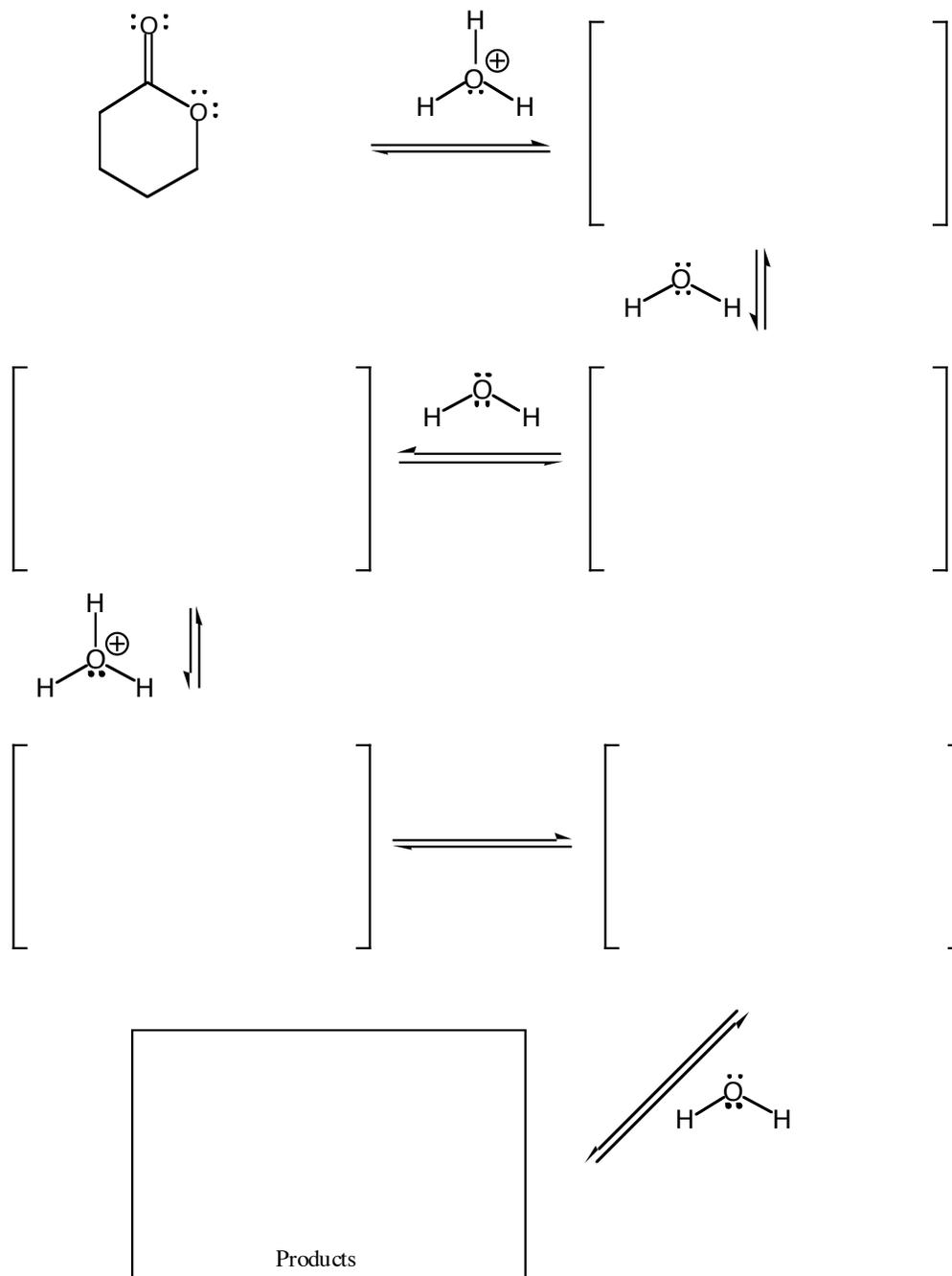


12. (6 points) Each of the following undergo the process of tautomerization. For each draw the other major tautomer, then for each pair, circle the one that is more stable.



