1. Alkenes contain a carbon to carbon double bond. Although such a bond may appear to be equal to two single bonds evidence from bond enthalpies suggests that the carbon atoms form sp2 hydrids and form a strong σ (sigma) bond and a weaker π (pi) bond. This helps explain why alkenes, which contain strong double bonds, undergo addition reactions with such ease.

(a) Explain what is meant by sp2 hydridisation of carbon.
(b) Use evidence from bond enthalpies to calculate the mean bond energies of the σ and π bonds respectively.
(c) Explain, in terms of bonding theory, why sigma bonds are much stronger than pi bonds.
(d) Explain why alkenes undergo addition reactions.

2. Draw the structure of the following alkenes.

(a) pent-2-ene (b) 2-methyl hex-3-ene
(c) cyclopentene (d) 1,2-dimethyl cyclobutene

3. Draw and name all possible alkenes produced on reaction with a dehydrating agent.

a) Propan-2-ol (b) Hexan-2-ol

4. The alcohol $CH_3CH(CH_3)CH(OH)CH_3$ can be dehydrated to form 3-methylbut-1-ene. It is also possible to dehydrate the alcohol to form another alkene X.

(a) Name the above alcohol above.
(b) Draw the extended structural formula of 3 methyl-but-1-ene.
(c) Draw the extended structural formula of alkene X.
(d) Name two substances which can be used to dehydrate alcohols.

5. Name the following halogenoalkanes.

(a) $CH_3CHClCH_3$ (b) CH_2ClCH_2Cl
(c) $CH_3CH_2CHBrCH_3$ (c) $CH_3CHClCHClCH_3$

6. Name all the possible alkenes which can be produced by base induced elimination of hydrogen halides from the following.

(a) 2 bromopropane (b) 2 iodobutane
(c) 2 chloropentane (d) 3 bromopentane
(e) chlorocyclobutane (f) chloroethane

ANSWERS ALKANES 3-2

1 (a) The mixing of the 2S orbital with two of the 2P orbitals

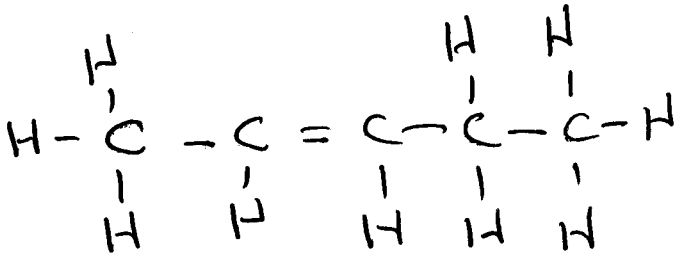
(b) C-C bond enthalpy = 346 KJ/mol from data book
Therefore sigma bond enthalpy = 346 KJ/mol

C=C bond enthalpy = 602
Since C=C is made up from 1 sigma and 1 pi bond, pi bond enthalpy will be 602 - 346 = 256 KJ/mol
(in σ bond)

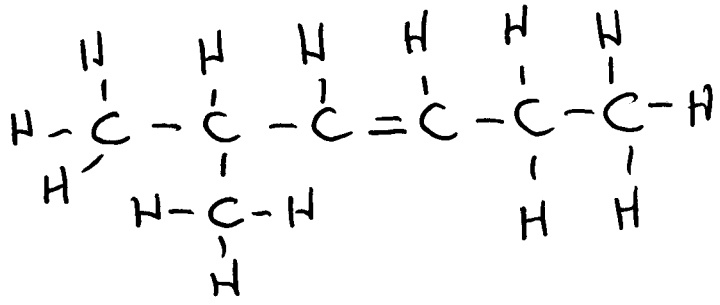
(c) end to end, overlap gives greater area of overlap resulting in a stronger bond
π bonds have side ways overlap producing less overall overlap therefore resulting in a weaker bond.

