The exam consists of 7 questions worth 101 pts and will be graded out of 100 pts.

1. _____/15
2. _____/15
3. _____/20
4. _____/15
5. _____/8
6. _____/12
7. _____/16

Regrading: All requests for regrades must be submitted in writing within 48 hours of the return of the exam. You must explicitly state what has been misgraded and why it is an error. The entire exam will be regraded, which could result in points being added or deducted overall.
1. Consider the following $S_N2$ reaction:

\[
\begin{array}{c}
\text{Br} \\
\text{DMF}
\end{array}
\rightarrow
\begin{array}{c}
\text{CN} \\
\text{CN}
\end{array}
\]

A. (4 pts) Draw a mechanism for the reaction using curved arrows.

B. (5 pts) Draw an energy diagram. Label the axes, the reactants, the products, intermediates, $E_a$, and $\Delta H^0$ as appropriate.

C. (3 pts) Draw the structure of the transition state.

D. (3 pts) Does the rate of reaction go up, down, or stay the same in each of these cases:
   a. The solvent is changed from DMF to CH$_3$CH$_2$OH.

   b. The concentration of $\text{CN}$ is increased.

   c. The concentration of 1-bromopentane is increased.
2. Consider the following SN1 reaction:

\[
\begin{align*}
\text{I} & \quad \text{H}_2\text{O} \\
& \quad \text{OH}_2
\end{align*}
\]

A. (4 pts) Draw a mechanism for the reaction using curved arrows.

B. (5 pts) Draw an energy diagram. Label the axes, the reactants, the products, intermediates, \( E_a \), and \( \Delta H^0 \) as appropriate.

C. (3 pts) Draw the structure of the rate determining transition state.

D. (3 pts) Does the rate of reaction go up, down, or stay the same in each of these cases:
   a. The substrate is changed to 2-iodo-3-methylbutane.
   b. The concentration of water is increased.
   c. The concentration of 2-iodo-2-methylbutane is increased.
3. (20 pts) Fill in the missing reagents or major product(s). Include stereochemistry where needed. Choose 5 out of the following six problems. Clearly mark the one you do not want graded. If there is no mark, the first five will be graded. The mechanism is given next to the problem.

A. (SN2)

\[
\text{Br} \quad \text{CH}_3\text{O} \quad \text{CO} \\
\begin{array}{c}
\text{CH}_3 \\
\text{CH}_3 \quad \text{Br}
\end{array}
\]

B. (SN1)

\[
\begin{array}{c}
\text{Cl} \\
\text{CH}_3 \quad \text{OH}
\end{array}
\]

C. (E1)

\[
\begin{array}{c}
\text{Br} \\
\text{CH}_3 \quad \text{OH}
\end{array}
\]

D. (E2)

\[
\begin{array}{c}
\text{Cl} \\
\text{Ph}
\end{array}
\]

E. (SN2)

\[
\begin{array}{c}
\text{Cl} \\
\text{Ph} \quad \text{HS}^-
\end{array}
\]

F. (E2)

\[
\begin{array}{c}
\text{HO}^-
\end{array}
\]

\[
\text{CH}_3 \\
\text{CH} \\
\text{CH} \\
\text{CH} \\
\text{CH}
\]

\[
\text{CH}_3 \\
\text{CH} = \text{CH}
\]

\[
\text{CH}_3 \\
\text{CH} = \text{CH}
\]

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\text{CH}_3 \\
\text{CH} = \text{CH}
\]

\[
\text{CH}_3 \\
\text{CH} = \text{CH}
\]

\[
\text{CH}_3 \\
\text{CH} = \text{CH}
\]
A student performed an elimination reaction with *trans*-1-chloro-2-methylcyclohexane and expected to get product A, but product B was the only product formed.

A. (3pts) Why is it reasonable to think that product A would be the major product in most E2 reactions?

B. (12pts) Explain the observed results by drawing appropriate structures and explaining the mechanism of formation of product B.
5. (8 pts) Consider the reaction below:

A. Is the starting material optically active or optically inactive?

B. Predict the product(s) of the reaction.

C. Explain why the product sample is optically inactive.

6. Explain why these reactions don’t work to give the indicated product. (4 pts each)
A.

B.

C.
7. Determine whether the reaction will go through primarily SN1, SN2, E1, E2, or more than one of these mechanisms equally well. Give only mechanisms that you expect to lead to a significant amount of product. Justify your answer. (4pts each)

A. \( \text{Br} \rightarrow \text{'OC(CH}_3)_3 \)

mechanism(s):

justification:

B. \( \text{Cl} \rightarrow \text{'OCCH}_3 \)

mechanism(s):

justification:

C. \( \text{Cl} \rightarrow \text{CH}_3\text{OH} \)

mechanism(s):

justification:

D. \( \text{I} \rightarrow \text{CH}_3\text{OH} \)

mechanism(s):

justification: