

Chemguide – answers

ELECTROPHILIC ADDITION – SYMMETRICAL ALKENES

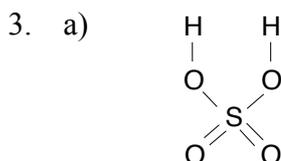
1. a) An addition reaction is one in which two molecules join together to make a bigger one with all the original atoms being present in the new molecule.
- b) (i) The double bond is made up of two parts, a sigma bond where the bonding pair of electrons is held on the line between the two nuclei, and a pi bond where the electron pair is held on a line above and below the plane of the rest of the molecule, and so is more exposed. An electrophile has a full or partial positive charge somewhere on it, and this is attracted to this exposed pair of electrons.
- (ii) Chlorine is more electronegative than hydrogen, and so the bonding pair of electrons is found closer to the chlorine end of the bond than the hydrogen end. That leaves a permanent dipole on the molecule with the chlorine end slightly negative, and the hydrogen end slightly positive. The slightly positive end will be attracted towards the pi bond of the ethene.
- c) Carbocation (or carbonium ion)
- d) As the slightly positive end of the XY molecule approaches the double bond, the pi bond is attracted towards it, and moves to form a new bond between the carbon and X. At the same time, the bonding pair of electrons between X and Y is repelled down entirely onto Y.

This leaves Y with a negative charge, and produces a carbocation carrying a positive charge on the other carbon.

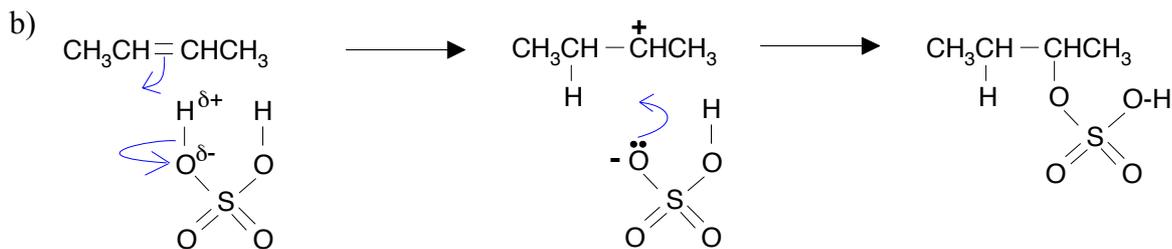
A lone pair on the Y ion is attracted towards the positive charge on the carbon, and a new bond is formed between the two.



b) The slowest reaction is with HF, and reaction rate increases as you go from HCl to HBr to HI. This is because the bond strengths of the H-X bonds fall from HF to HI. The first stage of the mechanism involves breaking the hydrogen-halogen bond, and this is most difficult to do with HF, easiest with HI.

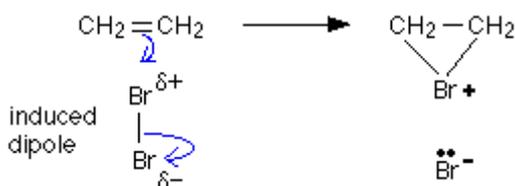


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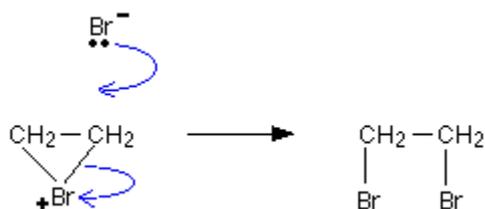


(I have had to twist the O-H bond around in the final molecule in order to keep the bond lengths sensible, and to avoid the H getting mixed up with the CH₃ group above it. Don't worry if you haven't done that. As long as everything is joined up in the right way, that's fine.)

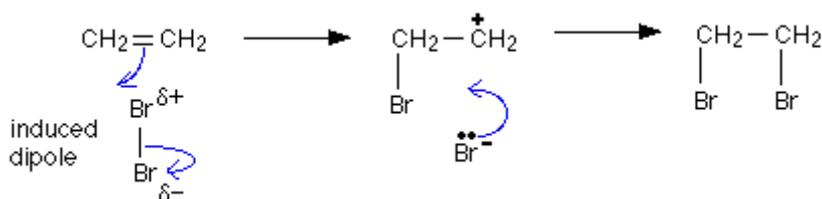
4. The pi bond repels the electrons in the bromine-bromine bond as it approaches, inducing a dipole in it.



In the second stage, a bromide ion attacks this bromonium ion from the back.



Alternatively, if you are *sure* that your examiners will accept it:



If you aren't sure, use the correct bromonium ion version. You are bound to get the marks for that.