1. (6 points, 3 each) Provide IUPAC accepted names for the following compounds.

\[
\begin{align*}
\text{2-methyl-1,3-pentadiene} & \quad \text{4-bromo-1-heptyne} \\
\text{[Image of structures]} & \\
\end{align*}
\]

2. (2 points) HOMO stands for \underline{highest occupied molecular orbital}.

3. (8 points) What starting materials would be required to form the following product from a Diels-Alder reaction?

\[
\begin{align*}
\text{[Image of structures]} & \\
\text{[Image of structure]} & \quad \text{(must be cis)} \\
\end{align*}
\]

4. (4 points) 1-Hexene has a heat of hydrogenation of -125 kJ/mole (or -29.9 kcal/mole). 1,3,5-Hexatriene has a heat of hydrogenation of -335 kJ/mole (or -80.1 kcal/mole). Does the triene display resonance stabilization? If so, how much?

\[
\begin{align*}
3(-125) &= -375 \quad \text{vs.} \quad -335 \\
\text{Yes. The triene has a resonance energy of 40 kJ/mole.} \\
\end{align*}
\]

5. (10 points) Draw all the isomers of \( \text{C}_4\text{H}_9\text{Br} \) and arrange them in order of decreasing reactivity in the \( \text{S}_\text{N}2 \) reaction. Be careful not to duplicate structures.

\[
\begin{align*}
\text{See recommended hw problem 11.33?} \\
\text{[Images of structures]} & \\
\text{Most reactive} & \quad \text{Least reactive} \\
\end{align*}
\]

\[
\begin{align*}
\text{1st} & \quad \text{1° with a little more steric hindrance} \\
\text{2nd} & \quad \text{2°} \\
\text{3rd} & \quad \text{3°} \\
\end{align*}
\]
6. (10 points, 2 each) Circle the reaction in each pair that would proceed faster.

- **$\text{Br} + \text{CH}_3\text{ONa} \xrightarrow{25^\circ \text{C}} \text{CH}_3\text{OH} \quad \text{SN}_2$$**

- **$\text{Br} + \text{NaSHCH}_3\text{CH}_3 \xrightarrow{25^\circ \text{C}} \text{ethanol} \quad \text{SN}_2$$**

- **$\text{Br} + \text{NaSCH}_2\text{CH}_3 \xrightarrow{25^\circ \text{C}} \text{DMSO} \quad \text{SN}_2$$**

- **$\text{Cl} + \text{COONa} \xrightarrow{40^\circ \text{C}} \text{DMSO} \quad \text{SN}_2$$**

- **$\text{OTs} + \text{COONa} \xrightarrow{40^\circ \text{C}} \text{DMSO} \quad \text{SN}_2$$**

- **$\text{sp}^2\text{C-I} \text{ won't do SN}_2$$**

- **$\text{sp}^2\text{C-I} \text{ won't do SN}_2$$**

- **$\text{OTs} \xrightarrow{\text{CH}_3\text{OH}} \text{OTs} \quad \text{SN}_1$$**

- **$\text{OTs} \xrightarrow{\text{CH}_3\text{OH}} \text{OTs} \quad \text{SN}_1$$**
7. (30 points, 3 each) Provide structures for the major organic products of each of the following reactions. If more than one compound is expected, indicate which will be formed in greatest yield. Be careful to indicate product stereochemistry when necessary.

\[
\begin{align*}
\text{Reagent A} + \text{HCl} & \xrightarrow{25°C, S_N 1} \text{Product 1} \quad (+ \text{H}_2\text{O}) \\
\text{Reagent B} & \xrightarrow{\text{Li, NH}_3, -33°C} \text{Product 2} \\
\text{Reagent C} & \xrightarrow{25°C, \text{CH}_3\text{OH}, S_N 1} \text{Product 3} \\
\text{Reagent D} + \text{CH}_3\text{ONa} & \xrightarrow{25°C, \text{CH}_3\text{OH}, E_2} \text{Product 4} \\
\text{Reagent E} + \text{NBS} & \xrightarrow{h_0, \text{CCl}_4} \text{Product 5} \\
\text{Reagent F} + \text{KCN} & \xrightarrow{25°C, \text{DMSO}, S_N 2} \text{Product 6} \\
\text{Reagent G} + \text{PBr}_3 & \rightarrow \text{Product 7} \quad (+ \text{H}_3\text{PO}_3) \\
\text{Reagent H} + \text{CN} & \rightarrow \text{Product 8} \quad \text{Diels-Alder}
\end{align*}
\]
8. Two organic products are formed in the following electrophilic addition reaction.
   a) (3 points) Draw the products.
   b) (1 point) Identify the kinetic product.
   c) (1 point) Identify the thermodynamic product.
   d) (5 points) Draw the reaction energy profiles for the formation of both products on the
      same energy diagram. Clearly label transition states and intermediates. Show the
      structure of any starting material, intermediate, or product on the diagram. You do not
      need to show transition state structures.
9. (10 points) Provide a complete electron-pushing mechanism for one of the following reactions. Include by-products as they are formed. Clearly indicate which one you are omitting.

A

\[
\text{Cyclohexanol} + H_2C\text{-SO}_3\text{Cl} \xrightarrow{\text{pyridine}} \text{Cyclohexyl sulfoxide} + \text{Pyridinium chloride}
\]

OR

B

\[
\text{Cyclohexane} \xrightarrow{H_2SO_4 \text{ catalyst}} \text{Cyclohexanone}
\]
10. (10 points) Provide a synthesis for one of the following compounds. You may begin with any organic reagents containing four carbons or less and any inorganic reagents you need. Clearly indicate which one you are omitting.

A

OR

B

Synthesis:

\[
\text{HC} = \text{C} \xrightarrow{\text{Na, NH}_3, \text{N}_2} \text{HC} = \text{CNa} \xrightarrow{\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}} \text{HC} = \text{C} - \text{CH}_2\text{CH}_2\text{CH}_3
\]

1) \text{BH}_3

2) \text{H}_2\text{O}_2, \text{NaOH}

\text{H}_2\text{O}

\text{HC} \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3

Synthesis:

\[
\text{HC} = \text{C} \xrightarrow{\text{Na, NH}_3, \text{N}_2} \text{HC} = \text{CNa} \xrightarrow{\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}} \text{HC} = \text{C} - \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3
\]

\text{HBr (excess)}

\text{Br Br}

\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3