1. A recent *Journal of Organic Chemistry* article by Jung and Pitzzi outlines the synthesis of the AB ring system contained in Ouabain. Ouabain has been used for more than two centuries in the clinical treatment of congestive heart failure. Predict the products (A, B, and C) for each of the following reactions employed by Jung and Pitzzi. (5 pts each)

\[
\begin{align*}
1) & \text{NaBH}_4 \\
2) & \text{H}_2\text{O} \\
& \text{m-CPBA, CH}_2\text{Cl}_2 \\
& \text{HOTs, MeOH} \\
& \text{HOTs, MeOH}
\end{align*}
\]
2. Predict the products for 4 of the following 5 reactions. Bear in mind things like regiochemistry, stereochemistry, etc. where appropriate. (5 pts each)

a) 
\[
\begin{align*}
\text{OH} & \rightarrow \text{CO} \\
\text{1) } \text{CrO}_3, \text{H}_3\text{O}^+ & \rightarrow \text{2) Na, DMF} \\
\text{3) benzyl bromide, DMF} & 
\end{align*}
\]

b) 
\[
\begin{align*}
\text{1) PhMgBr, Et}_2\text{O} & \rightarrow \text{2) H}_3\text{O}^+, \text{heat} \\
\text{3) OsO}_4, \text{NMO} & \rightarrow \text{4) HIO}_4
\end{align*}
\]

c) 
\[
\begin{align*}
\text{2-Methylpentan-3-ol} & \rightarrow \text{O} \\
\text{1) PCC, CH}_2\text{Cl}_2 & \rightarrow \text{2) mCPBA, CH}_2\text{Cl}_2
\end{align*}
\]

d) 
\[
\begin{align*}
\text{3-oxo-pentanal} & \rightarrow \text{1) ethylene glycol (1 eq), HOTs} \\
\text{2) Ph}_3\text{P} & \rightarrow \text{3) H}_3\text{O}^+
\end{align*}
\]

e) 
\[
\begin{align*}
\text{1,3-dithiane} & \rightarrow \text{OH} \\
\text{1) n-BuLi, hexanes} & \rightarrow \text{2) butanal, Et}_2\text{O} \\
\text{3) H}_2\text{O, HgCl}_2, \text{CH}_3\text{CN} & 
\end{align*}
\]
3. Synthesize **2 of the following 3 compounds** starting with benzene, monofunctional groups of 5 carbons or less, 1,3-dithiane, ethylene glycol (for protection), and any inorganic reagent or solvent needed (7 pts each)

see me with questions
4. Provide detailed arrow pushing mechanisms for 3 of the following 4 reactions (7 pts each)

a)
5. Provide a detailed arrow pushing mechanism for the following reaction

\[
\begin{align*}
\text{H-OTs} & \quad \text{heat} \\
\text{H} & \quad \text{OTs}
\end{align*}
\]

6. Given the following spectral data, provide a structure for the compound. Stop and think about organization before you begin to write. A correct structure unsupported by a sound proof will lose credit accordingly. The problem is designed to challenge you. Abundant credit will reward partial solutions if they are well reasoned and clearly written.

Elemental composition is \( \%C = 70.575 \), \( \%H = 5.923 \)
The unknown structure is:

![Chemical structure](image)

Proof:

Formula = C₈H₈O₂, M⁺ = 136

U.U = 8-4+1 = 5

IR:

3000 + = sp² C-H
below 3000 = sp³ C-H
2850 and 2750 = aldehyde C-H
1700 = C=O

¹³CNMR:

190 d = aldehyde CH
165 -115 = disubstituted aromatic
55 = OCH₃

¹HNMR

9.8 s, 1H = aldehyde CH
7-8 = para disubstituted aromatic
4 = OCH₃ group on aromatic ring

(3) Extra Credit:

Name one other city in Iraq besides Baghdad in which the Coalition forces are (or have been) fighting.

Lots of possible answers