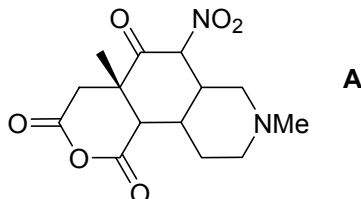


## Bifunctional Chemistry, Semester 2, 2009 (06522)

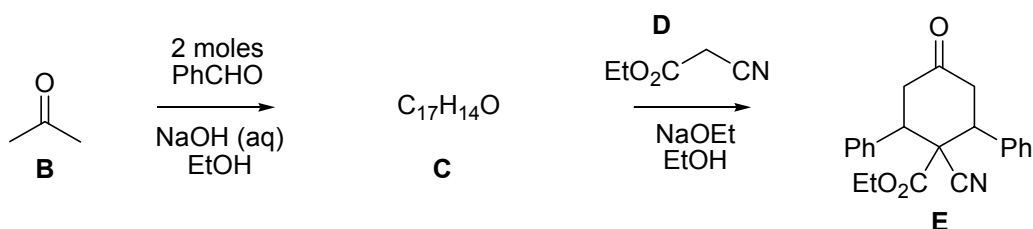
1. Answer **ALL** of the following parts.

- (a) Label all of the acidic hydrogen atoms in **A**, shown below, and explain which is the most acidic.



(4 marks)

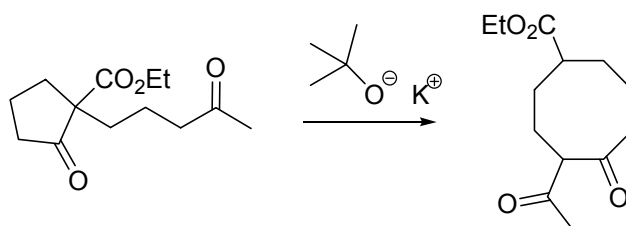
- (b) Consider the following scheme and then answer the following questions.



- (i) Give a mechanism to show how **B** may be converted to its enol tautomer with acid catalysis.
- (ii) Work out the structure of aldol product **C** for which the molecular formula is given. What product would form if the benzaldehyde (PhCHO) was accidentally omitted from the reaction mixture? Why is this product **not** formed at all when the benzaldehyde is present?
- (iii) Show how **D** can be converted into its enolate by treatment with ethoxide ( $\text{EtO}^-$ ), and then show how this reacts with **C** to form **E**.

(2,8,5 marks)

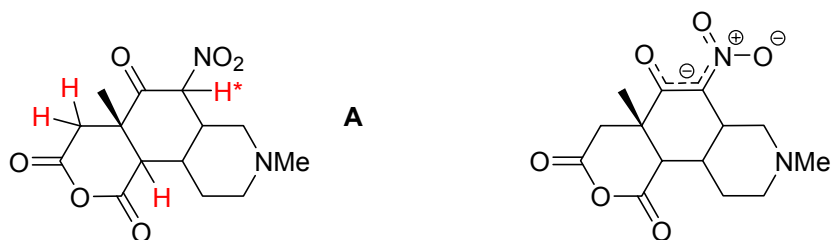
- (c) For the transformation below, give a mechanism to explain the formation of the product and state clearly the driving force for the reaction.



(6 marks)

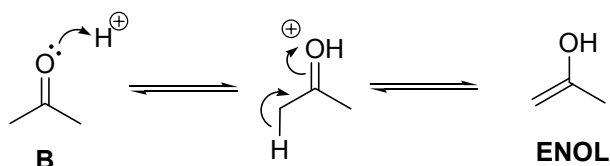
**Bifunctional Chemistry, Semester 2, 2009 (06522)**  
**MODEL ANSWER**

- (a) Label all of the acidic hydrogen atoms in **A**, shown below, and explain which is the most acidic.

