General Instructions:
Use scratch paper at the back of the exam to work out answers. Final answers must be recorded at the proper place on the exam itself for credit.
Print your name and ID # on each page.
Please keep your paper covered and your eyes on your own work.
Academic misconduct will lead to failure in the course.

1. (10 pts.)
   (a) Draw the two best resonance structures of nitric acid, HNO₃.

   (b) Draw two more resonance structures of the cation. Show electron-pushing arrows.

2. (8 pts.)
   (a) Draw (E,Z)-2,5-heptadiene

   (b) Name by IUPAC Rules
3. (9 pts.) One mole of each of the following is dissolved in a liter of water. Identify the species, other than water, which are present in greatest concentration in each solution.

(a) CH₃⁻N⁻CH₃

(b) ""

(c) NaNHCH₃

4. (15 pts.) Give an intermediate for each of the following reactions, not the product.

Intermediate

(a) \[ \text{O}_3 \] \[ \text{HBr} \] \[ \text{peroxides} \]

(b) \[ \text{HBr} \]

(c) \[ \text{HBr} \]

(d) \[ \text{Br}_2 \] \[ \text{H}_2\text{O} \]

(e) \[ \text{H}_3\text{PO}_4 \]
6. (6 pts.) **Circle** the strongest base of each pair.

   a) \( \text{HC}=\text{C}^- \) or \( \text{C}≡\text{N} \)

   b) \( \text{NH}_2 \) or \( \text{C} \)

   c) \( \text{I}^- \) or \( \text{F}^- \)

7. (12 pts.) Consider the following Energy Diagram.

   (a) **Circle** the rate-determining transition state for the conversion of \( \text{A} \) to \( \text{D} \).

   (b) **Circle** the largest rate constant and put a **box** around the smallest rate constant.

   (c) Is this overall reaction exothermic or endothermic?

   (d) What is \( K_{eq} \) for the conversion \( \text{B} \) to \( \text{C} \)?
8. (6 pts.) When an alkane is treated with chlorine in the presence of light, a hydrogen is replaced (substituted) by a chlorine atom in a free radical chain reaction. For the alkane shown below, draw all the monochlorinated isomers that can be formed.

\[ \text{Cl}_2, \text{light} \]

9. (4 pts.) Draw the most stable conformation of 3-methyhexane in Newman projection sighting down the 3,4 bond.
9. (20 pts.) Draw the major product(s) of the following reactions.

(a) \[\text{CH}_3\text{CH}_2\text{OH} + \text{H}_2 + \text{Pd} \rightarrow \text{H}_2\text{SO}_4\]

(b) \[\text{CH}_3\text{CH}_2\text{OH} + \text{H}_2\text{SO}_4 \rightarrow \text{Br}_2\]

(c) \[\text{Br}_2 + \text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{Br}_2\]

(d) \[\text{BH}_3, \text{THF} + \text{H}_2\text{O}_2, \text{NaOH} \rightarrow \text{H}_2\text{SO}_4\]
10. (10 pts.) Write the mechanism for the following reaction showing all intermediates and electron-pushing arrows.

6 pts. (a) \[
\text{\begin{align*}
\text{Hg(OAc)}_2, \text{CH}_3\text{CH}_2\text{OH} \\
\text{THF}
\end{align*}}\]

Write the reagent(s) over the arrow and the final product of this demercuration reaction.

4 pts. (b) \[
\text{\begin{align*}
\text{HgOAc}
\end{align*}}\]

Write the reagent(s) over the arrow and the final product of this demercuration reaction.