Alkenes

Properties of Alkenes

- Alkenes are a **homologous series** of **hydrocarbon molecules**. They are very similar to **alkanes** in that they contain **carbon** and **hydrogen atoms only**.
- like alkanes, that contain only **single bonds**, alkenes contain one or more **double bonds between carbon atoms**. These double bonds are known as **functional groups**.
- A **functional group** is a group of atoms within an hydrocarbon that determine the **chemical properties** and **reactions** of the molecule.
- Due to the double bonds alkenes are referred to as **unsaturated**. This means they can contain carbon atoms with **double bonds**, allowing more atoms to be **added** to them.
- While alkanes which contain **only single bonds** are **saturated**.

Nomenclature of Alkenes

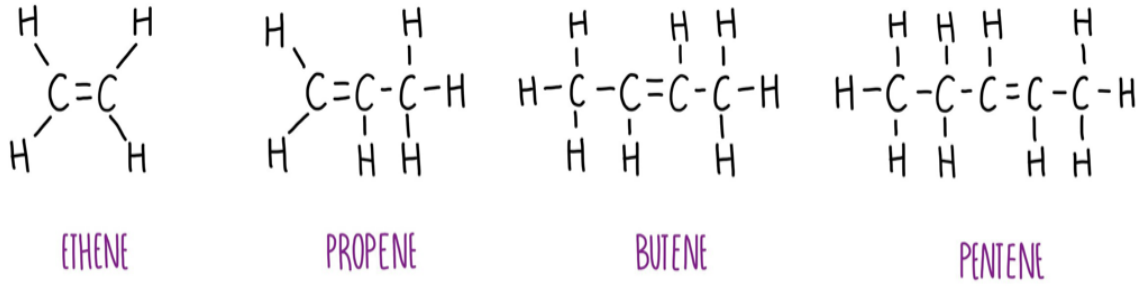
- Alkenes have a similar **nomenclature** alkenes. The first alkenes in the series all have **generic prefixes**; **eth-**, **prop-**, and **but-**, while the rest having **numerical prefixes** (e.g. pent-, hex-, hep-).
- The **suffix** for alkenes is also similar to that of alkanes. To denote an alkene we use the suffix **-ene**.

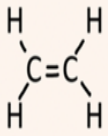
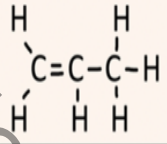
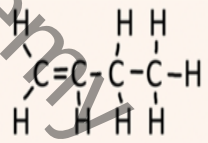
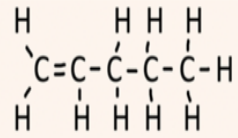
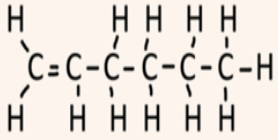
Molecular Formulae of Alkenes

- All alkenes have a molecular formula that will fit the following general pattern
- Alkene General Formula. **CnH2n**
- To use the general formula, replace n in the general formula with the number of C (carbon) atoms.
  eg. An alkene compound with 3 carbon atoms:

$$C_nH_{2n}$$
$$= C_{(3)}H_{2(3)}$$
$$= C_3H_6$$

- Here is some examples of Alkenes structure



n	Name	Molecular formula	Condensed formula	Displayed formula
1				
2	Ethene	C_2H_4	$H_2C{=}CH_2$	
3	Propene	C_3H_6	$H_2C{=}CHCH_3$	
4	But-1-ene	C_4H_8	$H_2C{=}CHCH_2CH_3$	
5	Pent-1-ene	C_5H_{10}	$H_2C{=}CH(CH_2)_2CH3$	
6	Hex-1-ene	C_6H_{12}	$H_2C{=}CH(CH_2)_3CH3$	

Incomplete Combustion by Alkenes

- When alkenes are burnt in oxygen, they often undergo **incomplete combustion**. Incomplete combustion happens when a hydrocarbon compound is burnt **without enough oxygen** to ensure **complete combustion**. When alkenes undergo complete combustion they produce **water** and **carbon dioxide**.

- When alkenes undergo incomplete combustion, a **carbon dioxide** and **water** are still produced, but in addition to these, **carbon soot** and **carbon monoxide** are also produced.

$$C_8H_{10} + 5O_2 \rightarrow 2CO + 2CO_2 + 4H_2O$$

- Carbon monoxide is a **poisonous gas** and can lead to deaths if inhaled in large quantities. The incomplete combustion of an alkene is a much less **exothermic** process than complete combustion producing a **smoky** and **yellow** flame.

Note: It is possible to construct balanced equations for the incomplete combustion of alkenes, for example the incomplete combustion of butene is as follows:

Alkene Reactions

- Alkenes are able to undergo a range of **chemical reactions** due to their **unsaturated** nature.
- Unsaturated hydrocarbons are able react to as they have the space to accommodate **new atoms** in their structure.