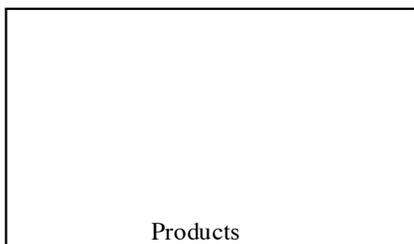
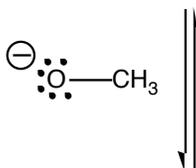
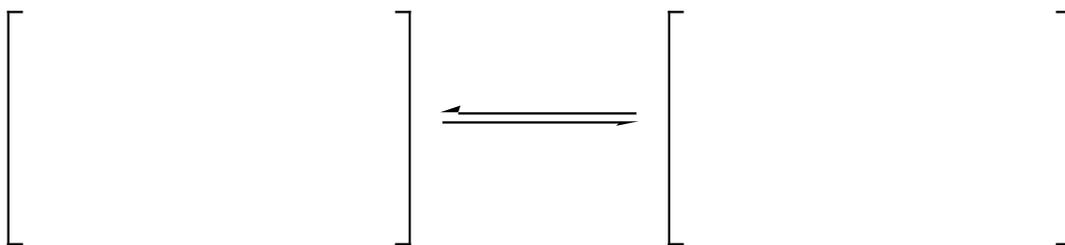
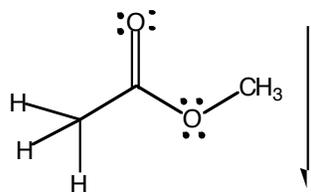
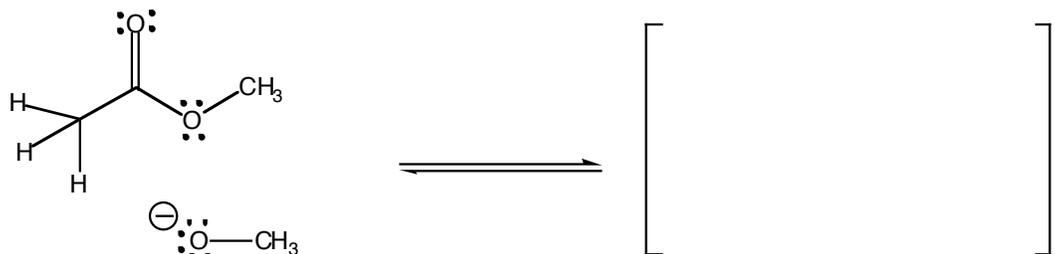
13. (29 points) Complete the following mechanism. Be sure to use arrows to indicate movement of all electrons and show all lone pairs and formal charges. Also, you must show all the products of each step. For resonance stabilized intermediates, you only need to draw one important contributing structure.

*Acid Catalyzed Ester Hydrolysis*



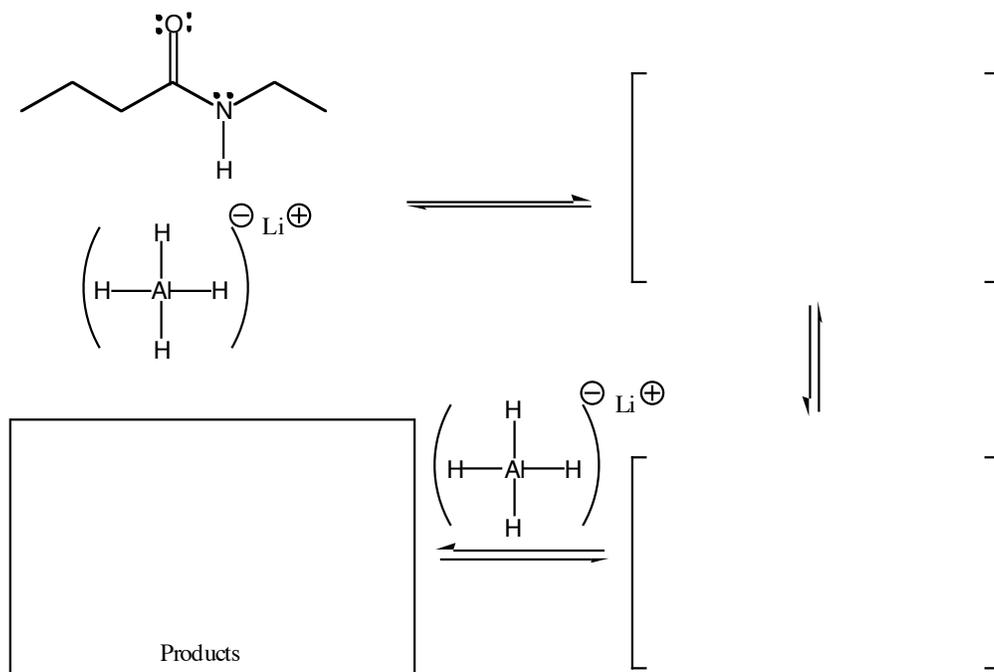
14. (19 points) Complete the following mechanism. Be sure to use arrows to indicate movement of all electrons and show all lone pairs and formal charges. Also, you must show all the products of each step. For resonance stabilized intermediates, you only need to draw one important contributing structure.

