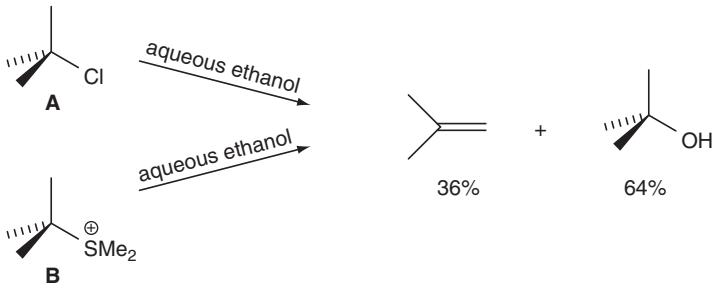
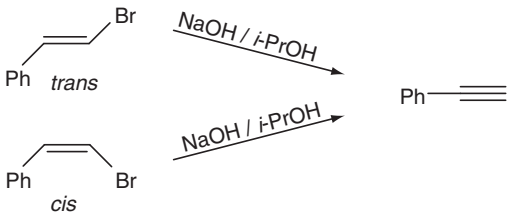
15 Organic chemistry 3: reactions of π systems

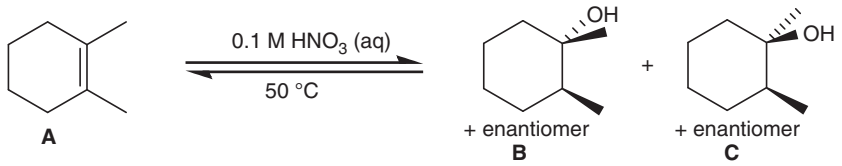
15.1 Compounds **A** and **B** both react in aqueous ethanol to give isobutene and *t*-butyl alcohol. **A** and **B** react at different rates, but give exactly the same proportions of the two products. What does this suggest about the mechanism for the reactions?



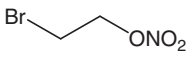
15.2 Both the *cis* and *trans* bromoalkenes shown below react with NaOH to form the alkyne, but the *cis* isomer reacts 2.1×10^5 times faster than the *trans* isomer. Explain why this is so.



15.3 When 1,2-dimethylcyclohexene, **A**, is treated with dilute acid, diastereoisomers **B** and **C** are formed in approximately equal proportions (together with their enantiomers). No matter how long the mixture is left standing, only around 10% of **A** is found to have reacted. With the aid of a suitable mechanism, account for these observations.

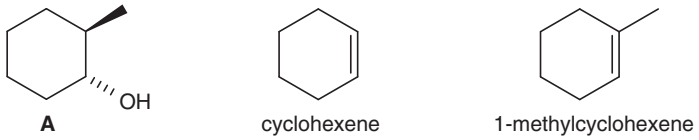


15.4 2-Bromoethyl nitrate, shown below, may be obtained in good yield by bubbling ethene gas through an aqueous solution of bromine and sodium nitrate. Give a mechanism for this reaction.

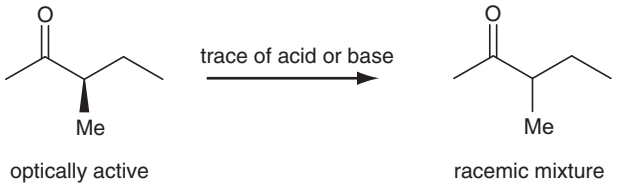


15.5 The diastereoisomers *cis*- and *trans*-but-2-ene both give 2,3-dibromobutane on reaction with bromine. However, one alkene gives only the achiral *meso* form of 2,3-dibromobutane, whilst the other gives only a racemic mixture of the optically active diastereomer. With the aid of clear mechanisms, explain these observations.

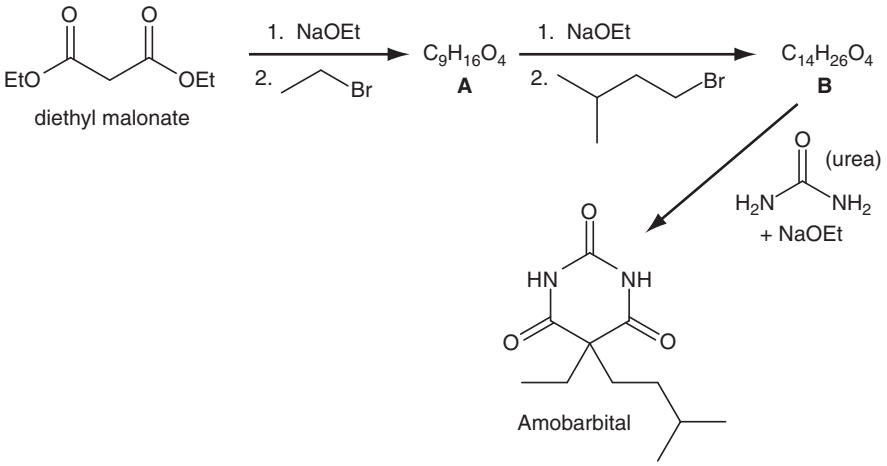
15.6 Compound **A**, shown below, may be prepared either from cyclohexene via an epoxide, or by the hydroboration of 1-methylcyclohexene. Give mechanisms for each of these reactions and account for the observed stereochemistry.