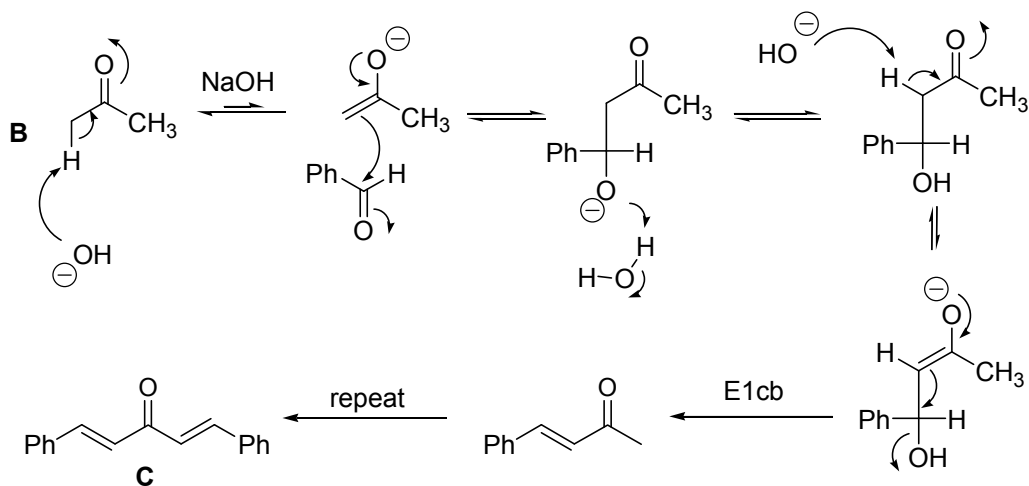


H\* is the most acidic. This acid's conjugate base is stabilised by greater degree of delocalization than the conjugate bases of other acidic hydrogens.

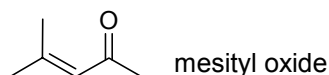
- (b) (i) Give a mechanism to show how **B** may be converted to its enol tautomer with acid catalysis.



- (i) Work out the structure of aldol product **C** for which the molecular formula is given. What product would form if the benzaldehyde (PhCHO) was accidentally omitted from the reaction mixture? Why is this product **not** formed at all when the benzaldehyde is present?

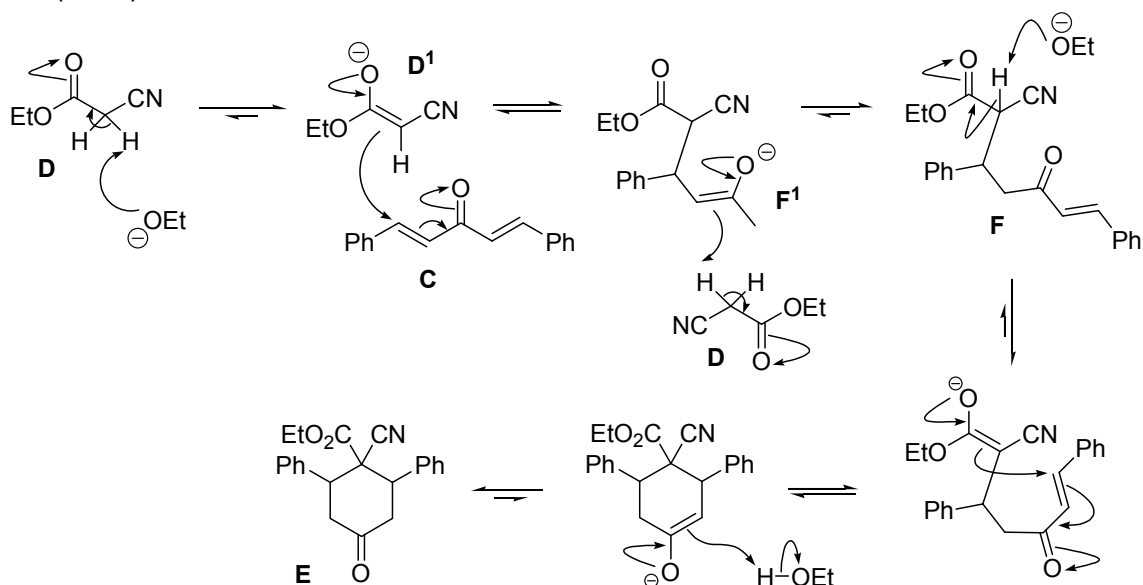


1) If benzaldehyde is omitted from the reaction a self-condensation of acetone will take place forming mesityl oxide initially.



