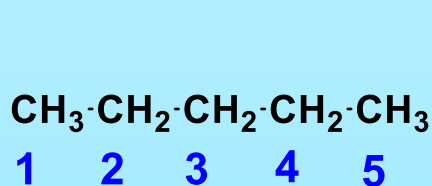


# Isomerism

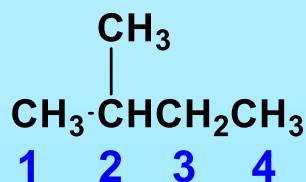
- There are many organic compounds that have the same molecular formula but have different physical and chemical properties – they are therefore different compounds
- Such compounds are said to be *isomers*
- So far we have seen compounds that are constitutional (or structural) isomers, e.g.
- In this topic, we will learn about structural isomers, however; in the second year we will learn about other types of isomers

# Isomerism

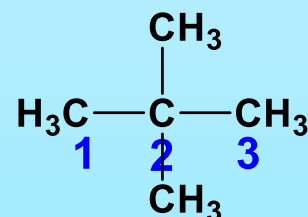
- So what are **constitutional isomers**?
  - Constitutional isomers are isomers that differ because their atoms are connected in a different order, i.e. they have different connectivity
  - There are a number of different types
1. Chain isomers ( $C_5H_{12}$ )



pentane



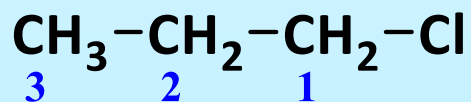
2-methylbutane



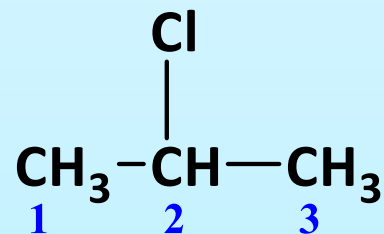
2,2-dimethylpropane

# Isomerism

## 2. Positional isomers (C<sub>3</sub>H<sub>7</sub>Cl)



1-chloropropane

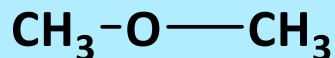


2-chloropropane

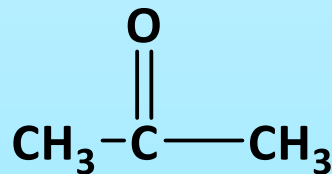
## 3. Functional group isomers



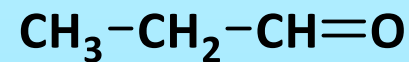
ethanol



Dimethylether



propanone



Propanal

# Natural occurrence

- Alkanes, alkenes and alkynes can be obtained from nature in the form of natural gas
- Methane, for example, is the main constituent of natural gas (often more than 90% by volume)
- Crude petroleum gives rise to much higher straight-chain alkanes, branched and cyclo-alkanes
- Individual components in crude oil can be isolated using fractional distillation

# PNG Liquified Natural Gas Project with Hides Gas Conditioning Plant through a 700-kilometre pipeline





# Hides Gas Conditioning Plant at Hela Province, Southern Highlands

- The plant processes up to 1 billion standard cubic feet of gas gathered from eight wells each day