Addition reaction

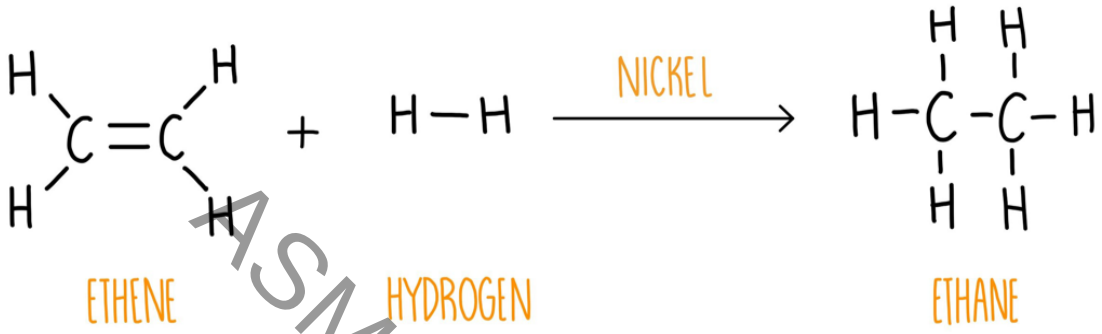
- Alkenes undergo a number of reactions that are collectively know as **addition reactions**. In an addition reaction, the double bond of an alkene is **opened up** and to form a **single carbon-carbon bond** and **one or more single bonds to other elements**:
- **Type of addition reaction**

There are generally **three** types of addition reactions

1. **Hydrogenation**
2. **Steam reactions**
3. **Halogen reactions**.

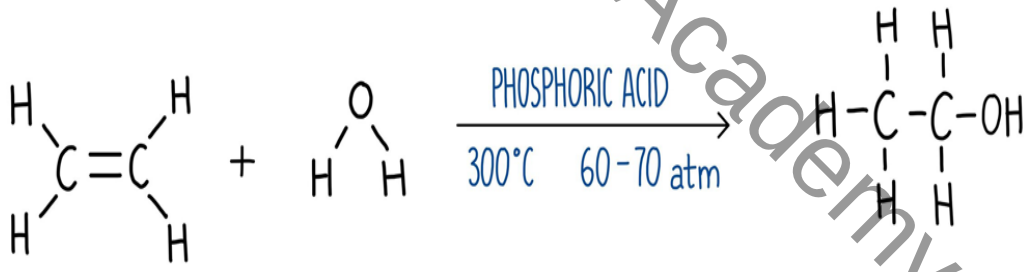
1. Hydrogenation

When **hydrogen** is added to an alkene the addition is called a **hydrogenation reaction**. In the presence of a catalyst the H2 molecule is able to **react with the double bond** of the alkene and open it up. This frees up **two bonds** on each carbon, allowing **two new bonds** to form between carbon and hydrogen atoms. This results in the formation of a **saturated alkane chain**.



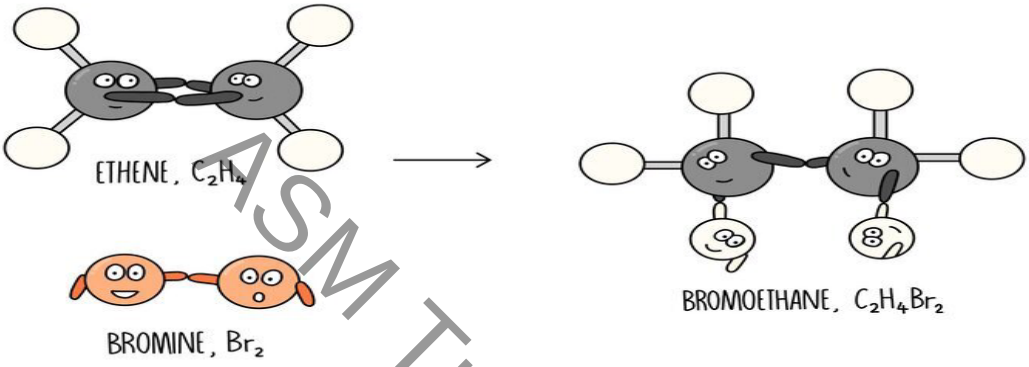
2. Steam Reactions or Hydration

Alkenes can also react with **water** in **gaseous form**. When steam reacts with alkenes, the double bond is opened. The molecule then gains **two new hydrogen atoms** and a new functional group called an **alcohol**. This process is also known as hydration.



3. Halogen Reactions

Finally, alkenes can react with **halogens** (group 7 of the periodic table) to form **saturated molecules** that contain atoms of the halogen. An example of one of these addition reactions is shown above. In this case, propene reacts with bromine to form a new molecule called **dibromopropane**



Testing of Alkenes

- The ability of alkenes to react with **halogens** means that they can be identified in solutions using **chemical tests**. Solutions of halogens are often **coloured** and by observing the change in colour when they react which substances, we can deduce if alkenes are present in said substance.

- The most common halogen used to test for alkenes is **bromine**. Bromine exists as an **orange liquid** at **room temperature** and so it can be easily used in chemical tests.

Bromine test:

Procedure:

1. The organic compound to be tested is taken in a test tube.

2. Dissolve it in 2ml of distilled water.

3. Add bromine water drop wise with constant shaking.

4. If the orange red colour of bromine disappears then the given organic compound is unsaturated (Alkenes having double bond is present). If the colour of bromine persists then the given organic compound is saturated (alkanes having single bond)

Observation:

If the solution turns from **orange to colourless**, alkenes **are present**.