1. (10) (a) Accurately draw the less stable chair conformer of 
\textit{cis}-1,3-dimethylcyclohexane.

(b) Accurately draw the more stable chair conformer of 
\textit{trans}-1,4-dimethylcyclohexane.

2. (3) Concerning the answer for question 1a, which of the following statements 
best describes the destabilizing interactions present in 
\textit{cis}-1,3-dimethylcyclohexane:

A. two equatorial hydrogens have gauche-butane interactions with a 
   neighboring methyl group.
B. the equatorial methyl groups are sterically crowded.
C. each axial methyl group has two 1,3-diaxial interactions, one with a 
   hydrogen and the other with a methyl group.
D. all of the above.

3. (8) (a) What is the \((\pi + \sigma)\) value for a hydrocarbon with formula \(\text{C}_6\text{H}_8\)?
You must show your work.
(b) Using bond-line structures (a.k.a. skeletal structures), draw three structures each with the formula \( C_6H_8 \).

(c) Give an IUPAC systematic name for one of the structures you drew above.

4. (4) Give IUPAC systematic names for the following alkenes:

\[
\begin{align*}
\text{CH}_2\text{CH}_3 \\
\text{CH}_3\text{C}=\text{CHCH}_2\text{CH}_2\text{CH}_3
\end{align*}
\]

\[
\begin{align*}
\text{CH}_3\text{CHCHCH}_2\text{CH}=\text{CH}_2 \\
\text{Br} \quad \text{Cl}
\end{align*}
\]

5. (4) Draw any alkene that contains exactly two vinylic hydrogens and four allylic hydrogens.

6. (6) Classify each of the following alkenes as \( E \) or \( Z \). You must show your work.

\[
\begin{align*}
\text{Cl} & \quad \text{CH}_2\text{CH}_3 \\
\text{Br} & \quad \text{CH}=\text{CH}_2
\end{align*}
\]

\[
\begin{align*}
\text{F} & \quad \text{CH(CH}_3)_2 \\
\text{FCH}_2 & \quad \text{CH}_2\text{CH}_3
\end{align*}
\]
7. (6) Use curved arrows to show the movement of electrons in the following transformation:

\[
\begin{align*}
\text{H}_3\text{C} - &\text{C} - \text{Cl}^- : \quad \text{H}_3\text{C} - &\text{C} - \text{O}^\cdot \text{O}^- \text{CH}_3 + \text{Cl}^-
\end{align*}
\]

8. (4) Draw a reaction coordinate diagram for a two-step reaction in which the first step is exergonic, the second step is endergonic, and the overall reaction is exergonic. Label reactants (R), products (P), intermediates (I), and transitions states (TS).

9. (4) Give the main organic product for the following reactions.

\[
\begin{align*}
\text{CH}_3\text{CH} = &\text{CHCH}_3 + \text{HCl} & \text{CH}_3\text{CH} = &\text{CHCH}_3
\end{align*}
\]

\[
\begin{align*}
\text{pentane} + &\text{HBr} & \text{pentane} + &\text{HBr}
\end{align*}
\]