1. (5 pts) a) Draw a detailed mechanism (using curved arrows) for the rearrangement outlined below.

b.) Draw an approximate energy diagram for the mechanism you drew in part a and explain why the rearrangement step is favorable in this reaction.

The rearrangement is favorable since it forms a resonance stabilized carbocation.
2. (5 pts) Draw the major product(s) for the following reactions.

a) \[
\begin{align*}
\text{Br} & \quad \text{Ph} \\
\text{CH}_3\text{CH}_2\text{OK} \\
\text{Ph} & \quad \text{CH}_3\text{CH}_2\text{O} \\
\end{align*}
\]

b) \[
\begin{align*}
\text{F} & \quad \text{OH} \\
\text{1. TsCl/pyridine} & \quad \text{2. CH}_3\text{SNa} \\
\text{F} & \quad \text{SCH}_3 \\
\end{align*}
\]

c) This reaction gives two products in a 95:5 ratio. Show both products. Extra credit if you can correctly identify the major product and provide a plausible explanation for why it predominates.

\[
\begin{align*}
\text{CH}_3 & \quad \text{N} \\
\text{N} & \quad \text{CH}_3 \\
\Delta & \quad \text{OH} \\
\text{95\%} & \quad + \\
\text{5\%} & \\
\end{align*}
\]

Since the Hoffmann elimination is an E2 process, elimination to form cyclohexene would require the quaternary ammonium leaving group to be axial. Since it is even bulkier than at t-butyl group this would be an extremely high energy conformation and therefore the rate will be very slow since very little of it is present at equilibrium.

d) The following reaction gives three major products. (Hint: 1 elimination product and 2 substitution products. Hint 2: Look at resonance in the intermediate.)

\[
\begin{align*}
\text{CH}_3\text{Br} & \quad \text{ethanol} \quad \Delta \\
\text{CH}_2\text{OCH}_2\text{CH}_3 & \quad + \\
\text{CH}_2\text{OCH}_2\text{CH}_3 & \quad + \\
\end{align*}
\]