2) In the reaction above **only** acetone has acidic  $\alpha$ -hydrogens (i.e. no enolate can form from benzaldehyde), **but** benzaldehyde is the more reactive electrophile. So the crossed condensation takes place.

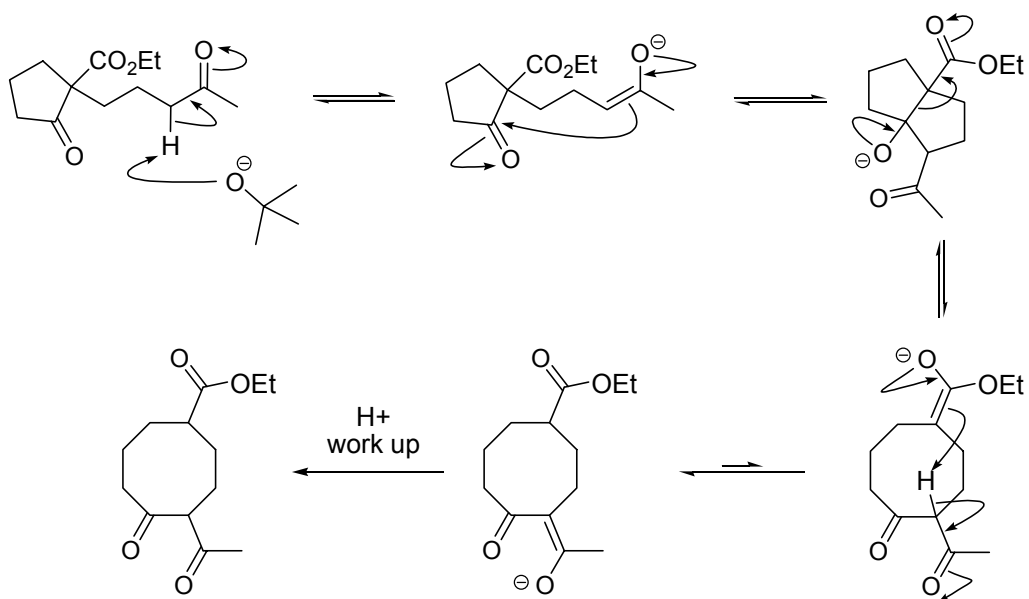
- (ii) Show how **D** can be converted into its enolate by treatment with ethoxide ( $\text{EtO}^-$ ), and then show how this reacts with **C** to form **E**.



Ethoxide deprotonates the cyanoacetate **D** ( $\text{EtOH}$   $\text{pK}_a \sim 16$ ; **D**  $\text{pK}_a \sim 10$ ) producing the enolate **D**<sup>1</sup> which then undergoes conjugate addition to the  $\alpha,\beta$ -unsaturated ketone **C** producing enolate **F**<sup>1</sup>. This keto enolate, **F**<sup>1</sup>, is much more basic than ethoxide and so can easily deprotonate **D** and thus perpetuate the cycle. **F**<sup>1</sup> may also deprotonate the solvent, which of course is present in higher concentration than **D**. E.g. if the reaction is performed in ethanol, this would produce more ethoxide.

Also, you may have spotted that there is an acidic  $\alpha$ -CH in the malonate portion of the product **F**. If deprotonated this then can trigger the second conjugate addition to form the cyclohexanone **E**.

- (c) For the transformation below, give a mechanism to explain the formation of the product and state clearly the driving force for the reaction.



*driving force for reaction is the production of this stable enolate*