CAIE IGCSE Chemistry

11.5 Alkenes

Notes

State that the bonding in alkenes includes a double carbon–carbon covalent bond and that alkenes are unsaturated hydrocarbons

- Alkenes contain at least one double carbon-carbon covalent bond
- Alkenes are unsaturated hydrocarbons:
    - Unsaturated means there is at least one double bond in the carbon chain
    - Hydrocarbon means there is only hydrogen and carbon present in alkenes

Describe the manufacture of alkenes and hydrogen by the cracking of larger alkane molecules using a high temperature and a catalyst

- Alkenes are manufactured by cracking long chain alkanes using a high temperature and a catalyst:
    - Long chain hydrocarbons are heated until vaporised. The vapours are passed over a hot catalyst to break the long chains. Alternatively, the vapours are mixed with steam at very high temperatures so that thermal decomposition occurs.
- Cracking of long chain alkanes produces alkenes, shorter chain alkanes and hydrogen

Describe the reasons for the cracking of larger alkane molecules

- Reasons for the cracking of larger alkanes:
    - Produces alkenes which can be used as chemical feedstock
    - Helps to meet supply and demand of fractions
        - Fractional distillation of crude oil usually produces more long chain alkanes and less short chain alkanes, the latter has higher demand
        - Cracking produces shorter chain alkanes which are more useful as fuels than long chain hydrocarbons

Describe the test to distinguish between saturated and unsaturated hydrocarbons by their reaction with aqueous bromine

- Alkanes are saturated hydrocarbons: contain only single covalent bonds
- Alkenes are unsaturated hydrocarbons: contain at least one double carbon-carbon bond
- To test for the presence of a double bond (i.e. whether a molecule is unsaturated), add aqueous bromine:
    - There will be a colour change from orange to colourless
    - In saturated compounds, aqueous bromine will remain orange

(Extended only) State that in an addition reaction…

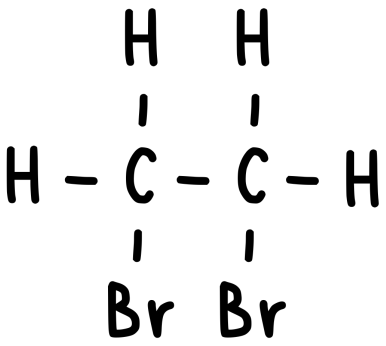
In addition reactions, two reactants will usually react to form only one product.

(Extended only) Describe the properties of alkenes in terms of addition reactions with… and draw the structural or displayed formulae of the products

- Alkenes will react with the following reactants in addition reactions, where the product of each reaction will not contain a double carbon-carbon bond

(a) Bromine or aqueous bromine

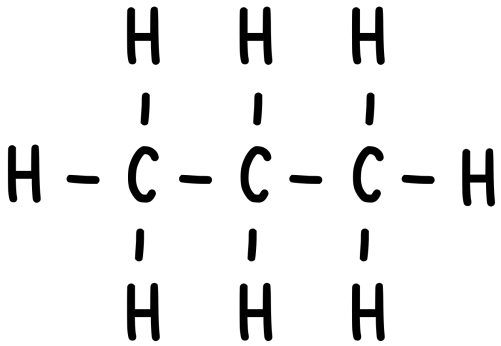
- As mentioned above, alkenes will react with aqueous bromine and decolourise it from orange to colourless.
- This is because the double bond is more reactive than a single covalent bond and will react with bromine to form a dibromoalkane.
- E.g. Write the word and balanced symbol equation for the reaction between ethene and bromine.
  Ethene + Bromine -> 1,2-dibromoethane
  $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$
- E.g. Draw the structural and displayed formulae of the products for the reaction between ethene and bromine.
  Structural formula: $CH_2(Br)CH_2(Br)$ or $C_2H_4Br_2$
  Displayed formula:



(b) Hydrogen in the presence of a nickel catalyst

- In the presence of a nickel catalyst, alkenes will react with hydrogen in an addition reaction to produce an alkane, by replacing the double carbon-carbon bonds with single covalent bonds.
- E.g. Write a balanced word and symbol equation for the reaction between propene and hydrogen, in the presence of a nickel catalyst.
  Propene + Hydrogen -> Propane
  $C_3H_6 + H_2 \rightarrow C_3H_8$

- E.g. Draw the structural and displayed formulae of the products for the reaction between propene and hydrogen, in the presence of a nickel catalyst.
  Structural formula: $CH_3CH_2CH_3$ or C_3H_8
  Displayed formula:



(c) Steam in the presence of an acid catalyst

- In the presence of an acid catalyst, e.g. sulfuric acid, alkenes will react with steam in an addition reaction to produce an alcohol, replacing the double carbon-carbon bond with a hydroxyl group (-OH) and a hydrogen atom
- E.g. Write a balanced word symbol equation for the reaction between ethene and steam, in the presence of an acid catalyst.
  Ethene + Steam -> Ethanol
  $C_2H_4 + H_2O$ (g) -> C_2H_5OH
- E.g. Draw the structural and displayed formulae of the products for the reaction between ethene and steam, in the presence of an acid catalyst.
  Structural formula: CH_3CH_2OH or C_2H_5OH
  Displayed formula: