"Don’t call me stupid." - Kevin Kline as Otto in *A Fish Called Wanda*
1. Assistant Beaker does not know as much about enolate chemistry as he should. He ran the following crossed aldol reaction without thinking. For full credit: A) give all the possible products of his reaction; B) give the structure of the major product which Beaker isolated and obtained the spectra below. Support your choice with key items from the spectra.

\[
\text{O} \quad + \quad \text{O} \\
\text{KOH} \quad \text{heat}
\]

**Possible products:**

- Crossed products
- Self Condensation

Product is the first one. The \(^1\text{H}\) signals in the alkene region in the NMR are the big key. Of all the products shown, it is the only one with TWO alkene peaks.
2. Supply the missing products for five of the following six equations. Give answers for only five, and indicate which problems you would like graded. (5 pts each)

a. \[
\begin{align*}
\text{O} & \quad \text{1) } \text{NH}_3 \text{ (1 eq)} \\
\text{O} & \quad 2) \text{MeOH, TsOH} \\
\text{O} & \quad \text{H}_2\text{N} \quad \text{O} \\
\text{O} & \quad \text{OMe} \\
\text{O} & \quad \text{O} \\
\text{OH} & \quad \text{Et}_2\text{CuLi, THF} \\
\text{O} & \quad \text{Ph} \quad \text{OH}
\end{align*}
\]

b. \[
\begin{align*}
\text{O} & \quad \text{1) } \text{PBr}_3 \\
\text{OH} & \quad 2) \text{EtOH} \\
\text{O} & \quad 3) \text{LDA, -78°C, THF} \\
\text{O} & \quad 4) \text{Me-I, THF}
\end{align*}
\]

c. \[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{O} & \quad \text{NaOMe} \\
\text{MeOH} & \quad \text{(hint: Dieckmann)} \\
\text{O} & \quad \text{O} \\
\text{OMe} & \quad \text{O} \\
\text{O} & \quad \text{O}
\end{align*}
\]

d. \[
\begin{align*}
\text{MgCl} & \quad \text{1) } \text{CO}_2 \\
\text{2) } \text{H}_3\text{O}^{+} \\
\text{3) } \text{SOCl}_2 \\
\text{O} & \quad \text{Cl} \\
\text{O} & \quad \text{Ph} \quad \text{OH}
\end{align*}
\]

e. \[
\begin{align*}
\text{O} & \quad \text{1) cyclopentanone, KOH, heat} \\
\text{2) } \text{Et}_2\text{CuLi, THF}
\end{align*}
\]

f. \[
\begin{align*}
\text{O} & \quad \text{1) } \text{NaH, 0°C, THF} \\
\text{2) } \text{epoxy styrene, THF} \\
\text{3) } \text{H}_3\text{O}^{+} \\
\text{O} & \quad \text{O} \quad \text{OH} \quad \text{Ph}
\end{align*}
\]
3. Propose synthesis routes for TWO out of the following three compounds. Legal starting materials include mono-functional compounds with a sum total of five carbons or less, dimethyl malonate, benzene, unsubstituted dithiane, bases for elimination and/or deprotonation (LDA and alkoxides are okay), ethylene glycol (for protection only!), MVK, and any inorganic reagent or solvent required to carry out the transformation (CN, PPh₃, NBS, etc. are all inorganic). Carboxylic acids are legal, acid halides are NOT (but if you make them, okay!). Keep in mind there are many correct synthesis routes for each compound. (15 pts each)

All reasonable routes accepted. For details of what is not acceptable, see the key for Exam 3 synthesis problems…
5. Give complete arrow pushing mechanisms for two of the next three equations. Be sure to include all relevant resonance structures and account for all products shown. You may use the back of this page if you wish. (15 pts each)

I. \[ \text{CH}_3\text{CO}_2\text{H} \xrightarrow{\text{H-OTs}} \text{CH}_3\text{CO}_2\text{H} \]

II. \[ \text{CH}_2\text{CH}_2\text{NH}_2 \xrightarrow{\text{KOH, Br}_2} \text{CH}_2\text{CH}_2\text{NH}_2 \]

III. \[ \text{C}_{6}\text{H}_5\text{O} \xrightarrow{\text{KOH, H}_2\text{O}} \text{C}_{6}\text{H}_5\text{OH} + \text{CH}_3\text{CO}_2\]
5. Given the following roadmap, give structures for A, B, and C. (3 pts each)

A =

B =

C =

(5) BONUS: Give a “named” reaction (named after a dead man, of course) from the last three chapters (2 pts). Give a correct example of your “named” reaction (3 pts).

Any reasonable example accepted.