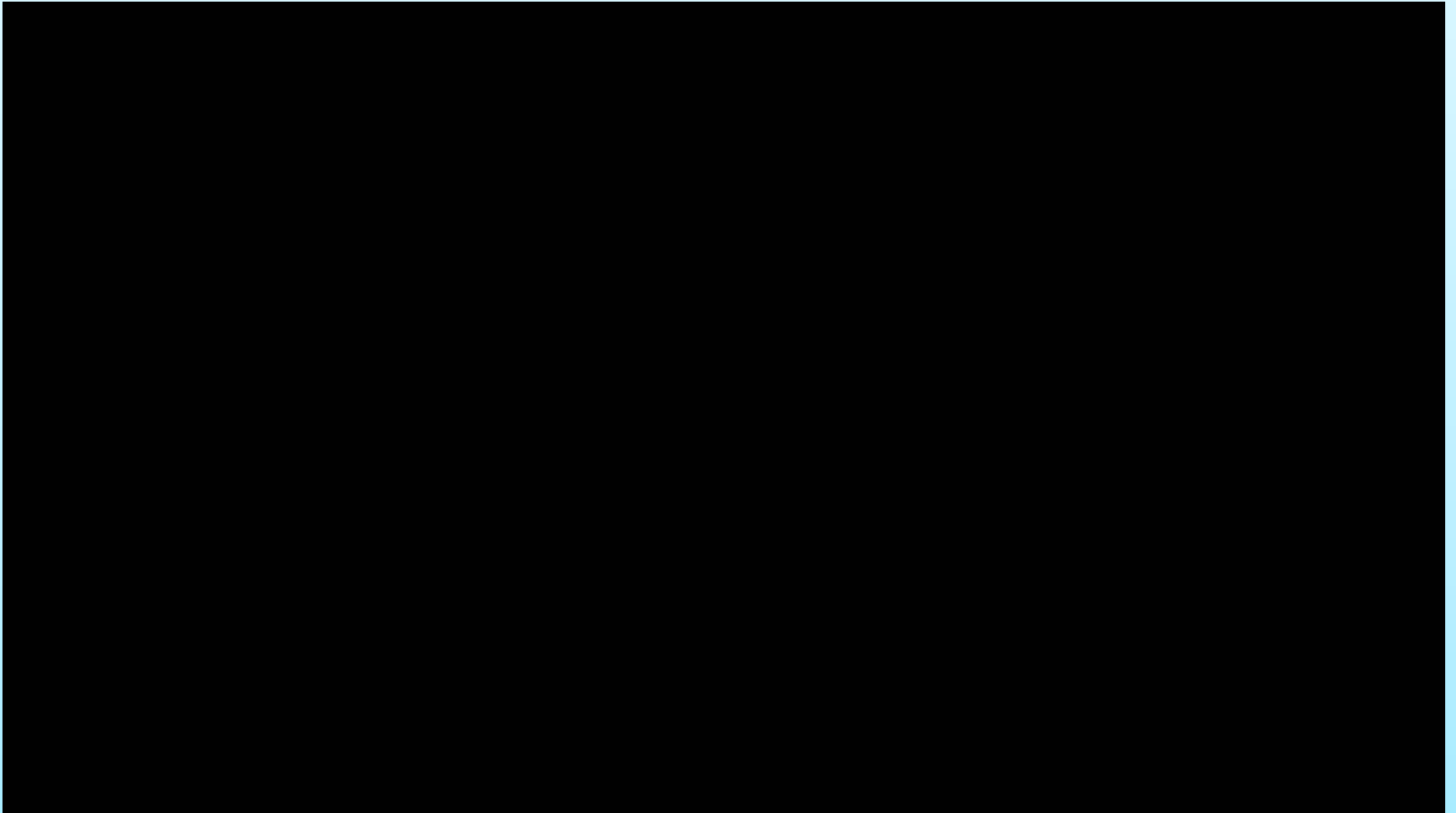




# **LNG Processing Plant at Caution Bay on the South Coast of Central Province, with the capacity of producing 8.3 million tonnes of LNG annually**



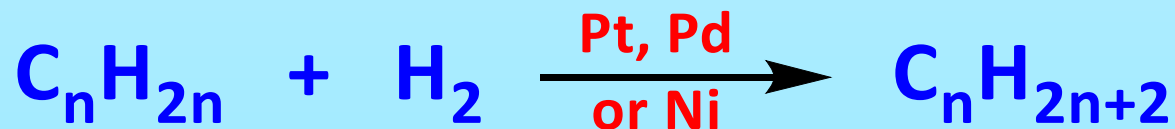
# Turning Natural Gas into Liquid Natural Gas





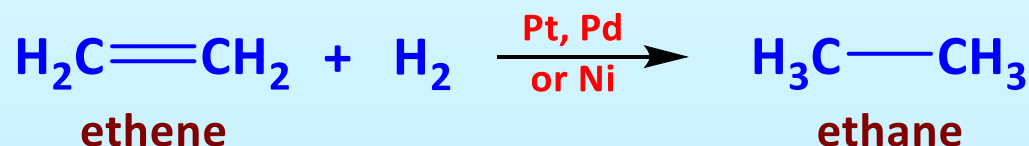
# Some basic reactions - alkanes

- Some of these compounds can be prepared in the laboratory using specific reactions:
- **Hydrogenation of alkenes** for example provides one of the most important methods for preparing specific alkanes (This is an example of an **addition reaction or reduction**)
- Here a mixture of the alkene and hydrogen is passed over a finely divided catalyst, usually platinum, palladium or nickel

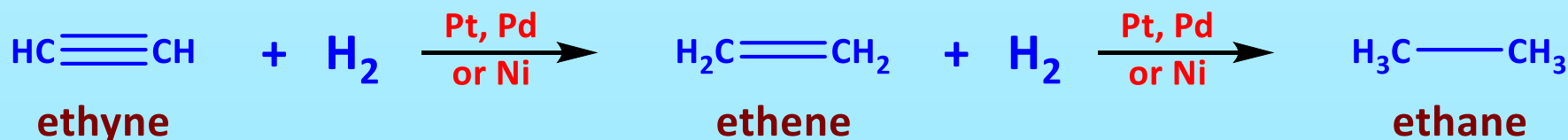
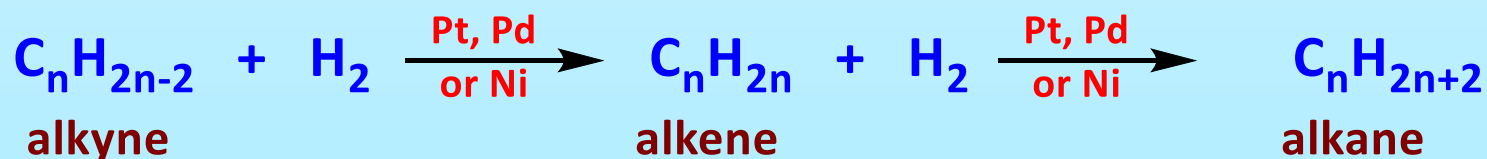


