

Answers to Hour Examination #2, Chemistry 302X-302A, 2005

1.

(a) Aldol followed by reductions:

1.  $\text{H}_3\text{O}^+/\text{H}_2\text{O}$  (aldol) 2.  $\text{H}_2/\text{Pd/C}$  (reduce) 3.  $\text{NH}_2\text{NH}_2/\text{HOCH}_2\text{CH}_2\text{OH}/\text{heat}$  (Wolff-Kischner - you could also use the Clemmenson)

or

1.  $\text{LiAlH}_4$  2.  $\text{H}_2\text{O}$  3.  $\text{HBr}$  4.  $\text{Li}$  (makes cyclohexyllithium) 5. react with cyclohexanone 6.  $\text{H}_2\text{O}/\text{H}_3\text{O}^+$  (protonate and eliminate). 7.  $\text{H}_2/\text{Pd/C}$

(b) Aldol followed by Michael:

1.  $\text{H}_3\text{O}^+/\text{H}_2\text{O}$  2.  $\text{KCN}, \text{H}_2\text{O}$

(c) Knoevenagel:

1.  $(\text{CH}_3\text{OOC})_2\text{CH}_2/\text{CH}_3\text{O}^- \text{Na}^+$

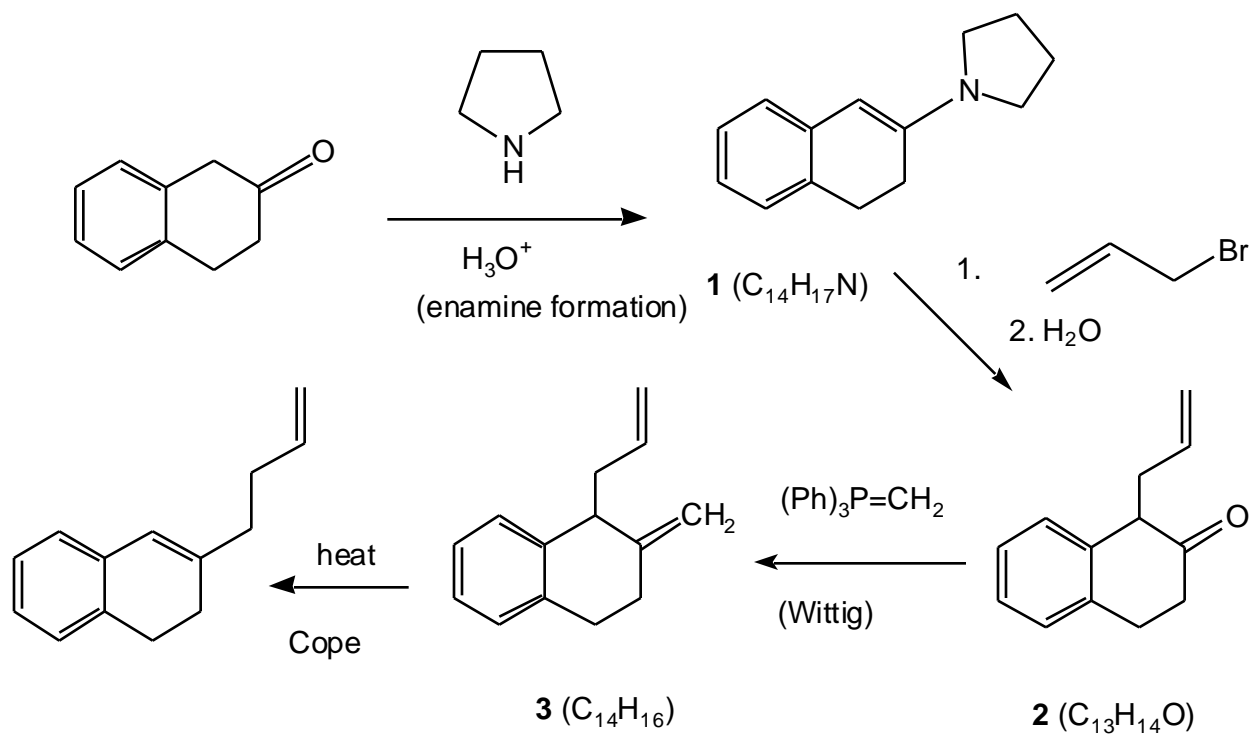
2. neutralize

2.