*Claisen Condensation*



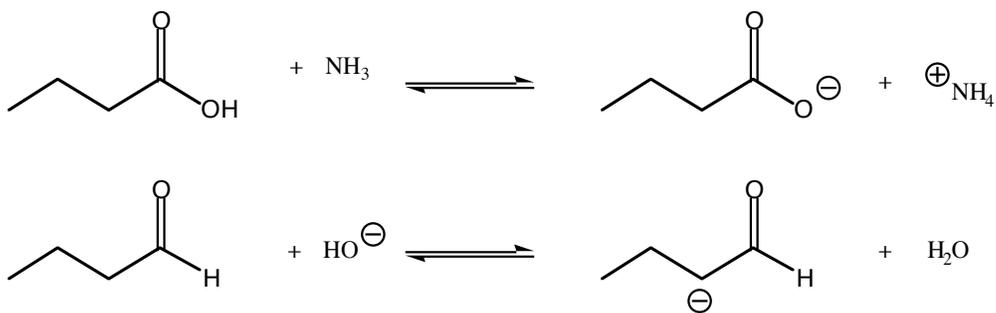
15. (13 points) Complete the following mechanism. Be sure to use arrows to indicate movement of all electrons and show all lone pairs and formal charges. Also, you must show all the products of each step. For resonance stabilized intermediates, you only need to draw one important contributing structure.

*Reduction of Amides with  $\text{LiAlH}_4$*

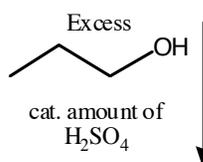
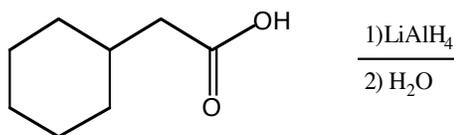
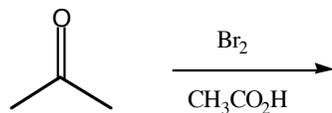


Note: In this reaction the chemist opens the flask and adds water in a second step that quenches any excess  $\text{LiAlH}_4$ . Therefore, you need a second step to add water when using this reaction in synthesis even though it is not shown in the mechanism above.

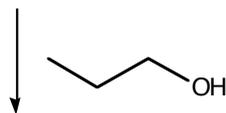
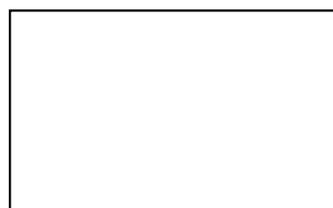
16. (6 pts) For the following equations that describe acid-base reactions, **circle the side that predominates at equilibrium.**



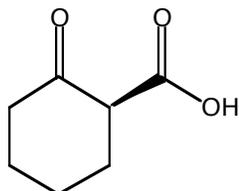
17. (25 points) Complete the following reactions. Draw the predominant carbon-containing organic product or products that will be formed. If a new chiral center is created in the reaction that produces a racemic mixture, label the chiral center with an asterisk (\*) and write "*racemic*" underneath. You do not have to draw both enantiomers.