# Some basic reactions - alkanes

## ➤ Specific example

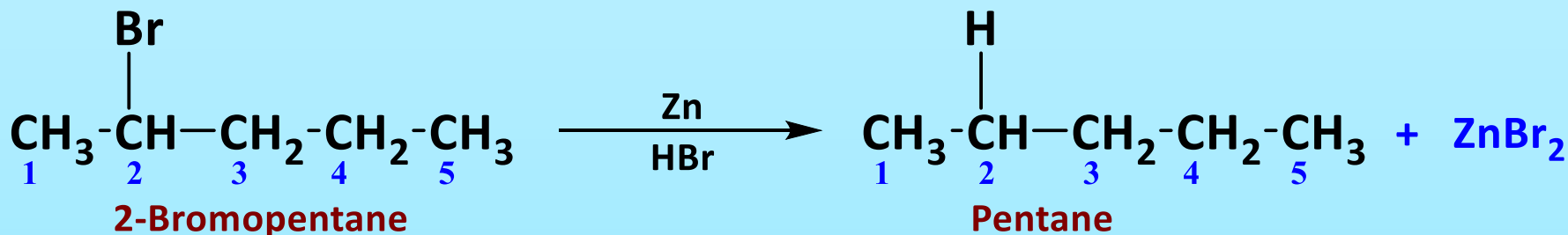


## ➤ Similarly, alkynes can also be hydrogenated (initially) to alkenes and then to alkanes



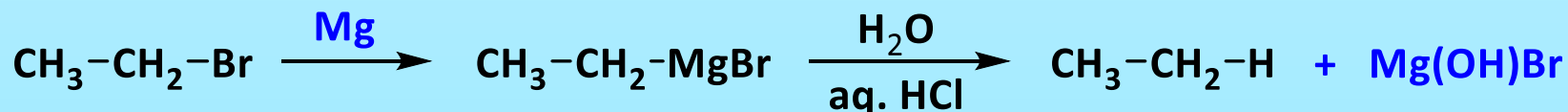
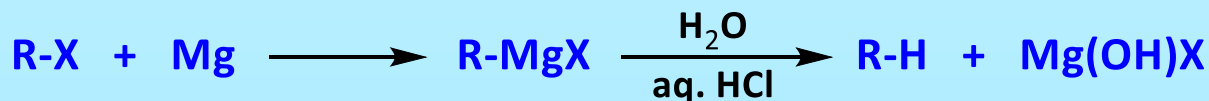
# Some basic reactions - alkanes

- **Reduction of haloalkanes** – alkyl halides are alkanes in which one of the hydrogen atoms has been replaced by a halide atom
- **Most of these compounds react with zinc metal and aqueous acid to produce an alkane**
- **A general and specific reaction are as follows:**



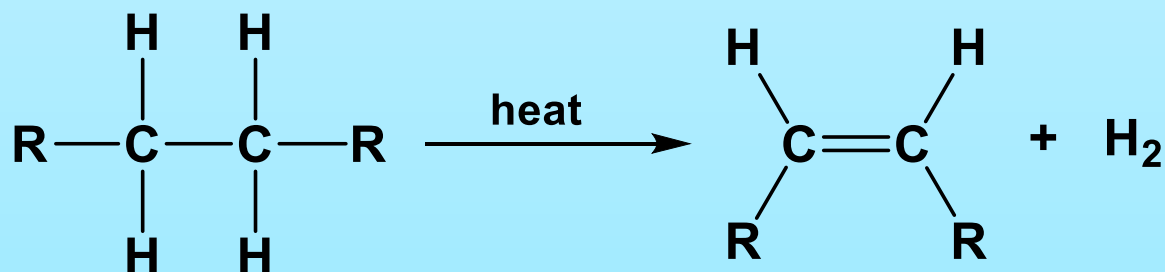
# Some basic reactions - alkanes

- **Grignard reaction** – the Grignard reaction is an organomagnesium halide, which has great application in organic chemistry
- In this reaction it is reacted with water (in the presence of an acid) to produce an alkane
- A general and specific reaction are as follows:



# Some basic reactions - alkenes

- Cracking of alkanes – this is an industrial source of alkene
- Large hydrocarbons in crude petroleum are broken down (cracked) into smaller fragments
- The technique used here is called *pyrolysis* (using heat)



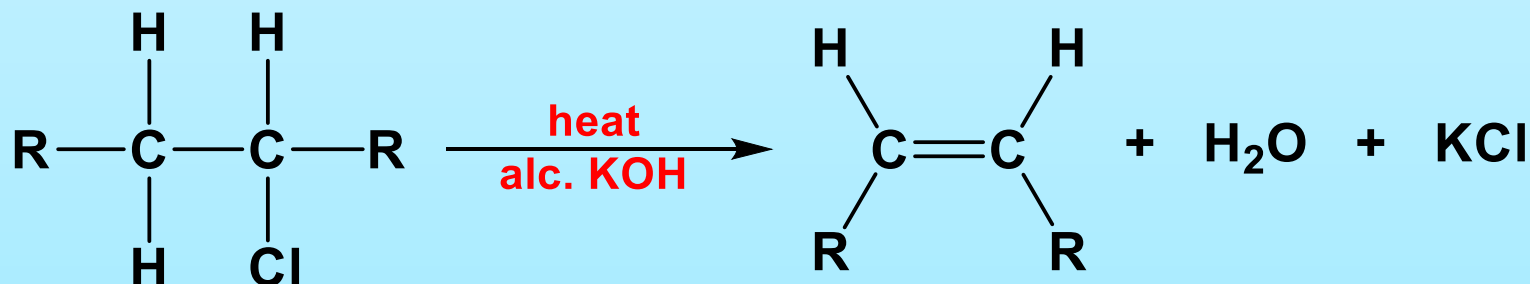


# Some basic reactions - alkenes

- In laboratories, a number of methods have been used to prepare specific alkenes
- A greater majority of alkenes are produced using **ELIMINATION** reactions, i.e. removal of atoms from adjacent carbon atoms resulting in the formation of a double bond
- The main compounds used in these reactions are alcohols and haloalkanes – we will learn more about these in (Haloalkanes) and (Alcohols and ethers ) topics

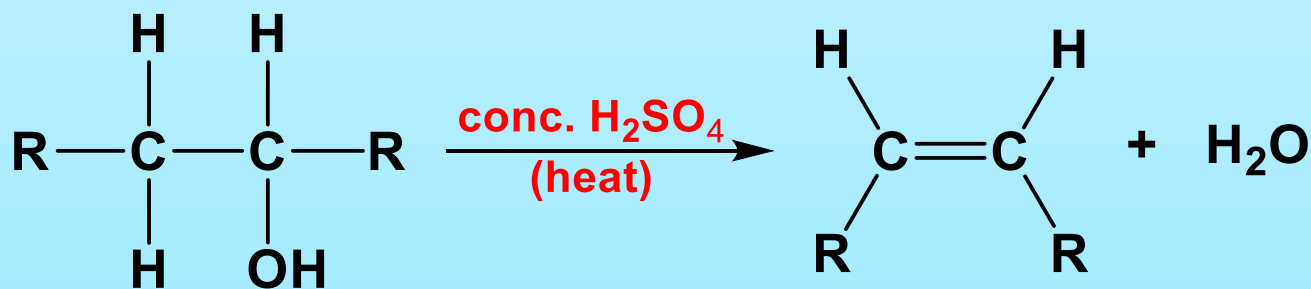
# Some basic reactions - alkenes

- Dehydrohalogenation of haloalkanes is a very popular method for preparing alkenes
- Here the haloalkane is heated in an alcoholic solution of potassium hydroxide resulting in the production of an alkene



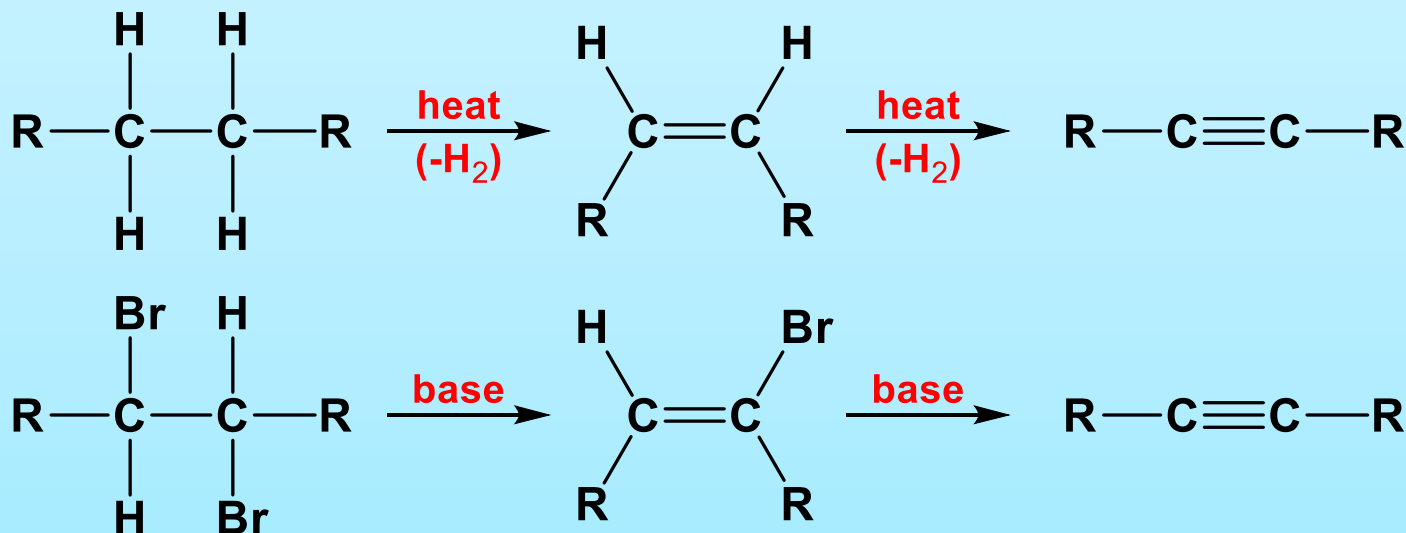
# Some basic reactions - alkenes

- Another method for preparing alkenes involves the dehydration of alcohol
- When most alcohols are heated in the presence of concentrated (excess) sulfuric acid at elevated temperatures, the molecule loses a water molecule and forms an alkene



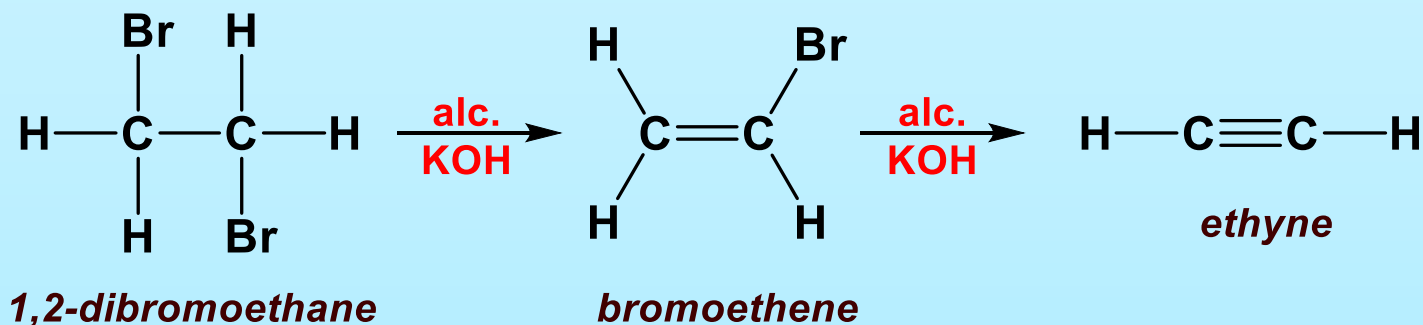
# Some basic reactions - alkynes

- As in the preparation of alkenes, reactions required for the formation of triple bonds also involve elimination reactions, i.e. atoms are removed from adjacent carbon atoms



# Some basic reactions - alkynes

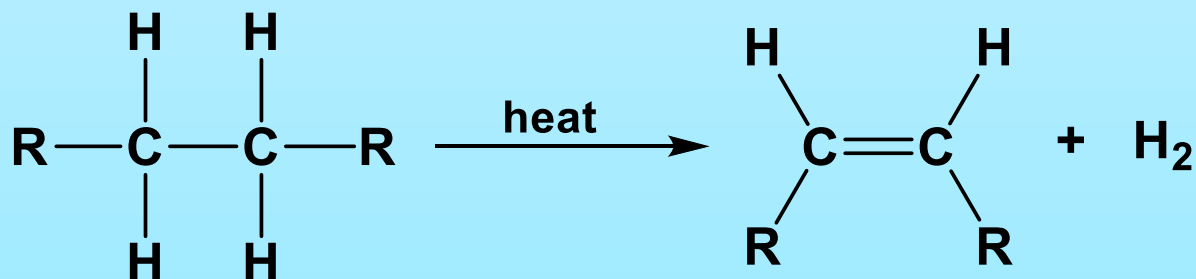
- Ethyne, for example, can be prepared by boiling 1,2-dibromoethane with an alcoholic solution of potassium hydroxide





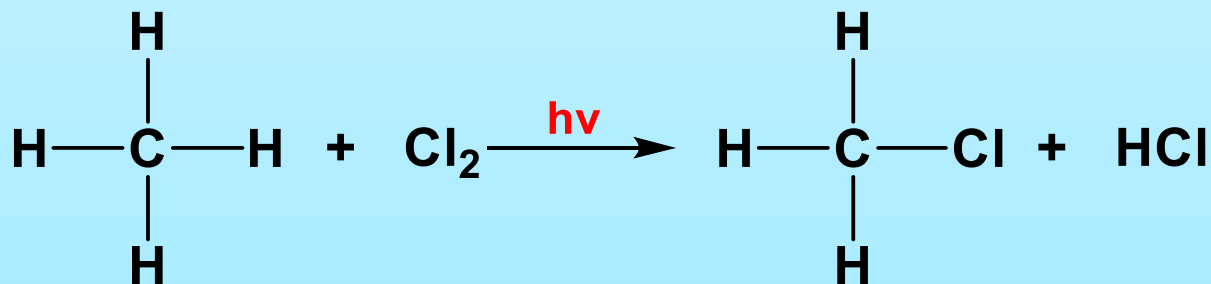
# Basic reaction mechanisms

- You would have realized now that alkanes are considered to be generally classed as being inert (i.e. unreactive)
- This is because the carbon-carbon and carbon-hydrogen bonds are very strong and therefore do not break easily
- As we have seen, they will break only when heated at very high temperatures (pyrolyzed)



# Basic reaction mechanisms

- One reaction of alkanes that does not require high temperatures is the halogenation reaction
- This reaction requires light (UV or sunlight) to proceed and follows a radical mechanism



# Reactions of alkenes

- Alkenes are highly reactive compounds in comparison to alkanes
- The pi electrons in the double bond act as a source of electrons, i.e. it functions as a base or a nucleophile
- They react with electron-deficient species such as acids or electrophiles
- Their reactions are characterized as *electrophilic addition* across the double bond

# Reactions of alkenes

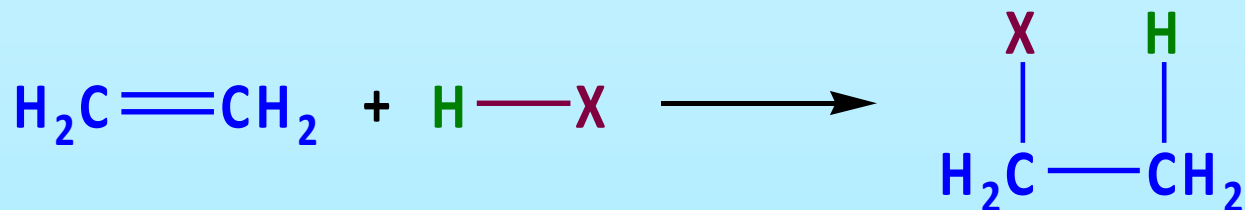
- These reactions can proceed through ionic or free radical mechanisms

## Ionic addition

- Ionic addition across the double bond is initiated by the more electropositive component of the attacking reagent
- It attaches itself to one of the unsaturated carbon atoms and induces a positive charge on the other carbon atom

# Reactions of alkenes

- The resulting transition state contains a positively charged “three valent carbon” which is referred to as a *carbocation* (*carbonium* ion)
- See the following example

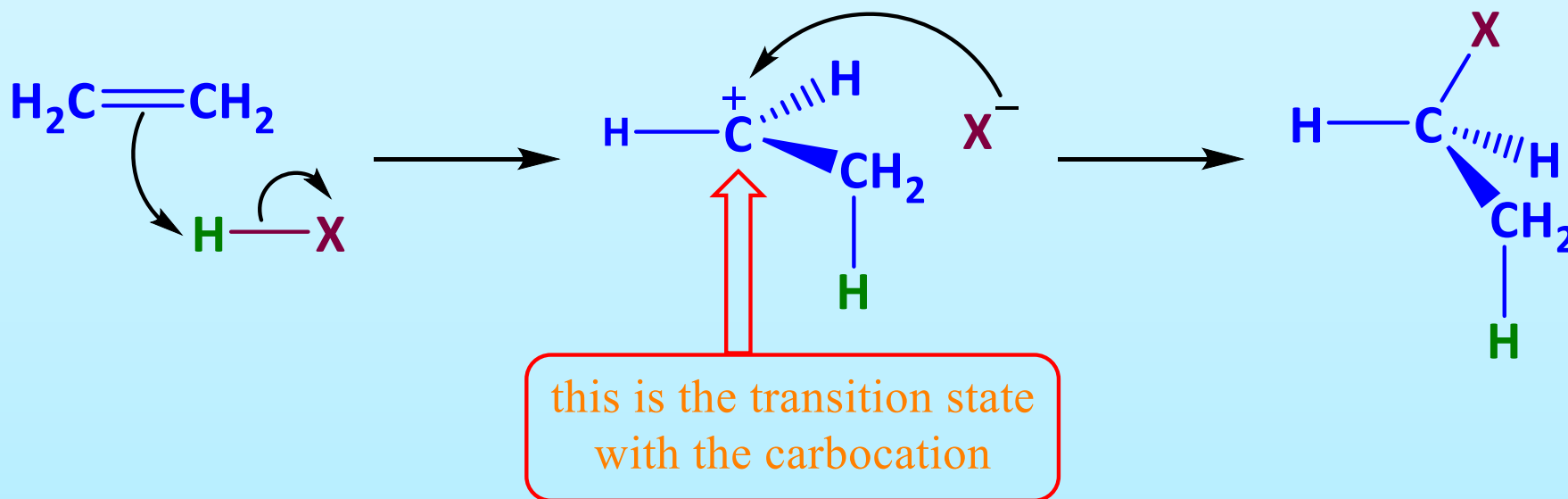


- In theory there are two possible products depending on where the H attaches itself



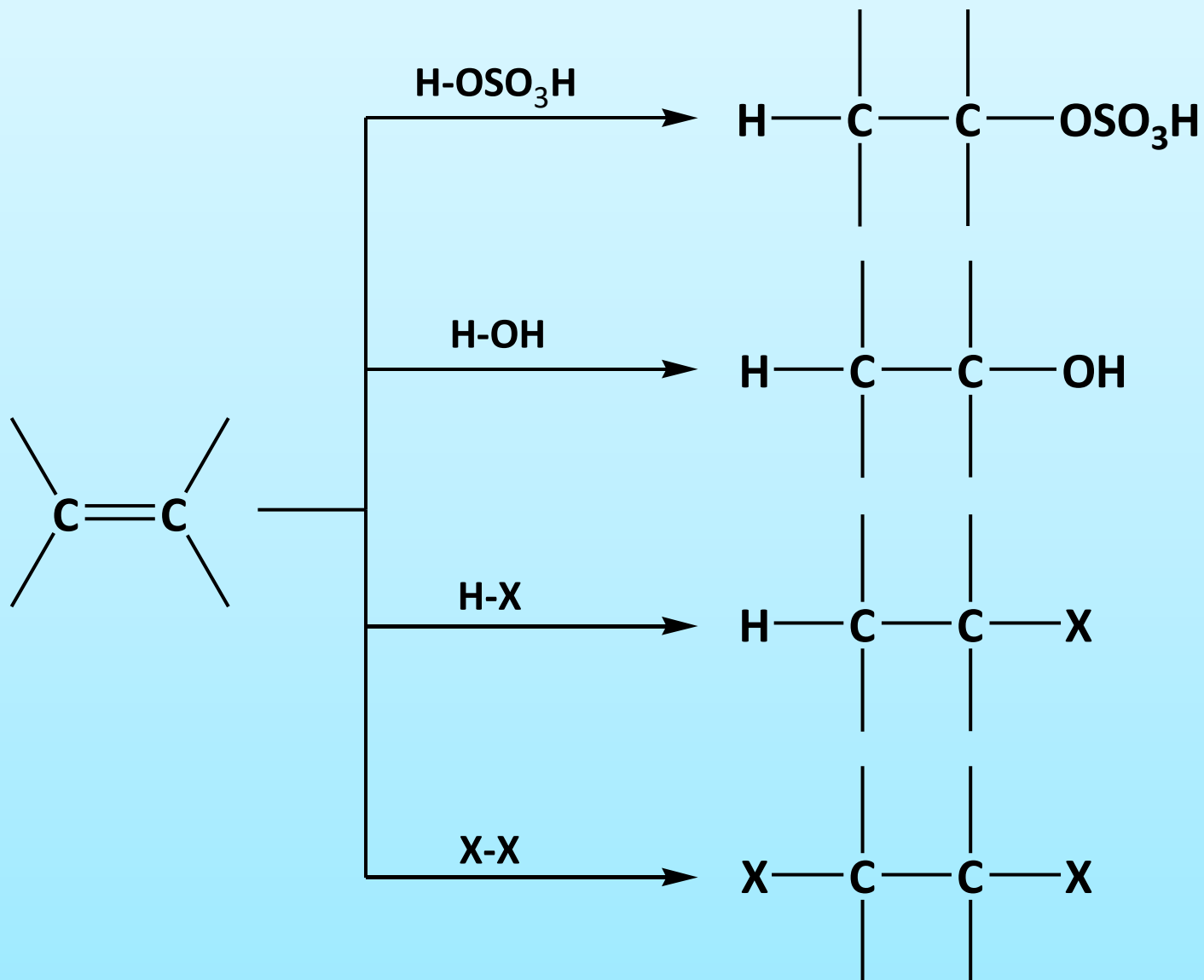
# Reactions of alkenes

## ➤ The resulting transition state



## ➤ Given below are the generic representation of the general ionic addition reactions:

# Reactions of alkenes

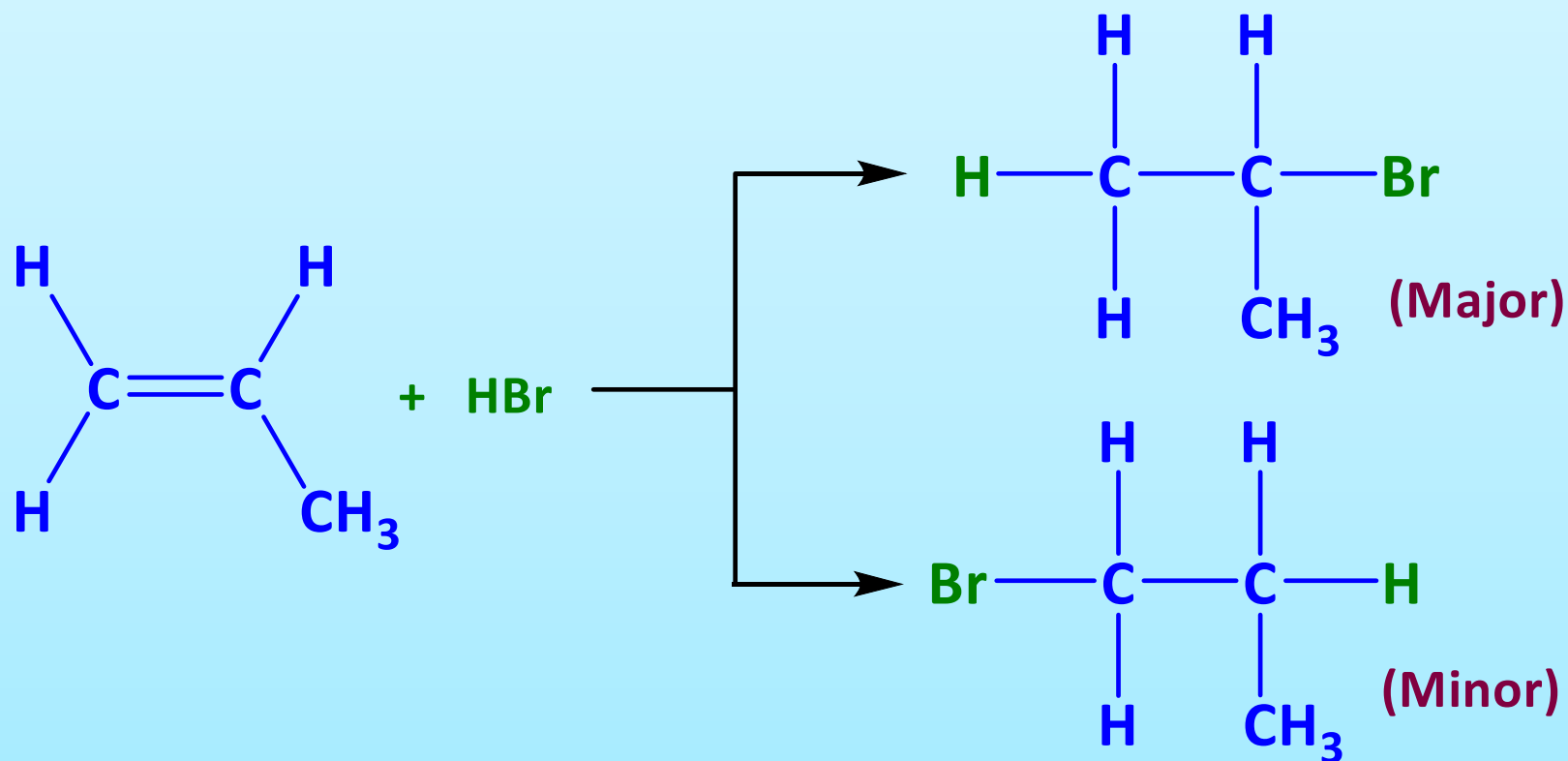


# Reactions of alkenes

- Hydrogen halides (HCl, HBr, HI, HF) add to double bonds of alkenes as shown above
- If one of these is added to an unsymmetrical alkene (like propene), the hydrogen atom (of the H-X) will add to the carbon atom of the double bond that already has the greater number of hydrogen atoms
- This addition is said to be following Markovnikov's rule

