1. [15 pts] Give the IUPAC name of the following compounds.

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

2. (10 pts). How many stereoisomers are possible for 2,3-dibromobutane. Explain your answer.

3. [15 pts] Draw the structure of the following compounds.

a) cis-1,2-dimethylcyclopentane

b) trans-1,4-dimethylcyclohexane

(draw MOST STABLE chair form)

c) (Z)-3-bromo-3-heptene

4. (15 pts) Write an overall equation to demonstrate the free-radical chlorination of 2,3-dimethylbutane. Include conditions and the production of the major organic product.

b. How many products are possible? __________

5. (10 pts) Acid HA has a pKa = 20; acid HB has a pKa = 10. If NaA is added to HB, will the position of equilibrium lie to the right or left. Explain your answer.

6. [10 pts] Draw the following structures.
a) An acid and an ester, each having the molecular formula \( \text{C}_3\text{H}_6\text{O}_2 \).

7. (24 pts) Use the following diagram to answer the following: (Positions refer to I, II, III, IV, V)

![Diagram](image)

What does I represent in the diagram _________________________

What does II represent in the diagram? _________________________

Which position(s) in the diagram represent(s) (an) intermediate(s)? ______

Which position(s) in the diagram represent(s) (a) transition state(s)? ____________

Is the reaction endothermic or exothermic. ______________________

The difference in energy between which two points represents the energy of activation ?

____________

For the following reaction, what are the appropriate structures at III, and V?

\[
\text{[Compound]} + \text{HBr} \]

III  V

8. (10 POINTS) Draw a Newman projection representing the most stable conformation of 1-bromo-2-methylpropane (as viewed along \( \text{C}_1 \) to \( \text{C}_2 \))
9. [25 pts] Draw the major organic product in each of the following reactions (5 points each).

\[ \text{CH}_3 \quad \text{H}_3\text{C} = \text{C} = \text{CHCH}_3 \quad + \quad \text{H}_2\text{O/H}_2\text{SO}_4 \quad \rightarrow \]

\[ \text{CH}_3 \quad \text{CH}_2 = \text{C} = \text{CH}_2 \quad \text{BH}_3 \quad \xrightarrow{\text{H}_2\text{O}_2 / \text{NaOH}} \]

\[ \text{CH}_3\text{CH}_2\text{CH} = \text{CH}_2 \quad \xrightarrow{\text{Br}_2 / \text{CCl}_4} \quad \text{room temperature} \]

\[ \text{CH}_3\text{H}_2\text{CH} = \text{CH}_2 \quad \xrightarrow{\text{Br}_2} \quad \text{high temperature} \]

\[ \text{Cyclic structure} \quad \xrightarrow{\text{O}_3} \quad (\text{CH}_3)_2\text{S} \]

10. (15 pts) For the elimination reaction of 2-bromo-3-methylbutane with \( \text{CH}_3\text{CH}_2\text{O-K}^+ \) in \( \text{CH}_3\text{CH}_2\text{OH} \), write an equation showing this reaction. **Include all possible products.** Circle the major product.

11. (15 pts) Give the product(s) expected in the following reaction. Indicate if the mechanism is S\(_{N1}\) or S\(_{N2}\). **Indicate the stereochemistry for the product(s)**
12. (16 pts) Starting with **ethane**, show how you would produce an **alcohol**. You may use reagents, solvents, conditions, as necessary. You must write chemical equations showing valid reactions.