$\text{SOCl}_2$



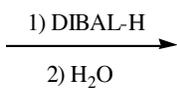
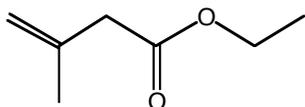
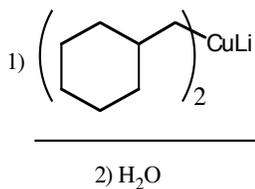
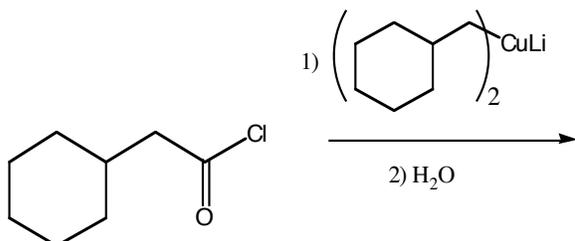
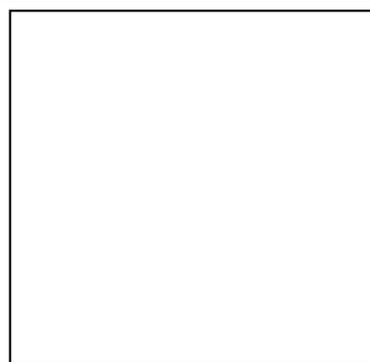
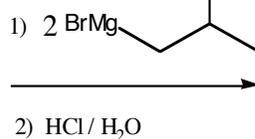
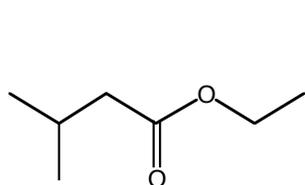
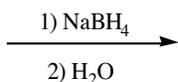
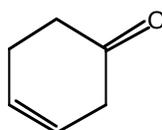
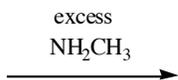
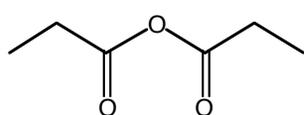
1)  $\text{LiAlH}_4$   
2)  $\text{H}_2\text{O}$



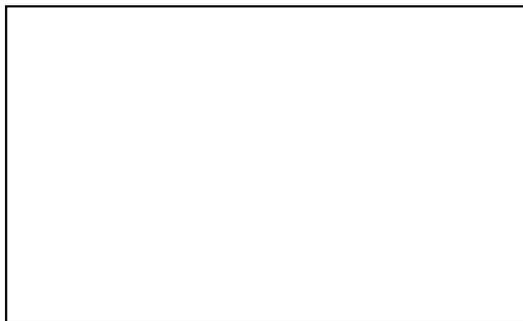
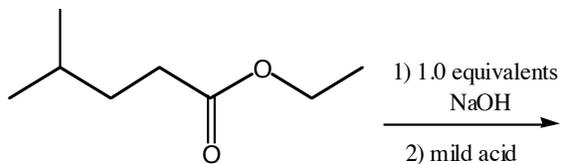
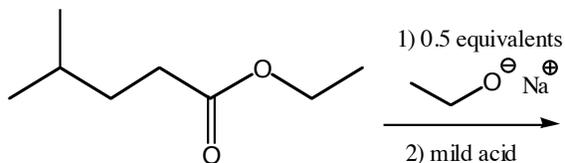
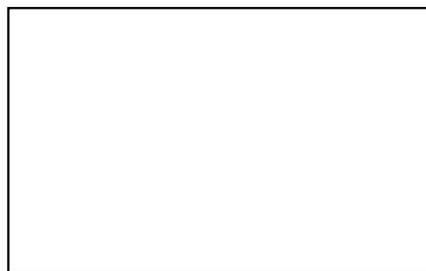
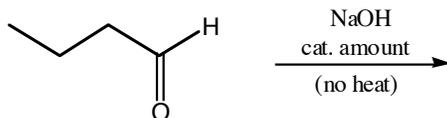
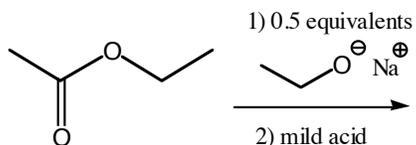
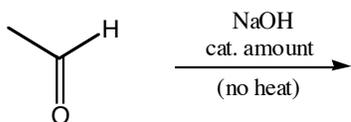
heat



