1. [4 pts] Provide a structural formula for \( p \)-toluenesulfonic acid.

2. [6] For each of the following, supply a structure for the major organic product(s); if no reaction occurs, write N.R. If an ortho-para mixture is expected, show both.

   (a) \[
   \begin{align*}
   \text{CF}_3 & \quad \text{HNO}_3 & \quad \text{H}_2\text{SO}_4 \\
   \end{align*}
   \]

   (b) \[
   \begin{align*}
   \text{CH}_3\text{CH}_2\text{C} & \quad \text{H}_2\text{NNH}_2 \quad \text{KOH} & \quad \text{(HOCH}_2\text{CH}_2)_2\text{O} \\
   \text{Cl} & \quad \text{heat} & \end{align*}
   \]

3. [10 pts] Concisely describe or sketch the \( ^1\text{H-nmr} \) spectrum of each of compounds given below. For each \( ^1\text{H-nmr} \) spectrum, give the number of protons and the multiplicity for each set of protons; you only need to give the order (for example, from most downfield to most upfield) of the approximate relative chemical shifts. Be sure to indicate clearly which peaks correspond to which protons.

   (a) \[
   \begin{align*}
   \text{H} & \quad \text{Cl} & \quad \text{CH}_3 \\
   \text{H} & \quad \text{H} & \end{align*}
   \]

   (b) \[
   \begin{align*}
   \text{Cl} & \quad \text{H} & \quad \text{CH}_3 \\
   \text{H} & \end{align*}
   \]