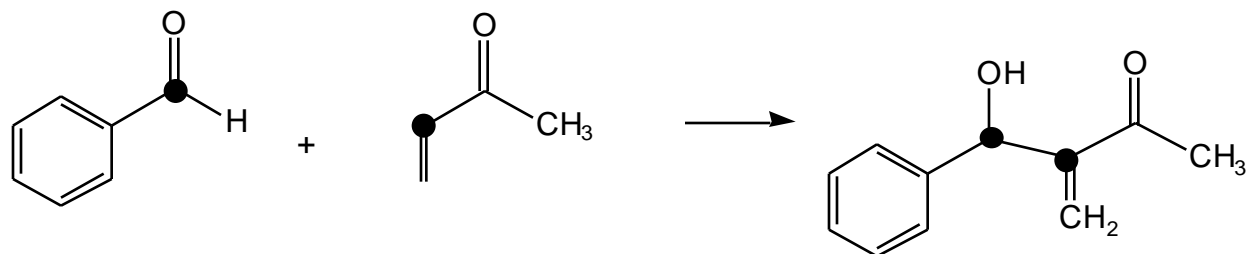
(a) 1.  $\text{LDA}$  2.  $\text{CH}_3\text{I}$  (an enamine process is also fine)

(b) 1.  $\text{CH}_3\text{Li}$  2.  $\text{H}_2\text{O}$  3.  $\text{H}_3\text{O}^+/\text{H}_2\text{O}$  (E1) 4.  $\text{BH}_3$  5.  $\text{HOOH}/\text{HO}^-$  6.  $\text{KMnO}_4$

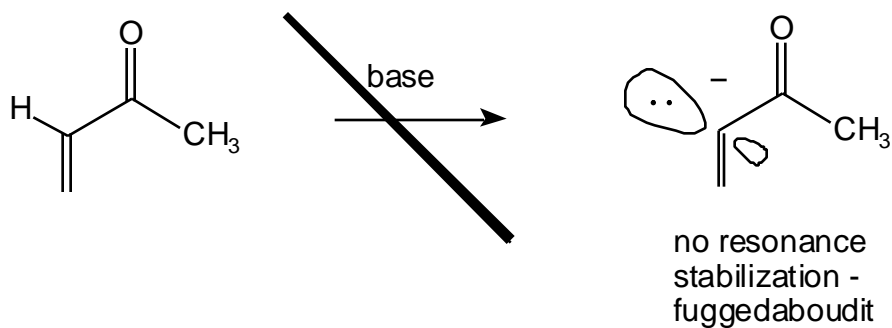
3.



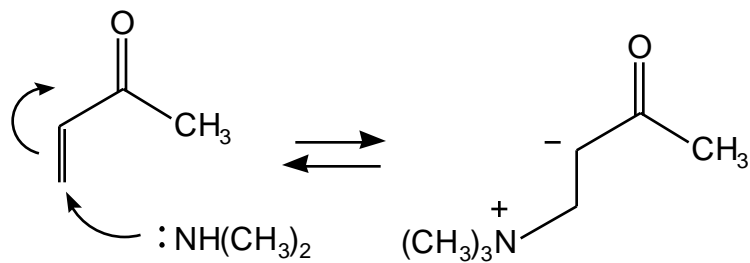
4. It is clear where the new bond joining the two pieces must be formed.



But it is equally clear, we hope, that there is no acidic hydrogen available for removal.