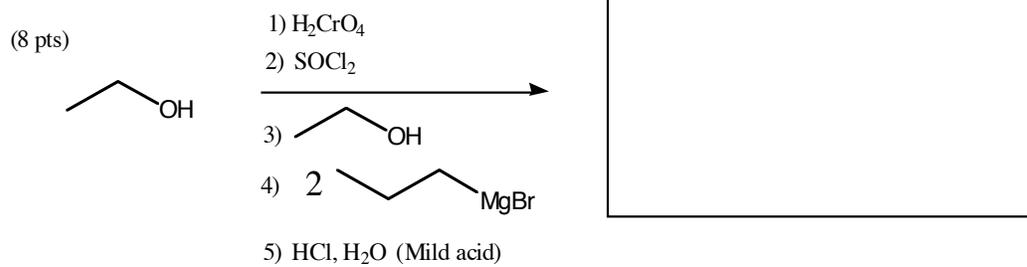
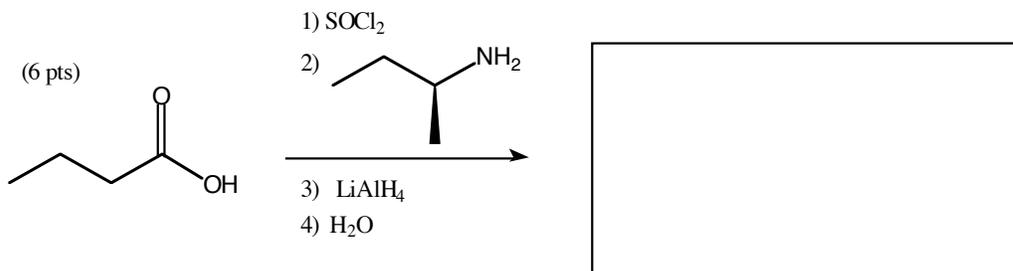
18. (17 points) Complete the following reactions. Draw the predominant carbon-containing organic product or products that will be formed. If a new chiral center is created in the reaction that produces a racemic mixture, label the chiral center with an asterisk (\*) and write "*racemic*" underneath. You do not have to draw both enantiomers.



19. (21 points) Complete the following reactions. Draw the predominant carbon containing organic product or products that will be formed. If a new chiral center is created in the reaction that produces a racemic mixture, label the chiral center with an asterisk (\*) and write "*racemic*" underneath. You do not have to draw all of the enantiomers. For aldol reactions, **DO NOT DEHYDRATE**. For aldol reactions, **DO NOT DEHYDRATE (it was worth repeating)**.



20. (14 points) For the following sequences of reactions, draw the predominant organic product or products after ALL the steps. You do not need to draw the intermediates formed along the way. If a new chiral center is created in the reaction that produces a racemic mixture, label the chiral center with an asterisk (\*) and write "*racemic*" underneath. You do not have to draw all of the enantiomers.

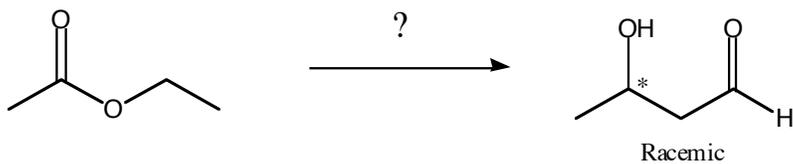


Signature \_\_\_\_\_

Pg 12 \_\_\_\_\_ (7)

21. For the following synthesis questions, show how the starting material can be converted into the product. Show ALL intermediate molecules synthesized along the way, and show the reagents needed for each step. To get full credit, you must use the predominant product expected for each step. All of the carbon atoms of the product must come from the starting material(s).

(7 pts)

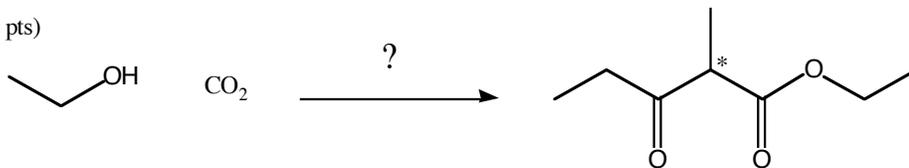


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Pg 13 \_\_\_\_\_ (16

21. For the following synthesis questions, show how the starting material can be converted into the product. Show ALL intermediate molecules synthesized along the way, and show the reagents needed for each step. To get full credit, you must use the predominant product expected for each step. All of the carbon atoms of the product must come from the starting material(s).

