Introduction: Okay, the usual. Try to make this your own work.

1) The heats of combustion for 2-methylheptane, 2,2-dimethylhexane, and 2,2,3,3-tetramethylbutane are 1306.3, 1304.6, and 1303.0 kcal/mole respectively. Construct an energy diagram showing the relative stabilities of these molecules.

2) Look down the C(4)-C(3) bond (see figure below) and draw the Newman projection of the chair conformation of methylcyclohexane, where the methyl group is equatorial.

3) Draw the most stable chair conformation of the following:

4) At +25 °C (298 K) about 97% of the molecules of isopropylcyclohexane will have the isopropyl substituent equatorial. Calculate the energy difference between the equatorial and axial conformations of isopropylcyclohexane at this temperature. \( \Delta G = -RT \ln(K) \), \( R = 2.0 \text{ cal/K}\cdot\text{mol} \), \( T = \text{temperature in K} \)
5) Determine whether the following pair of compounds represents diastereomers, enantiomers, structural isomers, different conformations of the same molecule or whether they are identical.

\[
\text{and}
\]

6) Trans-1,2-dimethylcyclohexane and trans-1,4-dimethylcyclohexane are more stable than their cis analogs; however, cis-1,3-dimethylcyclohexane is more stable than trans-1,3-dimethylcyclohexane. Explain. Use a diagram if it helps make your explanation clearer.

7) Which of the following two structures is expected to be much more polar? Briefly explain your reasoning.

\[
\begin{align*}
\text{Cl} & & \text{Cl} \\
\text{Cl} & & \text{Cl}
\end{align*}
\]

8) Add a methyl group to the disubstituted cyclohexane shown below and draw the molecule in such a way that:

\[
\text{OH}
\]

a) the Me and OH groups are gauche
b) the Me and OH groups are anti
c) the Me group is anti to C(1)

9) Draw structures of the following compounds:
   a) bicyclo[2.2.2]oct-2-ene  b) 2-methylbicyclo[2.1.1]hexane

10) The analgesic drug Demerol (ethyl 1-methyl-4-phenyl-4-piperidinecarboxylate) is produced entirely by chemical synthesis and it acts by binding to the same receptor site as morphine in the central nervous system. In its biologically active form, the six-membered ring is in the chair conformation, with the phenyl and the $N$-methyl groups occupying equatorial positions. Use this information and provide a perspective drawing of the Demerol molecule.

\[ \text{Ph} = \text{phenyl} \]

11) Menthol is a fragrant constituent of peppermint oil.

\[ \text{Menthol} \]

   a) Assuming that the cyclohexane ring in menthol is in the chair conformation and that the ring flip did not occur, draw all possible stereoisomers of this molecule.