1. Provide the product for the following reaction of this cyclic ether with excess HX. Draw the stepwise mechanism for the following transformation and determine which mechanisms these undergo. Remember that SN1 occurs kinetically faster than SN2.

[Diagram of cyclic ether with excess HI]

2. The following ether can, in principle, be synthesized by two different combinations of alkylhalide and metal alkoxide. Show both combinations that produce the ether and propose by which mechanisms the reactions go. Note that the combination that provides the SN2 mechanism is called the Williamson ether synthesis and the SN1 mechanism will lead to more elimination than substitution. Draw the elimination product for the mechanism that undergoes SN1/E2.

[Diagram of ether]

3. Provide correct organic product(s) and the mechanism for the following reactions. If stereochemistry pertains, ensure it is clearly demonstrated. If there is more than one product, then circle the major product. If no reaction occurs, place an X or NR in the box clearly.

[Diagram of reaction with NaBr, HBr, and H2O]
4. Provide products for the following reactions or syntheses.

a. \[
\text{mCPBA OR RCO}_3\text{H}
\]

b. \[
\text{excess HBr}
\]

c. 1. NBS/\text{hv} \\
2. NaH \\
3. BH_3(\text{THF}) \\
4. NaOH/H_2O_2 \\
5. PBr_3

d. 1. SOCl_2, pyridine \\
2. NaH \\
3. Br_2/H_2O \\
4. NaH \\
5. HBr

e. 1. NaH \\
2. \text{CH}_3\text{CH}_2\text{Br} \\
Mechanism?

\[
\text{H}_3\text{CO}
\]

1. HCl \\
Mechanism?

2. HI \\
Mechanism?
5. Propose a series of steps to bring about the following transformations. These reactions cannot be brought about in just one step, so you will need to propose a multi-step synthesis.

a.

b.

c.
6. Provide viable mechanisms for the following reaction.

\[
\begin{align*}
&\text{Vinyl alcohol} & \text{H}_2\text{SO}_4 & \text{Cyclohexene oxide} \\
&\text{CH}_3\text{OH} & & \\
\end{align*}
\]

7. Reactions. Provide reagents or products in the spaces provided. If there are multiple steps needed, then indicate with a 1./2. as appropriate.