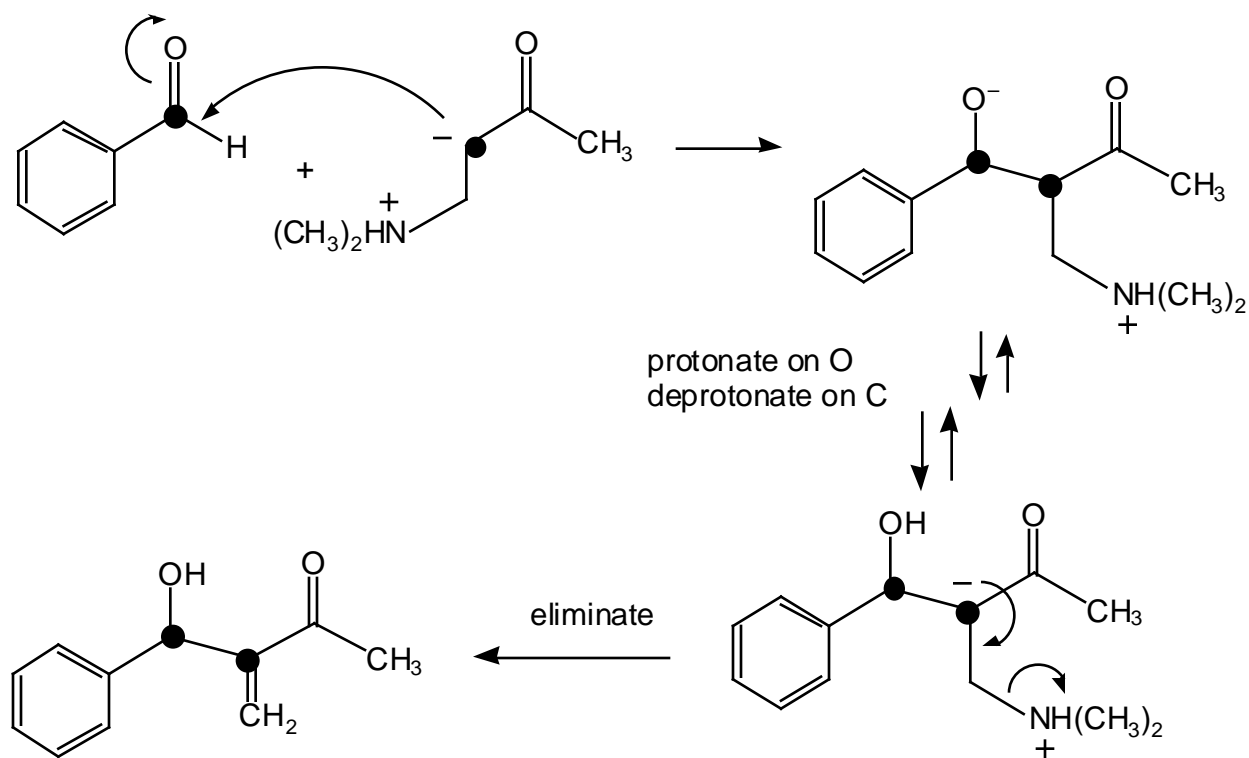


The role of the amine is to Michael in, thus generating the necessary resonance-stabilized intermediate.

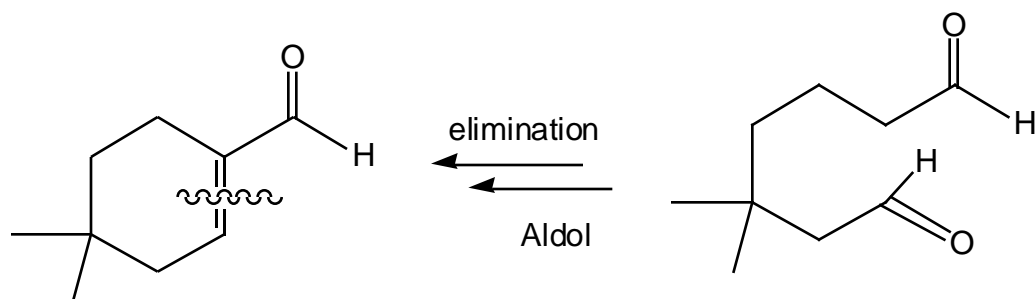


this intermediate is resonance stabilized

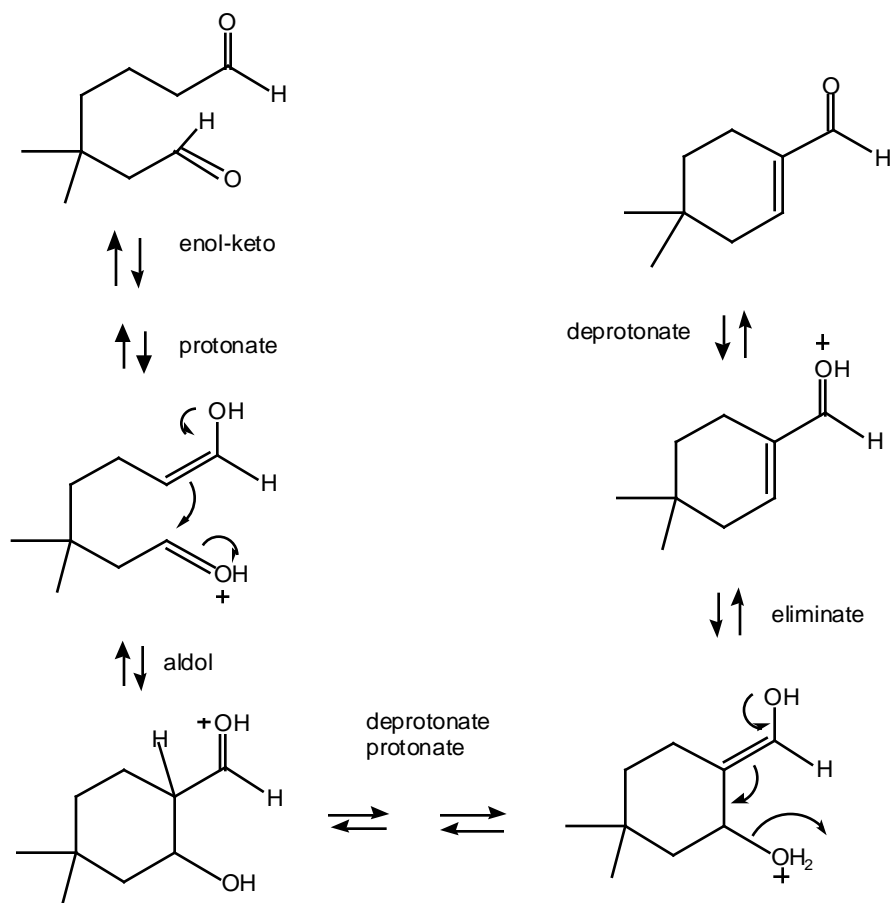
Now the junction bond can be formed.



