1. Please give the products for the following reactions:

   a) \( \text{CH}_3\text{CO} \quad + \quad \text{Br}_2 \quad (1 \text{ mol}) \quad \xrightarrow{\text{HBr cat.}} \) 

   b) \( \text{PhCH}_3 \quad \xrightarrow{\text{dilute aq. HCl cat.}} \) 

   c) \( \text{C}_3\text{H}_7\text{Cl} \quad \xrightarrow{\text{1.} \quad \text{H}_3\text{O}^+ \quad \text{2.} \quad \text{H}_2\text{O}} \) 

   d) \( \text{PhCHO} \quad + \quad \text{O} \quad \xrightarrow{\text{Et}_2\text{NH} \quad \text{EtOH}} \) 

   e) \( \text{C}_3\text{H}_7\text{NO} \quad \xrightarrow{\text{NaOC}_2\text{H}_5 \text{ (cat.)}} \) 

   f) \( \text{C}_8\text{H}_{15}\text{Br} \quad \xrightarrow{\text{CH}_3\text{OH/CH}_3\text{O}^- \quad 25 \degree \text{C}} \quad \text{LDA, THF} \quad -78 \degree \text{C} \)
2. Please write a reasonable mechanism for the following transformation:

a) [Chemical diagram]

b) [Chemical diagram]

3. When compound C in ethanol is stirred with one molar equivalent of NaOC₂H₅ and one equivalent of CH₃CH₂CH₂Br, a new compound D is formed. When D is refluxed with 3N H₃SO₄,
the ketone E is formed. Propose a structure for D, and give a stepwise electron-pushing mechanism leading from C to D to E.

4. Please first provide a retro synthesis for the following transformation, then write down a forward synthesis, you may use any reagent with less than 3 carbons: