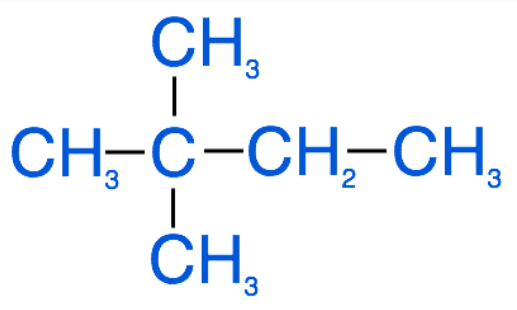
Organic Chemistry: Reactions of Hydrocarbons



Alkanes

- Alkanes are relatively unreactive due to their stable structure
- All atoms singly bonded to one another
- Alkanes generally require heat and the addition of a catalyst to push reactions forward

Combustion

- Alkanes are typically used as fuel as there is a lot of energy stored within them
- This energy can be released and harnessed to help heat homes, power electrical generators, and propel rockets into space
- Combustion reactions produce products that are harmful to the environment

Combustion

- Combustion is the reaction of a compound with oxygen to produce CO_2, H_2O and thermal energy
- The equation for the complete combustion of butane:

$$2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O + \text{thermal energy}$$

- The thermal energy produced from combustion is what is used for power and heat
- CO2 contributes to the greenhouse effect → climate change
- We need to consider the environmental impact of using hydrocarbons as fuel

Alkanes: Substitution Reactions

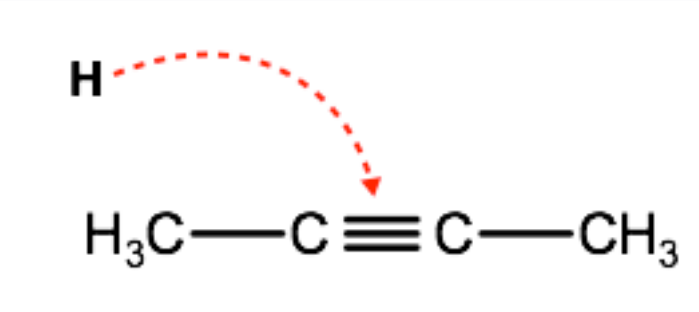
$$AB + CD \rightarrow AD + BC$$

- 2 molecules react with each other, and atoms from each are exchanged and substituted for each other, creating 2 products that are unique from the reactants
- Alkyl halides are produced from substitution reactions between hydrocarbons and halogens e.g: chloromethane
- These reactions require the input of heat and a catalyst to push them forward

$$CH_4 + Br_2 \rightarrow CH_3Br + HBr$$

Alkenes & Alkynes Reactions

- Alkenes & alkynes are more reactive than alkanes due to the multiple bond
- Double and triple bonds are weaker than single bonds, and therefore more reactive



- Alkenes & Alkynes undergo different types of addition reactions

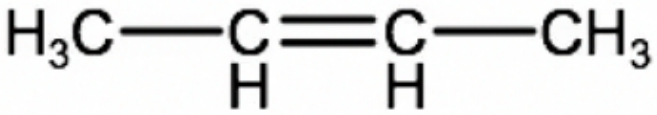
Addition Reactions

$$A + B \rightarrow AB$$

- 2 molecules react with each other and merge to form one product molecule
- Different types of addition reactions:
  - Hydrogenation
  - Halogenation
  - Hydration

Hydrogenation & Halogenation

Hydrogenation



ROSEDALE ACADEMY

Hydrogenation

- Hydrogenation reactions turn alkenes, alkynes and cyclic alkenes into alkanes and cycloalkanes
- Requires the input of energy to push reaction forward