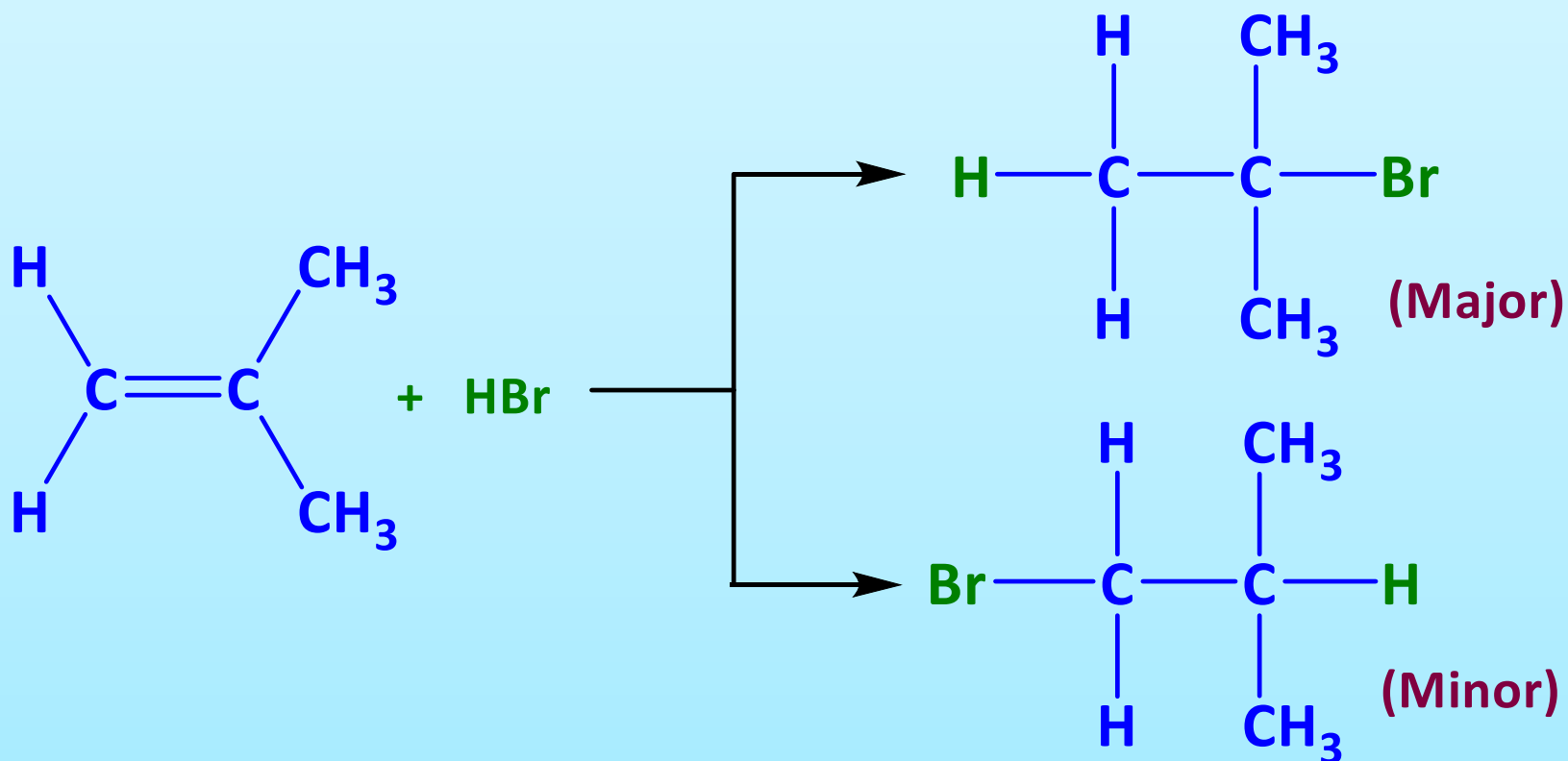
# Reactions of alkenes

## ➤ The Markovnikov's addition – example 1



# Reactions of alkenes

## ➤ The Markovnikov's addition – example 2

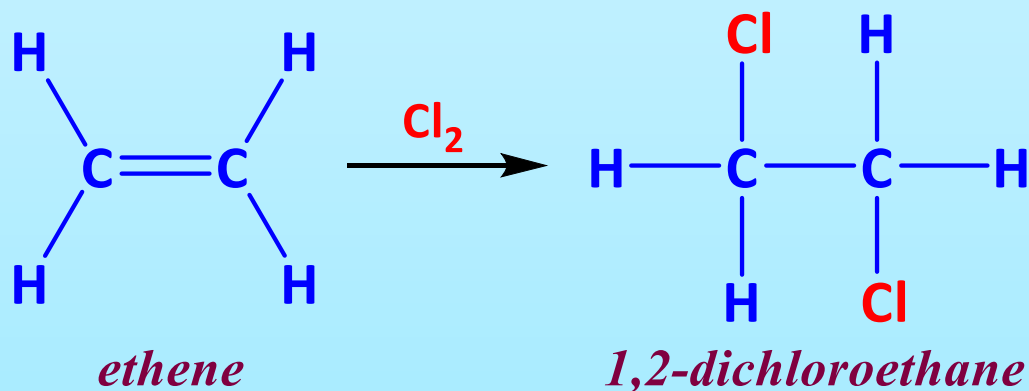




# Reactions of alkenes

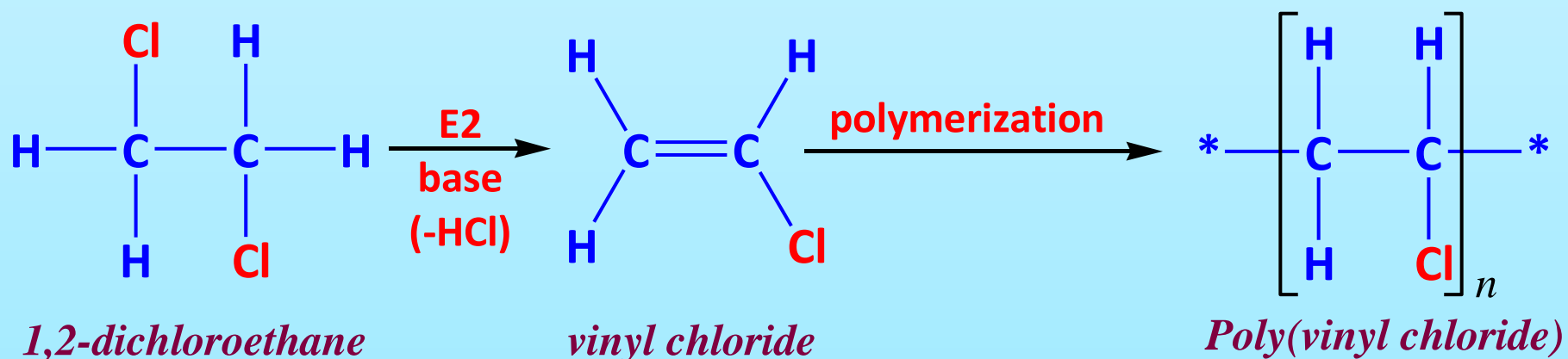
## Addition of bromine and chlorine to alkenes

- Alkenes react rapidly with bromine and chlorine in non-nucleophilic solvents to form vicinal dihalides, i.e. two halide atoms on adjacent carbons



# Reactions of alkenes

- This addition is a useful industrial process because 1,2-dichloroethane can be used as a solvent and can be used to make vinyl chloride which is the starting material for poly(vinyl)chloride [PVC]



# Reactions of alkenes

- Other examples of the addition of halogens to a double bond are as follows:

