1. There are variations on what follows but here is a reasonable path. To get 3, one simply backtracks and then follows the pathway outline in Problem 85.

\[
\begin{align*}
&CH_3OH & CH_3OH \\
&H_3O^+ & H_2O \\
&\xrightarrow{\text{Backward}} & \xrightarrow{\text{Forward}} \\
&\text{1} & \text{2} & \text{3}
\end{align*}
\]

2. All you need to know here is that ozonolysis cleaves double bonds to give carbonyl compounds. The product structures allow you to put the starting material together.

\[
\begin{align*}
&\text{R}_1\text{=)=}=\text{R}_3 & \text{1. O}_3 & \text{R}_1\text{=)=}=\text{R}_3 \\
&\text{R}_2\text{=} & \text{2. H}_2/Pd & \text{R}_2\text{=}
\end{align*}
\]

So,
3.

(a) H3O+/H2O or hydroboration or oxymercuration.
(b) HBr
(c) CH2N2 + light
(d) CF3COOOH
(e) B2H6
(f) (b) + (CH3)3COK
(g) 1. O3 2. HOOH
(h) (d) + KSH
(i) H2/Pd

4. Amy thought that intermediate 9 would be resonance stabilized, and therefore would be far more stable than 9a. However, the intermediate is NOT resonance stabilized when it is formed. The orbitals involved do not overlap, as a good 3D picture shows. Compound 7 is the major product, presumably because the secondary vinyl cation is more stable than the primary cation (9).
5.

The C=O bond in acetophenone is less double than that in acetone because of the following resonance forms:

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\text{C} & \quad \text{C} \\
\text{O} & \quad \text{O} \\
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\end{align*}
\]

The C=O bond in trichloroacetone is more double than that in acetone itself because the resonance form A for trichloroacetone is destabilized (dipole-dipole).

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\text{C} & \quad \text{C} \\
\text{O} & \quad \text{O} \\
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\end{align*}
\]

A is a strong contributor.

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\text{C} & \quad \text{C} \\
\text{O} & \quad \text{O} \\
\text{H}_3\text{C} & \quad \text{H}_3\text{C} \\
\end{align*}
\]

A is a weaker contributor.
these "molecules" are identical
thus, the Hs are homotopic

these "molecules" are enantiomers
thus, the Hs are enantiotopic, and
will show two signals in an optically
active solvent.