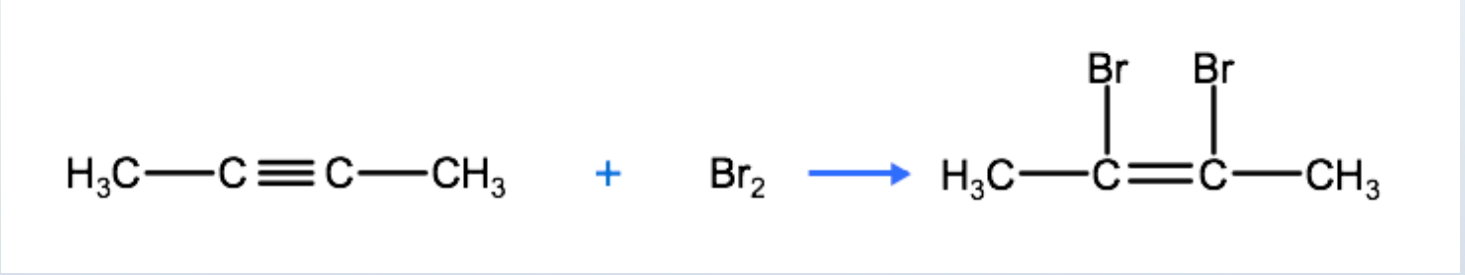
2-butene + hydrogen → butane

or

$$CH_3\text{-}CH{=}CH\text{-}CH_3 + H_2 \rightarrow CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_3$$

Halogenation

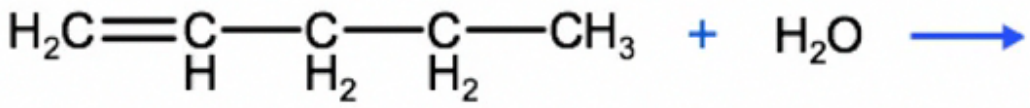
- Addition reaction that add halogen atoms to hydrocarbons
- Produces alkyl halides from alkenes and hydrogenated alkenes from alkynes



- The reaction above produces cis-2,3-dibromobutene which can itself react with Br2 to produce

2,2,3,3-tetrabromobutane

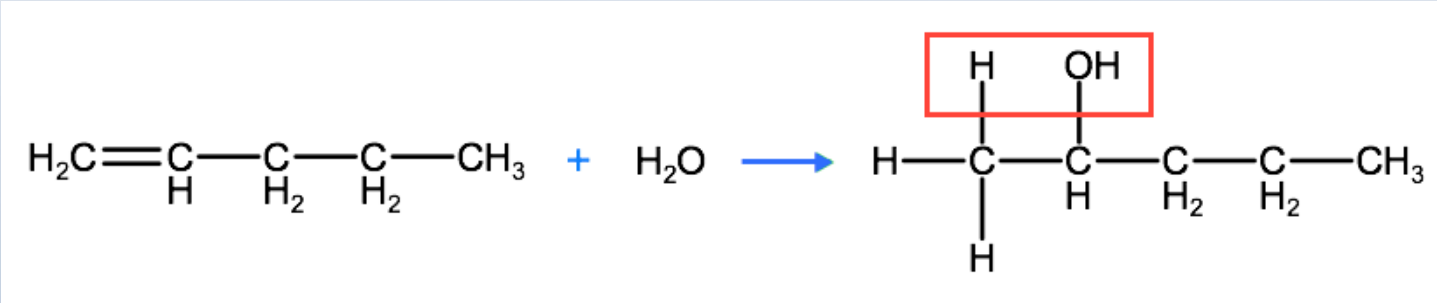
Hydration Reaction



ROSEDALE ACADEMY

Hydration Reactions

- In hydration reactions, water (H2O) molecules react with double or triple bonds adding 1 hydrogen atom and 1 hydroxyl group (-OH)
- Hydration reactions produce alcohols
- Hydration reactions follow Markovnikov's rule, in which the hydrogen atom is added to the carbon with the most hydrogen atoms bound to it



Summary

- Alkanes involved in complete combustion and substitution reactions
- Alkenes and alkynes are more reactive due to weakness of multiple bond
- Alkenes and alkynes involved in addition reactions including hydrogenation, halogenation and hydration
- Hydration reactions produce alcohols
- Markovnikov's rule: Hydrogens will be added to carbon with the most hydrogen atoms bound to it before the reaction