CHEM 241-Davis, Examination 1

YOUR NAME ____________________________
(Last, First)

University Honor Code Acknowledgment
I have neither given nor received assistance in taking this examination.

__________________________________
Signature

Notes
• This exam is worth 100 points
• There are 7 Problems on pages 3-9. Make sure your exam has all the pages.
• Nothing written on page 10 will be graded-this is for scratch work
• The exam period is for 75 minutes.

Points

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Total _____ (100)

EXAM BEGINS ON NEXT PAGE 3
Question 1 (10 pt). After acetone is dissolved in “heavy” water (water that contains the $^{18}$O isotope) a reaction occurs wherein the oxygen atom in acetone is replaced with an $^{18}$O label.

$$\text{H}_3\text{C}\text{O}\text{C}\text{H}_3 + \text{excess H}_2^{18}\text{O} \rightleftharpoons \text{H}_3\text{C}\text{O}\text{C}\text{H}_3 + \text{H}_2\text{O}$$

$\text{C}_3\text{H}_6\text{O} \text{ mw}=58$  
$\text{C}_3\text{H}_6\text{O} \text{ mw}=60$

In the mechanism of this exchange reaction there is an intermediate that occurs during the reaction that is neutral, has the formula $\text{C}_3\text{H}_8\text{O}_2$ and has a molecular weight of 78 g/mol. Draw the structure of this intermediate in the box below and be careful to distinguish any $^{16}$O and $^{18}$O isotopes that might exist in the intermediate:

$\text{C}_3\text{H}_8\text{O}_2 \text{ mw}=78$
Question 2 (10 pts). We learned that thionyl chloride, \( \text{SOCl}_2 \), reacts with carboxylic acids to give formation of acid chlorides:

\[
\begin{align*}
\text{H}_3\text{C}\text{O} & \quad + \quad \text{SOCl}_2 \quad \xrightarrow{\text{\textbullet}} \quad \text{H}_3\text{C}\text{OCl} \\
\text{O} & \quad + \quad \text{SO}_2 \quad + \quad \text{HCl}
\end{align*}
\]

In the reaction of thionyl chloride with a carboxylic acid the intermediate A is formed.

Provide a stepwise mechanism for the formation of an acid chloride and sulfur dioxide from reaction of intermediate A with chloride anion. **Show all intermediates, including electron pairs, formal charges and curved arrows in your mechanism.**

\[
\begin{align*}
\text{H}_3\text{C}\text{O} & \quad + \quad \text{Cl}^- \quad \xrightarrow{\text{\textbullet}} \quad \text{H}_3\text{C}\text{OCl} \\
\text{O} & \quad + \quad \text{SO}_2 \quad + \quad \text{Cl}^-
\end{align*}
\]

**Intermediate A**
Question 3. (20 pts) Provide the structures of the major reaction product that would occur for the following reactions. Indicate NR if no reaction is expected.

\[ \text{H}_3\text{CO} \quad \text{OCH}_3 \quad \text{H}_3\text{O}^+ \quad \text{H}_2\text{O} \]

(a) \[ \quad \rightarrow \quad \]

\[ \quad \]

\[ \quad \text{H}_3\text{O}^+ \quad \text{H}_2\text{O} \]

(b) \[ \quad \rightarrow \quad \]

\[ \quad \]

\[ \quad \text{CH}_3\text{MgBr} \quad \text{Et}_2\text{O} \]

(c) \[ \quad \rightarrow \quad \]

\[ \quad \]

\[ \quad \text{NH}(\text{CH}_3)_2 \]

(d) \[ \quad \rightarrow \quad \]

\[ \quad \text{C}_7\text{H}_{13}\text{N} \]

(e) \[ \quad \rightarrow \quad \]

\[ \quad \text{NH}_2(\text{CH}_3) \]

\[ \quad \text{C}_7\text{H}_{13}\text{N} \]
Question 4 (15 pts). Diazomethane reacts with carboxylic acids to give methyl esters and nitrogen gas.

\[
\text{RCOOH} + \text{CH}_2\text{N}_2 \rightarrow \text{RCOCH}_3 + \text{N}_2
\]

a) Draw Lewis structures for two resonance forms of diazomethane. To receive full credit you must show 2 valid resonance forms for diazomethane, both should include lone pairs of electrons and any formal charge (5 pts).

b) (10 pts). Draw a stepwise mechanism that illustrates how a methyl ester and N\(_2\) are formed from reaction of a carboxylic acid and diazomethane.
Question 5. (15 pts)

a) Briefly explain, using structures and just a few words, the chemistry that occurred in the following transformation: (5 pts)

\[
\text{H}_3\text{O}^+, \text{H}_2\text{O} \quad 1) \text{Mg, Et}_2\text{O}
\]

b) Propose a synthesis of compound 2 from 1. You can use any carbon source, in addition to compound 1, to make 2. Show all reagents and intermediates on the way to 2. (10 pts)
Question 6. (10 pts) Reaction of aldehyde 1 with Wittig reagent 2 gives a mixture of two isomers, 3 and 4. Hydrogenation of either compounds 3 and 4 give the same ester 5.

Draw the structures of 3 and 4 in the empty boxes below.
6. Circle the best answer (20 pts).

a) Circle the most nucleophilic species

b) Circle the most electrophilic species

c) Circle the strongest acid

d) Circle the best solvent for preparation of a Grignard reagent

e) Circle the most stable intermediate
BLANK PAGE FOR SCRATCH WORK-NOTHING WILL BE GRADED ON THIS PAGE