Chemguide – answers

ELIMINATION MECHANISMS

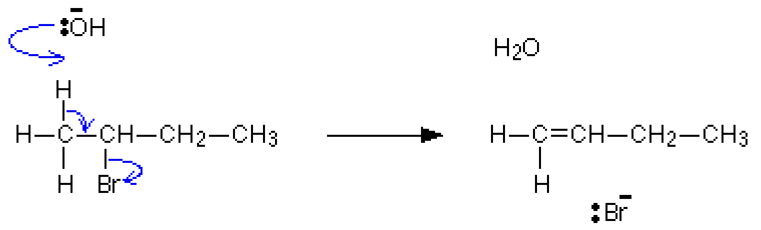
1. a) It is acting as a base.

   b) One of the lone pairs on the oxygen of the hydroxide ion moves to form a bond with a hydrogen atom in one of the CH_3 groups, producing a neutral water molecule. In the process, the electron pair in the hydrogen-carbon bond is repelled away, and forms a second (pi) bond between the two carbon atoms. To make room for this, the electron pair in the carbon-bromine bond is repelled entirely on to the bromine, producing a bromide ion.

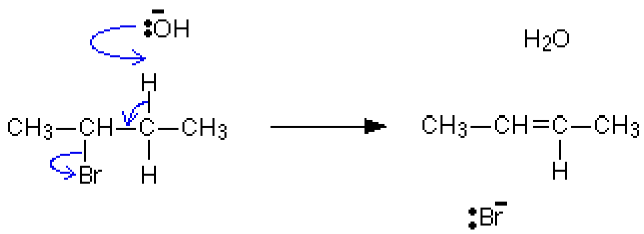
   c) Elimination is favoured by: using ethanol as the solvent; a higher temperature; using more concentrated sodium hydroxide solution

   d) Elimination is most likely with a tertiary halogenoalkane; substitution with a primary one.

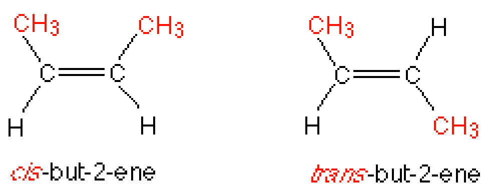
2. a)



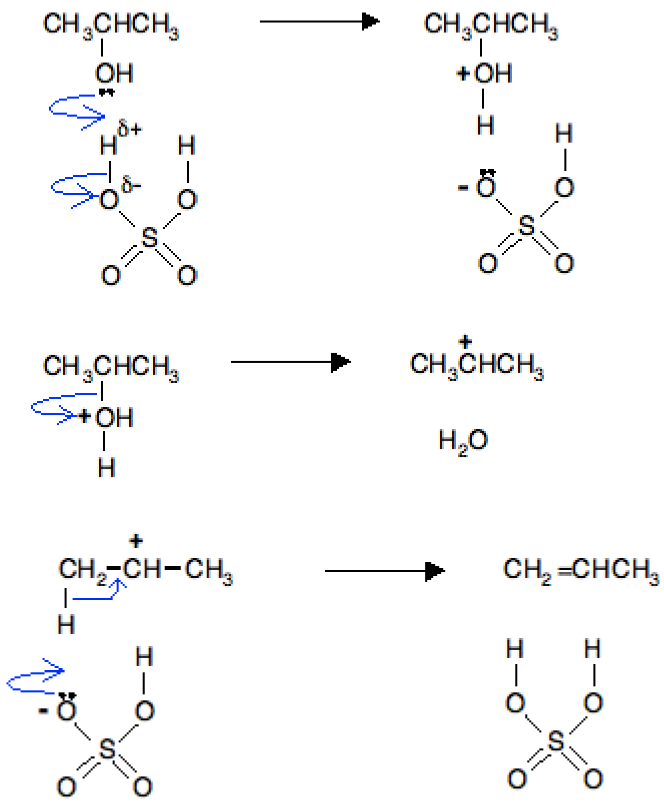
   b)



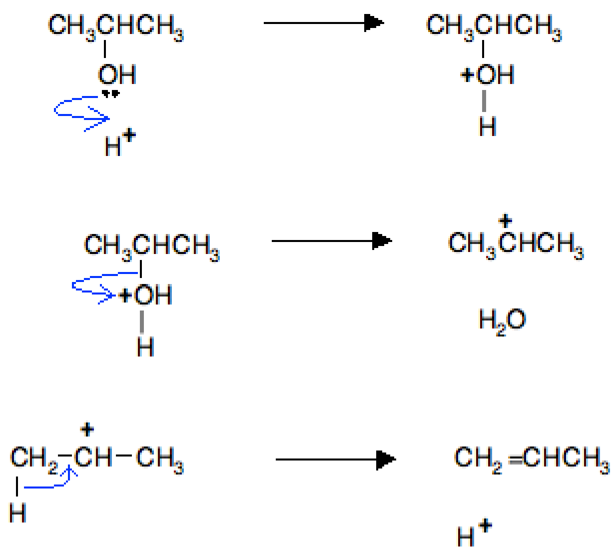
   c) Because there is no rotation around a carbon-carbon double bond, there is the possibility of geometric isomers – in this case:



3. a)



Or, if your examiners will accept it, you could use:



b) Because oxygen is more electronegative than hydrogen, the O-H bonds in sulphuric acid are strongly polarised with the hydrogen end fairly positive. The hydrogen in this bond is attracted to a lone pair on the oxygen in the ethanol. The lone pair moves to form a bond with that hydrogen, forcing the electrons in the O-H bond fully onto the oxygen, making it negatively charged.

The ethanol's oxygen has accepted a hydrogen ion from the sulphuric acid leaving the oxygen with a positive charge.

The lone pair on the negative oxygen in the hydrogensulphate ion in turn takes a hydrogen ion from the CH_3 group in the alcohol. The lone pair moves towards this hydrogen, and the electron pair from the carbon-hydrogen bond forms a second (pi) bond between the two carbon atoms.

To make room for that, the electron pair in the carbon-oxygen bond moves entirely on to the oxygen, neutralising the positive charge, and releasing a neutral water molecule.

At the end of the sequence, the sulphuric acid has been regenerated unchanged – it is acting as a catalyst.

c) A $CH_3CH_2^+$ ion (a primary carbocation) is too energetically unstable. To form it would need too big an input of activation energy. Using this mechanism avoids the formation of this ion, and so needs less activation energy.

d) but-1-ene
cis-but-2-ene (or (Z)-but-2-ene)
trans-but-2-ene (or (E)-but-2-ene)