CHEM 108B Organic Chemistry II
EXAM 2, Version A (300 points)

In each of the following problems, use your knowledge of organic chemistry conventions to answer the questions in the proper manner. **Be sure to read each question carefully.** You will have the entire class period to complete this exam (approximately 2 hours), but hopefully you won’t need it! You are welcome to use pre-built models.

Keep your eyes on your own paper. Electronic devices of any kind are not allowed, including cell phones and calculators. Any student found using any of said devices, or found examining another student's exam, will be promptly removed from the exam room and at minimum will receive a zero on this exam. Such an incident may also be considered a form of academic dishonesty and reported to the UCSC Judiciary Affairs Committee.

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<table>
<thead>
<tr>
<th>Functional Group</th>
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<tbody>
<tr>
<td>Acid chloride</td>
<td>-oyl chloride</td>
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<tr>
<td>Acid Anhydride</td>
<td>-oic anhyride</td>
</tr>
<tr>
<td>Carboxylic Acid</td>
<td>-oic acid</td>
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<tr>
<td>Esters</td>
<td>-oate</td>
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<tr>
<td>Amides</td>
<td>-amide</td>
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1. **Nomenclature** – suffixes for acyl derivatives on the cover page

(a) (20 points) Provide IUPAC names for **any three** of the following compounds. “X” out the ones to skip.

![Chemical structure 1](image1.png)

![Chemical structure 2](image2.png)

![Chemical structure 3](image3.png)

![Chemical structure 4](image4.png)

![Chemical structure 5](image5.png)

(b) (20 points) Draw structures corresponding to the following names.

- Diisopropylamine
- N-Methylaniline
- Pyridine
- N-Methyl-N-Propylcyclohexylamine

(c) (10 points) Name the following compound.

![Chemical structure 6](image6.png)
2. Carbohydrates Nomenclature

(a) (9 points) Draw one example of each type of carbohydrate using Fischer projections.

(i) D-Ketotetrose
(ii) L-Aldopentose
(iii) D-Ketohexose

(b) (16 points) Draw the structure of D-Glucose as a Fischer projection and of α-D-Glucopyranose in a Haworth projection as well as a chair conformation. Stereochemistry is important!!

α-D-Glucose:

FISCHER          HAWORTH            CHAIR

(c) (15 points) Consider the Fischer projection of β-D-Gulose below.

(i) Indicate the R/S configuration on C2-C5 in the boxes provided.

(ii) Draw the Haworth and chair forms of β-D-Gulopyranose (redraw templates from above).
3. Acid-Base Chemistry

(a) (9 points) The following compounds are arranged from most (left) to least (right) acidic. Fill in the $pK_a$ values of each in the boxes provided.

\[
\begin{array}{cccccccccc}
\text{HCl} & \text{H}_3\text{O}^+ & \text{H}_2\text{O} & \text{NH}_4^+ & \text{H}_2\text{O} & \text{NH}_3 & \text{CH}_4 \\
\end{array}
\]

(b) (20 points) Rank the following sets of compounds in terms of acidity where 1 is the most acidic.

Set 1

\[
\begin{array}{ccccccc}
\text{EtO} & \text{Cl} & \text{OCH}_3 & \text{CH}_2 & \text{CH}_2 \\
\end{array}
\]

Set 2

\[
\begin{array}{ccccccc}
\text{NH}_2 & \text{NH}_2 & \text{NEt}_3 & \text{NH}_2 \\
\end{array}
\]

(c) (11 points) Draw the products of the reaction between the most acidic compound in Set 1 and the most basic compound in Set 2. Draw one additional non-equivalent resonance structure of the conjugate base. Include arrow-pushing for each step.
4. (45 points) Single Step Reactions - Skip any one reaction ("X" it out). Fill in the box with the missing reactant, reagent(s), or product.

(a) 

(b) 

(c) 

(d) 

(e) 

(f) 


5. Reaction Puzzles

(a) (17 points) Fill in the box with missing reagents. More than one set of reagents may be required in each box.

(b) (23 points) Fill in the boxes with missing reagents or product. More than one set of reagents may be required in each box.
6. Mechanisms – Choose either page 6 or 7. “X” out the page to skip or page 6 will be graded.

(a) (25 points) Do you remember the episodes of Breaking Bad that referred to the “P2P cook”? That was in reference to a reductive amination reaction between phenylacetone (phenyl-2-propanone, P2P) and methylamine, which literally puts the “meth” in “methamphetamine.”

Show the arrow-pushing mechanism for the reaction of phenylacetone with methylamine. Be sure to draw the imine intermediate in the brackets provided. This time only you may choose to leave out the arrows for acid-base reactions and write “PT” for proton transfer on top of the arrow.

(b) (20 points) Show the arrow-pushing mechanism for the nucleophilic acyl substitution reaction between acetyl chloride and sodium ethoxide in ethanol. Be sure to draw the product in the box provided.
7. **Mechanisms** - Choose either page 6 or 7. “X” out the one to skip or page 6 will be graded.

(a) (20 points) Draw the arrow-pushing mechanism for the **intramolecular aldol reaction** of 1,6-hexanediol. *Hint: The product has six carbons.*

(b) (25 points) The Citric Acid Cycle is a metabolic process responsible for breaking down sugars into multiple CO₂ molecules via decarboxylation reactions. Show the **arrow-pushing mechanism** for the **decarboxylation** of Oxalosuccinate into α-Ketoglutarate under acidic conditions. *Hint: the first step is an acid-base reaction.*

Oxalosuccinate

α-Ketoglutarate
8. (40 points) Multi-Step Synthesis – Choose any two

Carry out the syntheses of the indicated target molecules using the starting material provided and any other reagents or carbon sources needed. Draw the product after each synthetic step. No mechanisms.