1. Name the following compounds

- cis-3-butyl-3-ethyl cyclohexane
- Cycloamyl - cyclopentane
- 1-sec-buty1-3-ethyl cyclohexane

2. Carry out a 180° rotation about the C₂-C₃ axis in 2,3-dibromobutane and show the various conformers in terms of Newman projections. For a start the sawhorse representation of the starting conformer is shown below.

- a. Which, if any, conformer does not have a dipole moment? D
- b. Which conformer is the most stable? D least stable? A

3. Given that the t-butyl prefers the equatorial position, write chair conformations for:

- trans-1-t-butyl-3-chlorocyclohexane
- cis-1-t-butyl-4-chlorocyclohexane
4. Write the most stable chair conformation of trans-1,4-dimethylcyclohexane. Then write the flipped conformation of the right of it.

![Most stable conformation](image1)

![Flipped conformation](image2)

a. Calculate the energy differences between these two conformations given that a 1,3-diaxial CH₂-H cost 0.9 kcal/mol.

\[4 \times 0.9 = 3.6 \text{ kcal/mol}\]

5. Write the chair structure of the most stable conformation of 1,2,3,4,5,6-hexachlorocyclohexane. Basic chair conformation is provided below.

![Chair conformation](image3)

Write the wedge-dash structure of the compound shown above.

![Wedge-dash structure](image4)
6. Consider the following free-radical reaction

\[ \text{Ph-CH}_2\text{-H} + \text{Br}_2 \xrightarrow{\text{light}} \text{PhCH}_2\text{Br} + \text{HBr} \]

Bond energies: Ph-CH\_2-H = 46 kcal/mol, Br-Br = 118 kcal/mol, PhCH\_2-Br = 58 kcal/mol, H-Br = 98 kcal/mol.

a. Calculate the delta H of the overall reaction and place answer in the box shown above.

b. Write the official mechanism of this reaction, including the initiation step, two propagation steps and the chain termination step which leads to PhCH\_2CH\_2Ph.

chain initiation step

\[ \text{Ph-CH}_2\text{-H} \xrightarrow{hv} 2 \text{Ph}^* \]

delta H

\[ 4 \text{ kcal/mol} \]

propagation steps

\[ \text{Ph-CH}_2\text{-H} + \text{Br}^* \rightarrow \text{PhCH}_2\text{-Br} + \text{H}^* \]

\[ -58 \text{ kcal/mol} \]

chain termination step

\[ 2 \text{PhCH}_2\text{-Br} \rightarrow \text{PhCH}_2\text{CH}_2\text{Ph} \]

\[ -12 \text{ kcal/mol} \]

c. Calculate the delta H of the chain initiation and two propagation steps in place answer in boxes provided above.

d. Circle the rate determining step.
7. Write structures for all possible mono-chlorinated products of 2-methylpentane. (there are five)

\[
\begin{align*}
\text{C-C-C-C-C} & \quad \xrightarrow{Cl_2} \quad \text{C-C-C-C-C} + \text{C-C-C-C-C} \\
\text{C-C-C-C-C} & \quad \xrightarrow{Cl_2} \quad \text{C-C-C-C-C} + \text{C-C-C-C-C}
\end{align*}
\]

8. Write the major mono-brominated product in the following bromination reaction.

\[
\begin{array}{c}
\text{a.} \\
\text{Br}_2 \quad \text{light} \\
\end{array}
\]

9. Calculate the relative reactivity of tertiary hydrogens and primary hydrogens from the following data. SHOW WORK

\[
\begin{align*}
\text{CH}_3 & \quad \text{Cl}_2/\text{light} \quad \text{CH}_3 \\
\text{H}_2\text{C}-\text{C}=\text{CH}_3 & \quad \text{H}_2\text{C}-\text{C} \quad \text{H}_2\text{C} \quad \text{H}_2\text{C}\text{Cl} \\
111^\circ & \quad 38\% \quad 62\% \\
1^\circ & \quad \frac{38\%}{1} = 38\% \quad \frac{62\%}{9} = 6.8\%
\end{align*}
\]
14. Consider the following plots of PE vs. reaction coordinate illustrating a) the fluorination of methane and b) the bromination of methane.

a. Which reaction is exothermic? ______ Which one is endothermic? ______

b. Which transition resembles the intermediate radical? ______

c. Which reaction is more selective? ______

d. Which reaction has less CH bond breaking in the transition state? ______

EXTRA CREDIT - The loss of HBr from an alkyl halide requires that the H and Br be on adjacent carbons and that the H and Br be anti-coplanar to each other. Given that which one of the cyclohexyl chlorides eliminates HBr the faster. Remember what position t-butyl groups occupy in cyclohexane rings.

cis 4-chloro-1-t-butylcyclohexane or trans 4-chloro-1-t-butylcyclohexane

1/ lone CL are anti-Coplanar