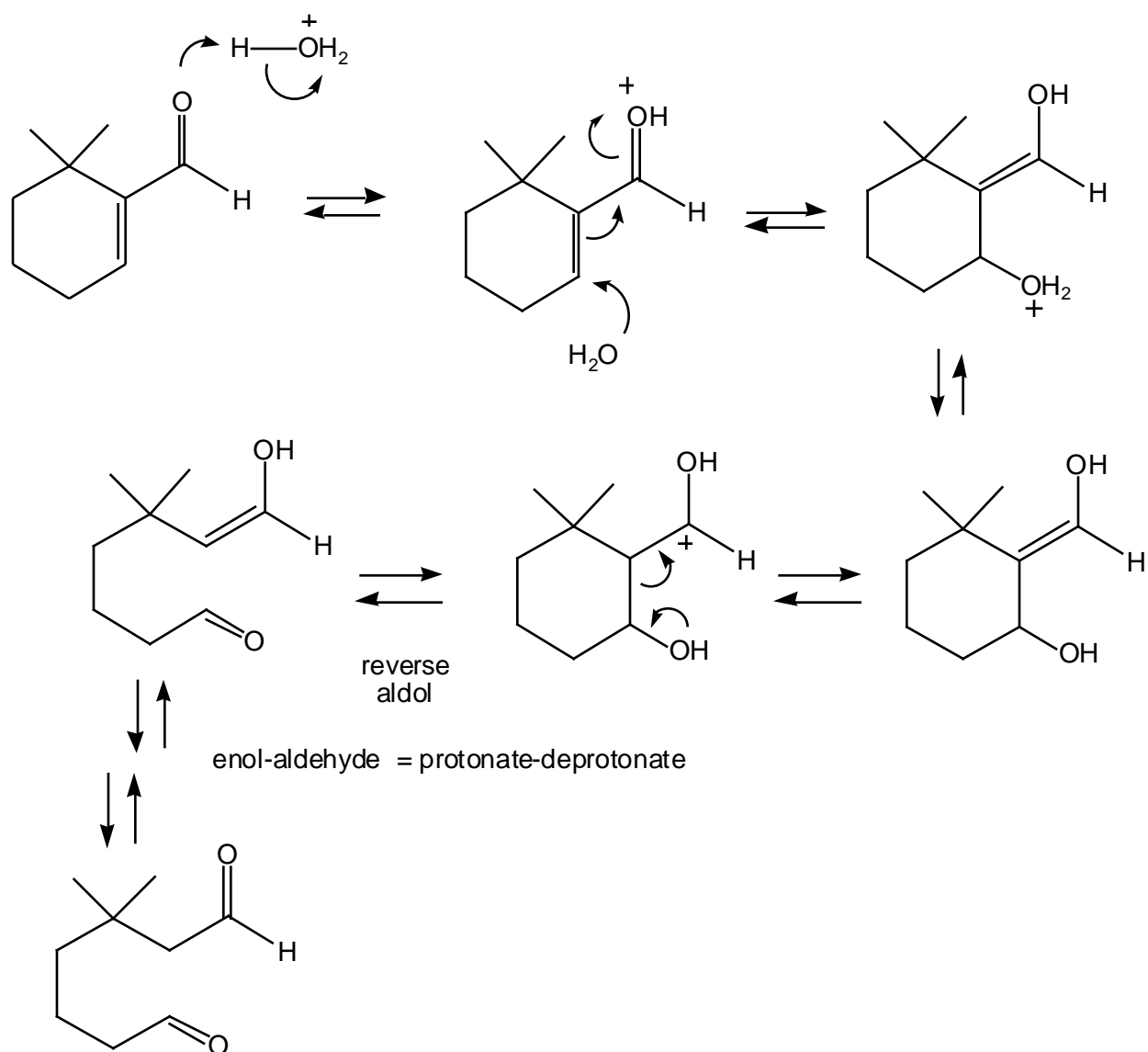
5. No magic methyl shifts here - this must be an open-close problem. Let's do it backward: as we know that all  $\alpha,\beta$ -unsaturated carbonyl compounds come from aldols, just deconstruct the product to the open compound we must make.



here are the steps sketched out for the closure of the dialdehyde to the product - not every keto-enol eq. is shown in detail here:



Here is the formation of the dialdehyde from starting material:



6. It is just a double Michael. The ester is needed to stabilize the product of the first

Michael.

