YOUR NAME
(Last, First)

Initial of Last Name

Instructions

• Fill in your name in the space above and on the next page

• Put your discussion section number in the space provided.

• Print the initial of your last name in the box above

• Please sign the Honor Code acknowledgment on the following page

• DO NOT OPEN THIS EXAM UNTIL INSTRUCTED TO DO SO

• Provide your answers in blue or black pen. Cross mistakes out completely

• Answer questions in the spaces provided
CHEM 237-Davis, Examination 2

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 125 points
• There are 5 Problems on pages 3-7. Make sure your exam has all the pages.
• Nothing written on page 8 will be graded-this is for scratch work

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Total _____ (125)

EXAM BEGINS ON NEXT PAGE 3
Problem #1-Multiple Choice (each Correct Answer is worth 5 points)

1. Circle the compound with the lowest energy chair conformation.

2. Circle any true statement.
   - Transition states are intermediates
   - **Carbocations are intermediates**
   - Carbocations are transition states

3. Circle the most stable carbocation

4. Circle the carbocation that can not rearrange to a more stable carbocation.

5. Circle the best value for the strength of a covalent C-C single bond
   - 0.1-1
   - 5-10
   - **80-100**
   - 1000-1200 (kcal/mol)

6. Circle the best value for the strength of a C-C Pi bond
   - 0.1-1
   - 5-10
   - **60-70**
   - 160-200
   - 1000-1200 (kcal/mol)
7. Circle the major product of this reaction.

8. Circle the compound with the most polar bond.

9. Circle the most stable free radical

10. Circle the highest energy conformation

11. According to Zaitsev’s rule, circle the most stable alkene
2. (10 points) Cyanic Acid, HOCN, and isocyanic acid HNCO have the same pKa value (pKa=3.5). Explain, with structures, why these two structurally different acids have the acidity value. Use carefully drawn structures to support your answer. Include all lone pairs and formal charges where necessary.

\[ \text{HOCN} \quad \text{HNCO} \]

Cyanic Acid       Isocyanic Acid

3. (15 points) The benzylic cation shown below is actually more stable than a tertiary carbocation even though it is formally a primary carbocation. Briefly explain why this might be the case, and provide structures to bolster your reasoning.

\[ \text{CH}_2\text{C}=\text{C}=\text{O} \]

Benzylic Cation
4. Mechanism (20 pts) a) Draw a step-wise mechanism for the following reaction. Show all lone pairs, curved arrows and formal charges for full credit.

\[
\text{OH} \quad \text{H}_2\text{SO}_4 \quad \text{Heat} \quad \rightarrow \\
\begin{array}{c}
\text{HO} \\
\text{H}
\end{array} \quad \rightarrow \\
\begin{array}{c}
\text{H} \\
\text{H}
\end{array}
\]

b) Draw a step-wise mechanism. Show all lone pairs, curved arrows and any formal charges.

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{H}
\end{array} + \text{Br}_2 \quad \text{light} \quad \rightarrow \\
\begin{array}{c}
\text{H}_3\text{C} \\
\text{Br}
\end{array} + \text{HBr}
\]

\[
\text{Br} \quad \text{Br} \quad \rightarrow \quad 2 \text{Br}.
\]

\[
\begin{array}{c}
\text{H}_3\text{C} \\
\text{H}
\end{array} \quad \text{Br} \quad \rightarrow \quad \text{H-Br} + \\
\begin{array}{c}
\text{CH}_3 \\
\cdot
\end{array}
\]

\[
\begin{array}{c}
\text{CH}_3 \\
\cdot
\end{array} + \text{Br-Br} \quad \rightarrow \quad \begin{array}{c}
\text{H}_3\text{C} \\
\text{Br}
\end{array} + \cdot \text{Br}
\]
5. (25 pts) Consider the following diagram that outlines the reaction progress for a hypothetical reaction:

A \rightarrow B \rightarrow C \rightarrow D

where A is the reactant, B and C are intermediates along the reaction pathway and D is the product.

A. Carefully label the positions of A thru D on the diagram
B. Carefully label the position of each transition state with an arrow and the label “TS”
C. Carefully indicate the Gibbs free energy ($\Delta G^\circ$) for the reaction
D. Is the reaction of A to D a favorable process? Yes or No? **Yes**
E. What is the rate-determining step for this reaction? **B to C**
F. Indicate the activation energy barrier of $\Delta G^{\dagger\dagger}$ for the rate-determining step.
Blank page for scratch work