(d) Alkenes have a (C to C) double bond which contains a π bond which can easily be broken allowing other atoms to join (bond) on. The sigma bond remains intact so the alkene molecule does not break up giveing the net result that new atoms add on to the alkene without the number of carbons in the main chain changing.

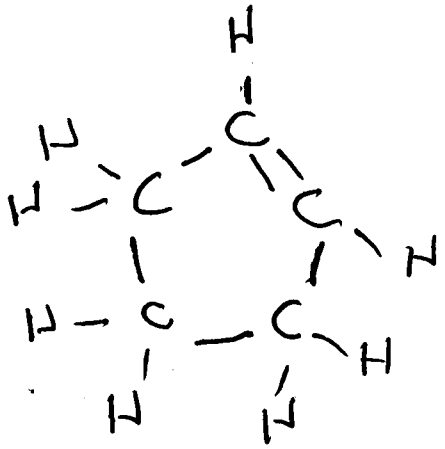
2. (a)



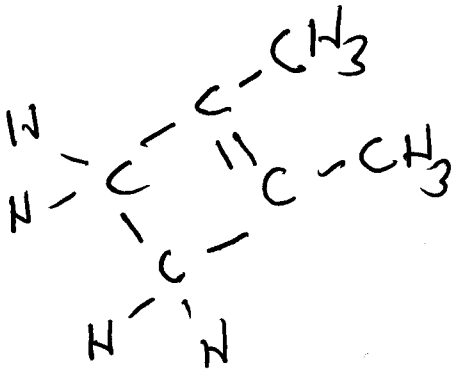
(b)



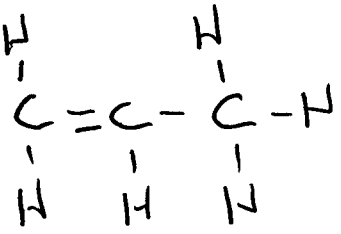
(c)



(d)

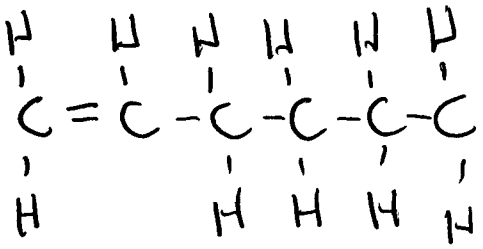


3. (a)



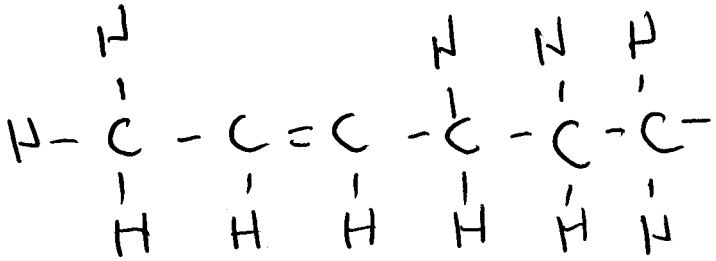
propene

(b)



Hex-1-ene

and

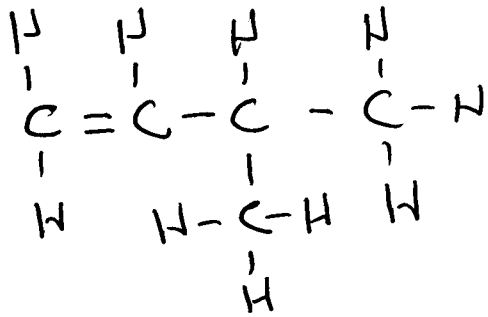


Hex-2-ene

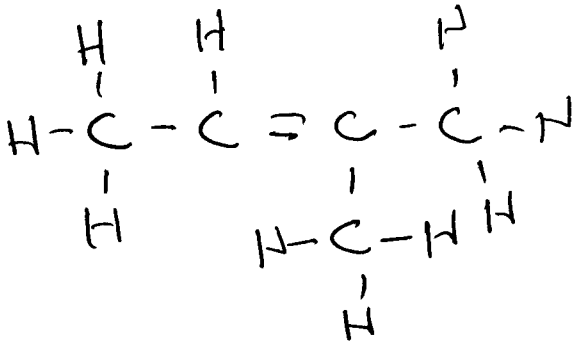
4.

(a) 3 methyl butan-2-ol

(b)



(c)



(d) Aluminium oxide or Conc sulphuric acid.

5 (a) 2, chloropropane

(b) 1,2 dichloroethane

(c) 2 Bromobutane

(d) 2,3 dibromobutane

6. (a) propene (b) but-1-ene
but-2-ene

(c) pent-1-ene (d) pent-2-ene
pent-2-ene

(e) cyclobetene (f) ethene

Addition Reactions 3.3

1. Use Markownikow's rule, where necessary, to predict the products of the following reactions.

(a) Ethene and hydrogen
(b) ethene and hydrogen iodide
(c) propene and hydrogen bromide
(d) But-1-ene and water
(e) but-2-ene and hydrogen chloride
(f) propene and bromine
(g) propene and water/ H^+
(h) but-2-ene and water/H^+
(i) but-1-ene and bromine
(j) but-2-ene and hydrogen

2. Name the following monohalogenoalkanes and classify them as primary, secondary, or tertiary.

(a) $CH_3CHBrCH_3$
(b) $CH_3CH_2CH_2I$
(c) $CH_3C(CH_3)ClCH_3$
(d) $CH_3CHClCH(CH_3)CH_3$
(e) $CH_2ClC(CH_3)_2CH_3$
(f) $CH_3C(CH_3)ClCH(CH_3)CH_3$

3. Draw the extended structural formulae of the following monohalogenoalkanes and classify them as primary, secondary, or tertiary.

(a) 2-iodo,2methylpropane
(b) chlorocyclobutane

4. Name the following halogenoalkanes.

(a) $CH_2ClCHClCH_3$
(b) $CH_2ICH_2CH_2I$
(c) CH_3Cl
(d) CH_2Cl_2
(e) $CH_2BrCHBrCH_3$
(f) $CH_3CH_2CI_3$

5. When propene is bubbled through an aqueous solution of bromine, 1,2 dibromopropane is produced. When propene is bubbled through bromine dissolved in an aqueous solution of sodium chloride a mixture of 1,2 dibromopropane and 1bromo, 2 chloropropane is produced.

(a) Show the mechanism for the reaction of bromine and propene.
(b) Explain why 1bromo, 2 chloropropane is produced when the bromine is dissolved in a solution of sodium chloride.
(c) Suggest an explanation for the fact that the proportion of the 1bromo, 2 chloropropane increases as the concentration of the sodium chloride increases.

6. Name and give the ionic formula of the alkoxides produced in the following reactions

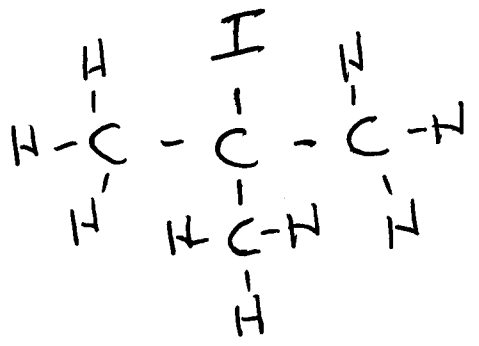
(a) Sodium and propanol
(b) lithium and ethanol
(c) potassium and butanol
(d) sodium and methanol

Answers Addition Reactions 3.3

1. (a) Ethane (b) Iodoethane
(c) 2 Bromopropane (d) Butan-2-ol
(e) 2 Chlorobutane (f) 1,2 dibromo propane
(g) propan-2-ol (h) butan-2-ol
(i) 1,2 dibromo butane
(j) butane

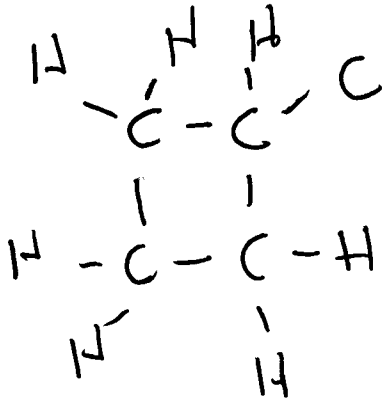
2. (a) 2, Bromopropane - Secondary
(b) 1, Iodo propane - primary
(c) 2 chloro 2 methyl propane - tertiary
(d) 2 Chloro 3 methyl butane - sec
(e) 1 chloro 2,2 dimethyl propane - prim
(f) 2 chloro 2,3 dimethyl butane - tert

3. (a)



tert

b



Sec

4. (a) 1,2 dichloropropane

(b) 1, diIodopropane

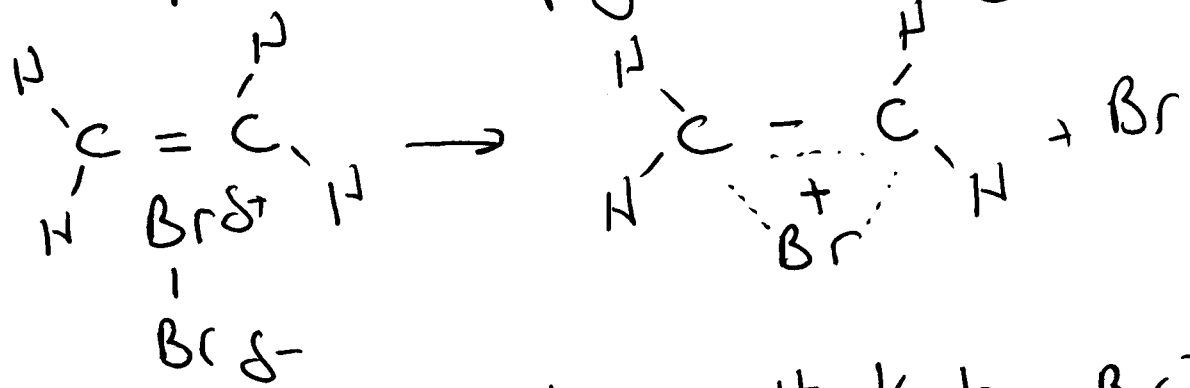
(c) chloromethane

(d) dichloromethane

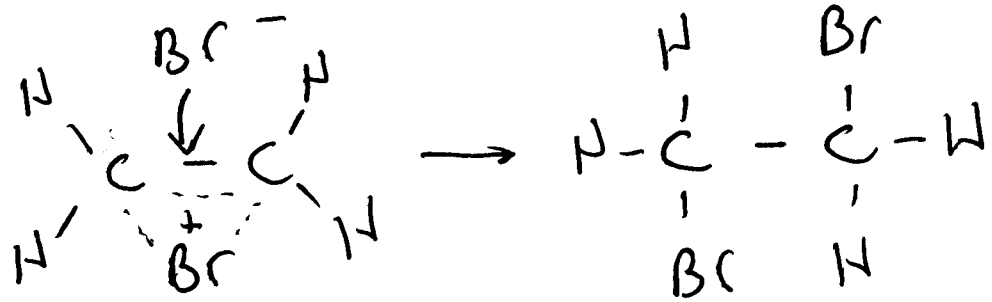
(e) 1,2 dibromopropane

(f) 1,1,1 triIodopropane

5. (a) Step 1 - electrophylic attack by Br_2



step - nucleophylic attack by Br^-



(b) if NaCl is present then Cl^- ion can act as a nucleophile and attack intermediate from step 1 (aq)

(c) if concentration of NaCl is higher then it is more likely that Cl^- will nucleophillically attack the intermediate than Br^- i.e rate of Cl^- attack will be faster than rate attack by Br^-.