1. (25 points) In each case below, select the substrate that would be expected to react faster in a substitution reaction under the conditions shown and show its expected major substitution product. Indicate whether this is an $S_N1$ reaction or an $S_N2$ reaction. (Don’t worry about the possibility of elimination here.)

   a. \[
   \text{Cl} \quad \text{vs.} \quad \text{Cl} \quad \xrightarrow{\text{NaI}} \quad \text{acetone}
   \]

   b. \[
   \text{Br} \quad \text{vs.} \quad \text{Cl} \quad \xrightarrow{\text{NaOH}} \quad \text{H}_2\text{O}
   \]

   c. \[
   \text{F} \quad \text{vs.} \quad \text{Br} \quad \xrightarrow{\text{NaCN}} \quad \text{DMF}
   \]

   d. \[
   \text{Cl} \quad \text{vs.} \quad \text{I} \quad \xrightarrow{\text{H}_2\text{O}} \quad \text{heat} \quad \text{(careful!)}
   \]

   e. \[
   \text{Br} \quad \text{vs.} \quad \text{Br} \quad \xrightarrow{\text{NaSCH}_3} \quad \text{DMF} \quad \text{(make a model!)}
   \]

2. (20 points) Briefly discuss why each of the following statements might be true:

   a. Primary iodides react faster than secondary iodides in $S_N2$ reactions.
   b. Tertiary iodides do not react with the $S_N2$ mechanism.
   c. Primary iodides do not react with the $S_N1$ mechanism.
   d. Higher concentration of a good nucleophile favors $S_N2$ reaction over $S_N1$ reaction.
   e. Treatment of a secondary bromide with a strong hindered base results in elimination.
3. (25 points) The following conditions are available:

i. H$_2$O, heat  
ii. MeOH, heat  
iii. NaI, acetone  
iv. NaOH, H$_2$O  
v. KO-t-Bu, DMF  
vi. NaOH, DMF

From this list, pick the conditions that would best effect the desired transformation in each of the cases below, indicating S$_N$2, S$_N$1, E2, or E1. (Use each reagent no more than once; one is not used. Only one reagent in each case is the best for the indicated job.) In each case, explain your reasoning.