## A) Electrophilic Addition Reactions of Ethene : Saturday 10th November 2018

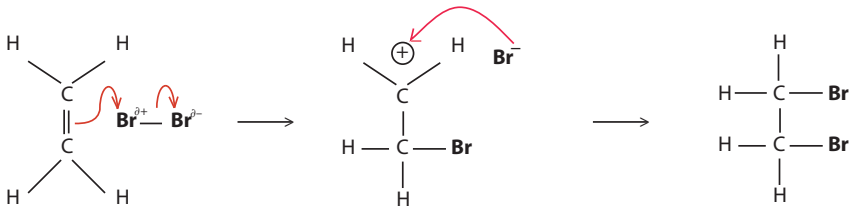
### i) The bromination of Ethene (the formation of 1,2-dibromoethane)

You will remember that a π bond is created by the overlap of two (unhybridised) 'p' orbitals between two adjoining σ bonded C atoms; and, that the π bond therefore contains an area of high electron density situated above and below the two bonded C atoms. **These negatively charged areas are capable of inducing polarity into any neutrally charged species that approaches them** – and when a non-polar diatomic molecule such as $H_2/Br_2/Cl_2/I_2$/etc approaches a π bond, this is PRECISELY what happens! The approaching molecule becomes polarised because the area of high electron density in the π bond repels the electron cloud surrounding the approaching molecule thus pushing some of the electron cloud off the atom that is closer to the π bond, and this atom will thus become "∂+", and the other atom of the diatomic molecule (which has had the electron cloud forced onto it) becomes "∂-". This is exactly what happens when a $Br_2$ molecule approaches an Ethene molecule.

**Stage 1**
Heterolytic bond fission

**Stage 2**
The first bond has been formed

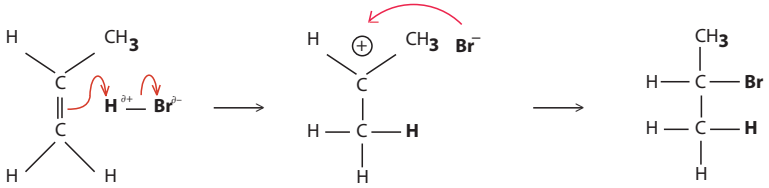
**Stage 3**
and now the second is formed



NB Please remember that a double-headed curly arrow indicates the movement of TWO electrons.

### ii) The formation of 2-bromopropane (1-bromopropane forms less often)

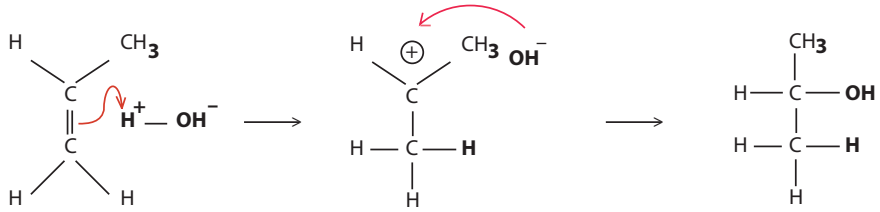
*Please confirm (as you learnt how to do in Foundation Chemistry) that the name of this substance is in fact 2-bromopropane.*



### iii) The formation of an Alcohol from an Alkene :

The addition of Water in the form of Steam to an Alkene to produce an Alcohol
e.g. Propene + Steam —> Propanol (at 600K/60 atm/Catalyst $H_3PO_4$)
*The phosphoric acid, $H_3PO_4$, is normally adsorbed onto a silica substrate. (600K is roughly 300˚C.)*

$C_3H_6$ + $H_2O$ —> $CH_3CH(OH)CH_3$ (most often Propan-2-ol)



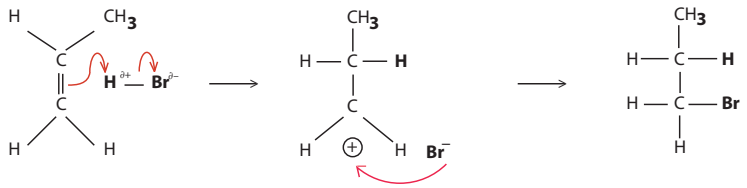
**Propan-2-ol is created here, but propan-1-ol is also occasionally created.**

I was going to do just one-page blogs, but you will need to learn a lot in two short years if you want to get an **'A*'** in your exams and get into the University of your choice, so let us cover a fair bit of ground each week.

There is only one product possible when **either** the electrophilic attacking molecule (i.e. the halogen/the hydrogen/ the halogenoalkane/the steam) **or** the nucleophile (i.e. the alkene) is symmetrical. However, **when BOTH the electrophile AND the nucleophile are asymmetrical, then TWO products can be formed**.

On page 1, I showed you how HBr and HOH (steam, $H_2O$ (g)) react with Ethene. Now, let us look at what happens when BOTH the reacting molecules are non-symmetrical.

- **The formation of 1-bromo propane (the molecule that does NOT usually form)**[1]
  *Here also, please confirm that the name of this substance is in fact 1-bromo propane.]*



*If you want to read about Markovnikov's Rule, then please read the Chapter on Alkenes.*

OK, one more little thing for today.

- **The CLASSIC test** for an Alkene (but not for Benzene nor for Alkynes) is the reaction with Bromine Water where the Alkene will decolourise the Bromine Water immediately[2] even in the dark and in freezing cold conditions (therefore it cannot possibly be a *uv* initiated homolytic bond fission free radical reaction). That is a *better* test for Alkenes than the one with Potassium Permanganate ($KMnO_4$)[3] which I am just about to describe.

- **However, the 2016 Edexcel exam required candidates to know that a "diol" is formed in the reaction between an Alkene and $KMnO_4$** viz. an organic compound that has two "OH" Alcohol functional groups in the compound (and a "triol" would have three "OH" Alcohol functional groups in the compound). This is what happens. With all its oxidisation states, $MnO_4^-$ is $(Mn^{7+}O^{2-}{}_4)^-$ . NB [(1x7) + (4 x(-2)) = -1]

| Add Alkene to | Colour of $MnO_4^-$ | Alkene initially converted into a | Then into | $Mn^{7+}$ eventually converted into |
|---|---|---|---|---|
| **Acidified, hot $MnO_4^-$** | **Purple** | Diol | Aldehydes/ Ketones/ Carboxylic Acids/ $CO_2$ (g) | $Mn^{2+}$ which is such a pale pink colour as to be virtually **Colourless** |
| **Alkaline, cold $MnO_4^-$** | **Purple** | Diol | No further change to the diol but the | **Green $Mn^{6+}$** is then turned into **browny-black** $Mn^{4+}$ by Oxygen from the air |

Please note the colour changes. In hot conditions the purple will go colourless, but in cold conditions the purple will eventually go browny-black as the Manganate ion is oxidised: purple $Mn^{7+}$ —> Green Mn $^{6+}$ —> Blackish $Mn^{4+}$.

This is First Year stuff, but next year my blogs will contain more difficult material.

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[1] It tends to form when there are impurities present in the reaction.
[2] An Alkyne will **not** decolourise Bromine water immediately. It is a slow reaction. The reaction **will** happen (and that answers the question "How Far?"), but it takes place very slowly (and that answers the question "How Fast?"). By the middle of your second term of 'A' Level Chemistry, you should find that things start to fall into place – and when they do so, you will feel a massive surge of satisfaction, and you might even begin to think that you are a genius.
[3] The oxidisation state of Mn in $MnO_4^-$ is "+7".