(16 pts)



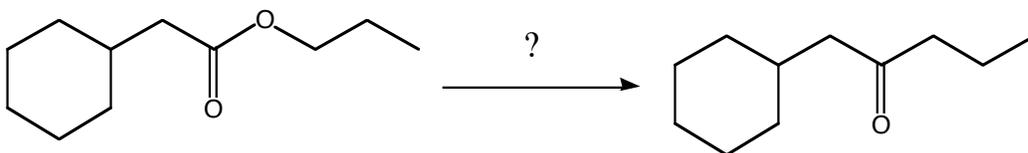
Racemic

Signature \_\_\_\_\_

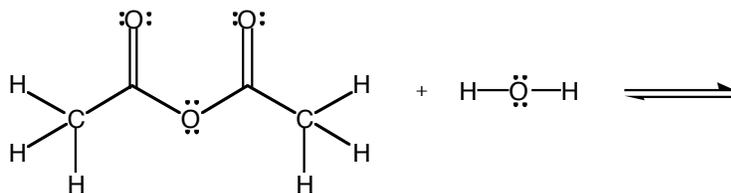
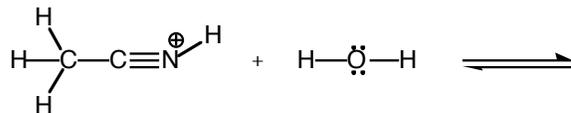
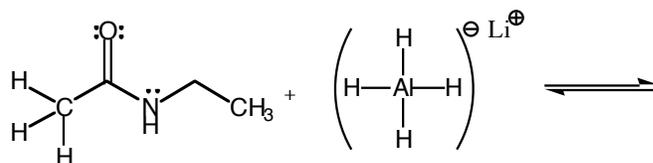
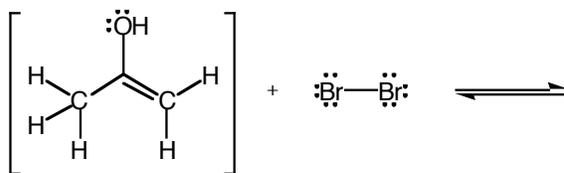
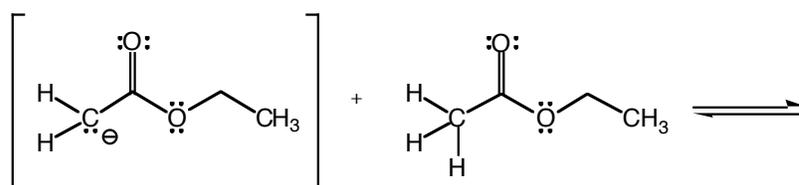
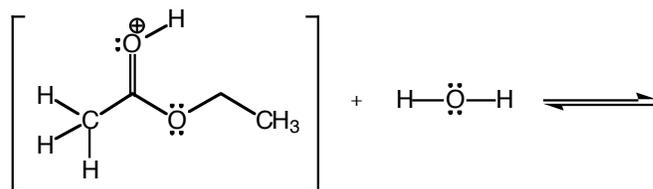
Pg 14 \_\_\_\_\_(16

21. For the following synthesis questions, show how the starting material can be converted into the product. Show ALL intermediate molecules synthesized along the way, and show the reagents needed for each step. To get full credit, you must use the predominant product expected for each step. All of the carbon atoms of the product must come from the starting material(s).

(16 pts)



22. (3 pts each) The mechanisms we have been studying largely involve nucleophiles of various types attacking electrophiles of various types, with protons being transferred quite often as well. The following reagents represent individual steps from some of these mechanisms. **For each pair of molecules, draw a circle around the nucleophile.** DO NOT DRAW THE PRODUCTS OF THESE STEPS. Do not make this hard. We are just checking that you are understanding these mechanisms, not just memorizing them.



Signature \_\_\_\_\_

Pg 16 \_\_\_\_\_ (6)

23. (6 pts) One of the fundamental paradigms of organic chemistry is that a functional group reacts the same in a complex molecule as it does in a simple molecule. The following step was used in the synthesis of atorvastatin (Lipitor). Write the predominant product of the following transformation, including the correct stereochemistry. This will take you a while to draw and it is not worth that many points, so definitely leave it until the end.

