1. The following is an example of a Diels-Alder reaction which you will learn more about next semester. This reaction is believed to proceed through a single step. At room temperature, the reaction enthalpy is -9.1 kcales mol⁻¹ and the entropy of -0.027 kcales mol⁻¹. Calculate the equilibrium constant for the reaction. Show all your work. (You do not need to know anything about the Diels-Alder Reaction to answer the question.) (5 pts)

\[
\Delta G = \Delta H - T \Delta S
\]

\[
= (-9.1) - (298)(-0.027)
\]

\[
= -0.6 \text{ kcales/mol}
\]

\[
\Delta G = -RT \ln K_e
\]

\[
K_e = e^{-\frac{0.6}{0.027}} = 5.5
\]

2. a. Calculate the degrees of unsaturation of a compound with the formula C₁₁H₁₃Cl₂NO₃. (3 pts)

\[
\frac{10}{2} = 5 \text{ degrees of unsaturation}
\]

b. What does this mean? (2 pts)

There is some combination of rings and bonds that add up to 5

3. Designate the following alkenes as (E) or (Z). (4 pts)
4. Give the product for the electrophilic addition of HCl to 1-(1,1-dimethylethyl)-cyclohexene. Draw the most stable chair conformation of the product. (5 pts)

\[
\text{\chem{C_7H_{13}} + HCl} \rightarrow \text{\chem{C_7H_{14}Cl}}
\]

\[
\text{\chem{t-butyl group}} \quad \text{\chem{H_3C-Cl}} \quad \text{\chem{Cl}}
\]

5. Give the mechanism for the free radical chlorination of methane to chloromethane. (6 pts)

**Initiation**

\[
\text{Cl}_2 \rightarrow 2 \text{Cl}^.
\]

**Propagation**

\[
\text{Cl}^. + \text{H}_3\text{C}_2\text{H}_3 \rightarrow \text{H}_3\text{C}_2\cdot + \text{HCl}
\]

\[
\text{H}_3\text{C}_2\cdot + \text{Cl}_2 \rightarrow \text{H}_3\text{C}_2\text{Cl} + \text{Cl}^.
\]

**Termination**

\[
\text{Cl}^. + \text{Cl}^. \rightarrow \text{Cl}_2
\]

\[
\text{Cl}^. + \text{CH}_3 \rightarrow \text{Cl}^.-\text{CH}_3
\]

\[
\text{H}_3\text{C}_2\cdot + \text{CH}_3 \rightarrow \text{H}_3\text{C}_2\text{-CH}_3
\]