15.7 In the presence of a trace of acid or base, the optically active ketone shown below readily forms a racemic mixture. With the aid of appropriate mechanisms, explain how this occurs.



15.8 A synthesis of the drug *Amobarbital* (also called amylobarbitone) is shown below.

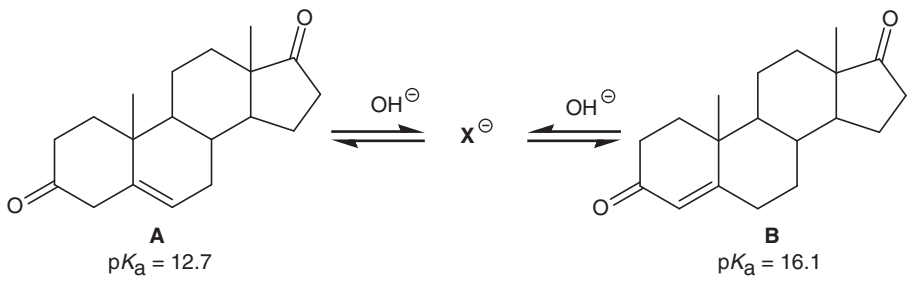


(a) The sodium ethoxide can react with the diethyl malonate either as a nucleophile, or as a base. Give the mechanisms for each of these reactions.

(b) Identify the intermediates **A** and **B**, and give mechanisms for their formation.

(c) Intermediate **B** reacts with urea and NaOEt to form amobarbital. What is the role of the NaOEt? Give a mechanism for the formation of amobarbital.

15.9 Both *5*-androstene-3,17-dione, **A**, and 4-androstene-3,17-dione, **B**, may be deprotonated in hydroxide to give a common anion, $\mathbf{X}^-$. The pK_a of **A** to form the anion is 12.7, whereas the pK_a of **B** is 16.1.



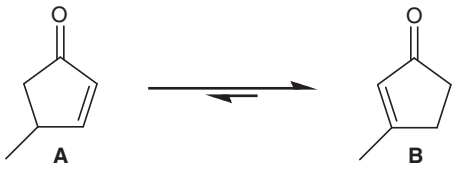
(a) Identify the acidic proton in **A** and in **B** which must be lost to form the common anion $\mathbf{X}^-$. Give a mechanism in each case.

(b) Suggest why the pK_a of **A** is lower than that of **B**, and why both are lower than the pK_a of acetone (around 20).

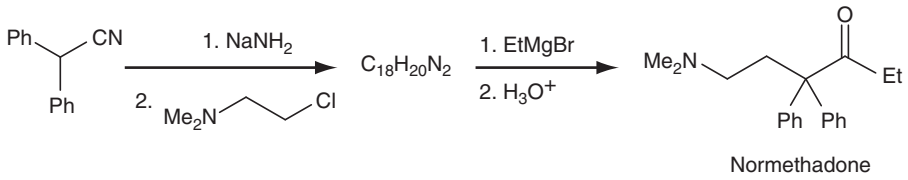
(c) Give expressions for K_a(**A**) and K_a(**B**), the acidity constants for **A** and **B**, and calculate the values of these equilibrium constants from the given pK_a values.

(d) Write an expression for the equilibrium constant for **A** $\rightleftharpoons$ **B** in terms of K_a(**A**) and K_a(**B**), and calculate its value. Comment on your answer.

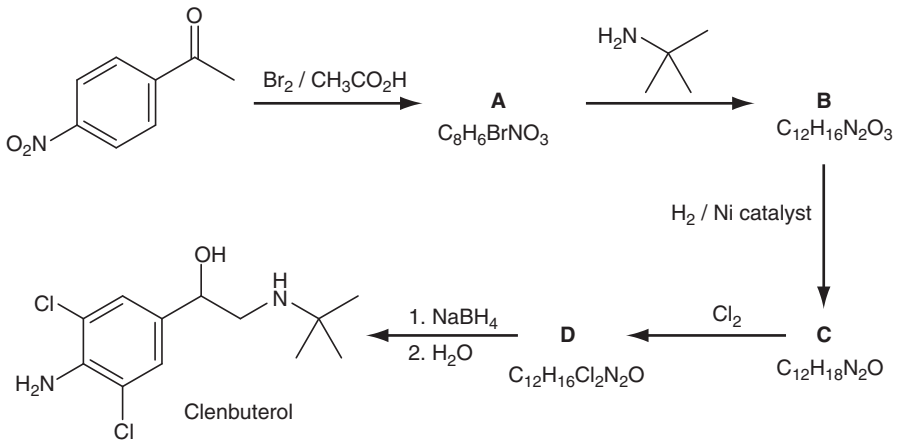
15.10 In the presence of a catalytic amount of acid or base, 4-methylcyclopent-2-enone, **A**, isomerizes to 3-methylcyclopent-2-enone, **B**. Give a mechanism for this reaction. Why is **B** favoured at equilibrium rather than **A**?



15.11 A synthesis of the drug *Normethadone* is shown below. Give the mechanisms for all the reactions involved in the synthesis.



15.12 A synthesis of the bronchodilator *Clenbuterol* is shown below.



(a) Identify the intermediates **A–D**.

(b) Give a mechanism for each step of the reaction scheme, except for the catalytic reduction of **B** to **C**.

(c) How do the two substituents on the benzene ring affect the reaction with chlorine in the formation of **D** from **C**?