CHAPTER

12

Hydrocarbons

Animation 12.1: *Hydrocarbons*
Source & Credit: *chemwiki*

Students Learning Outcomes

Students will be able to:

- Explain why a systematic method of naming chemical compounds is necessary. (Analyzing);
- Characterize a hydrocarbon. (Understanding);
- Distinguish between saturated and unsaturated hydrocarbons. (Understanding);
- Name of alkanes upto decane. (Remembering);
- Draw electron cross and dot structures of simple alkanes. (Applying);
- Write a chemical equation to show the preparation of alkanes from hydrogenation of alkenes and alkynes and reduction of alkyl halides (Remembering);
- Draw structural formulae of alkanes, alkenes and alkynes upto 5 carbon atoms (Understanding);
- Write a chemical equation to show the preparation of alkenes from dehydration of alcohols and dehydrohalogenation of alkyl halides (Remembering);
- Write a chemical equation to show the preparation of alkynes from dehalogenation of 1,2- dihalides and tetrahalides (Remembering);
- Write chemical equations showing halogenation for alkanes, alkenes and alkynes (Remembering) and
- Write a chemical equations showing reaction of $KMnO_4$ with alkenes and alkynes (Remembering);

Introduction:

The simplest class of organic compounds is hydrocarbons (compounds consisting of only carbon and hydrogen elements). Carbon is the only element capable of forming stable, extended chains of atoms bonded through single, double, or triple bonds. Hydrocarbons are divided into four general classes, depending upon the nature of bonds present in their molecules. These are alkanes, alkenes, alkynes and aromatics. Each carbon atom of a hydrocarbon has four bonds.

Hydrocarbons are further classified as saturated and unsaturated. The members of these classes have different chemical properties because of different nature of bonds present in them. However, their physical properties are similar because of comparable electronegativities of carbon and hydrogen. Thus, they are almost nonpolar and insoluble in water. They dissolve readily in non polar solvents. They are gases or volatile liquids and their volatility decreases with the increase of molecular mass. That is the reason low molecular mass hydrocarbons are gases at room temperature, such as: CH_4 and C_2H_6. Moderate molecular mass hydrocarbons are liquids, such as, C_6H_{14}; while higher molecular mass hydrocarbons are solids.

Fossil fuels are hydrocarbons. They are not only major sources of energy but also are raw materials used to make thousands of consumer products. Hydrocarbons are the starting materials for the synthesis of organic chemicals of commercial importance. These chemicals are essential for making plastics, synthetic rubbers, synthetic fibres and fertilizers, etc.

Hydrocarbons

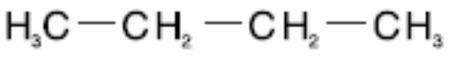
Hydrocarbons are those compounds which are made up of only carbon and hydrogen elements. Hydrocarbons are regarded as the parent organic compounds since other organic compounds are considered to be derived from them by the replacement of one or more hydrogen atoms by other atoms or group of atoms.

Types of Hydrocarbons

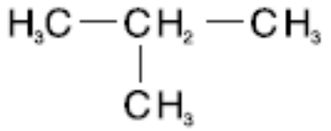
On the basis of structure, hydrocarbons are divided into two main classes:

(i) Open chain or Aliphatic hydrocarbons: These are the compounds in which the first and the last carbon are not directly joined to each other. The open chains of carbon may be straight or branched.

For example



Straight chain (*n*-butane)



Branched chain (isobutane)

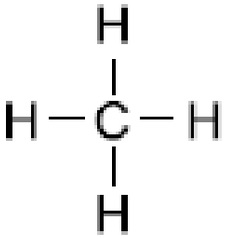
Types of open chain hydrocarbons

Open chain hydrocarbons have been further subdivided into saturated and unsaturated hydrocarbons.

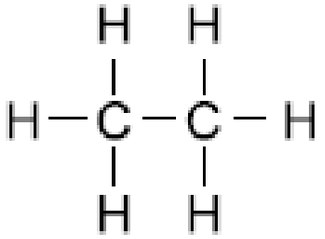
(a) Saturated hydrocarbons

The hydrocarbon in which all the four valencies of carbon atoms are fully satisfied (saturated) by single bonds with other carbon atoms and hydrogen atoms are called saturated hydrocarbons. Saturated hydrocarbons are also called alkanes. Thus, an alkane is a hydrocarbon in which the carbon atoms are connected by only single covalent bond (there are no double or triple covalent bonds in alkanes).

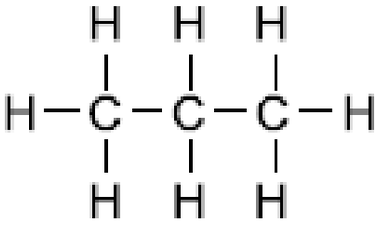
Methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) are all saturated hydrocarbons because they contain only carbon-carbon single bonds, as shown below:



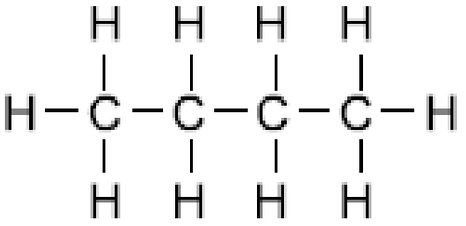
Methane



Ethane



Propane

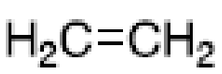


Butane

The general formula of saturated hydrocarbons is CnH_{2n+2} , where n is the number of carbon atoms in one molecule of the alkane.

(b) Unsaturated hydrocarbons:

The hydrocarbons in which two carbon atoms are linked by a double or a triple bond are called unsaturated hydrocarbons. The compounds in which two carbon atoms are linked by a double bond are called alkenes. For example, ethene and propene.

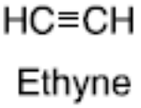


Ethene

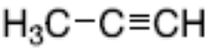
Propene

These compounds have general formula C_nH_{2n} and functional group >C= C<.

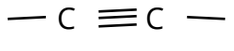
The hydrocarbons in which two carbon atoms are linked by a triple bond are called alkynes. For example, ethyne and propyne.



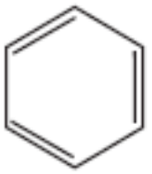
Ethyne



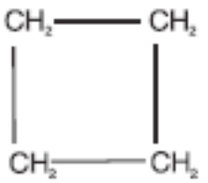
Propyne

They have general formula C_nH_{2n-2} and functional group 

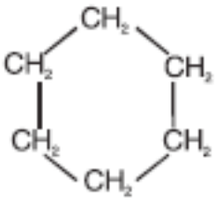
(ii) Closed chain or Cyclic hydrocarbons: Compounds having rings of carbon atoms in their molecules are called closed chain or cyclic hydrocarbons, e.g. benzene (C_6H_6), cyclobutane and cyclohexane.



Benzene



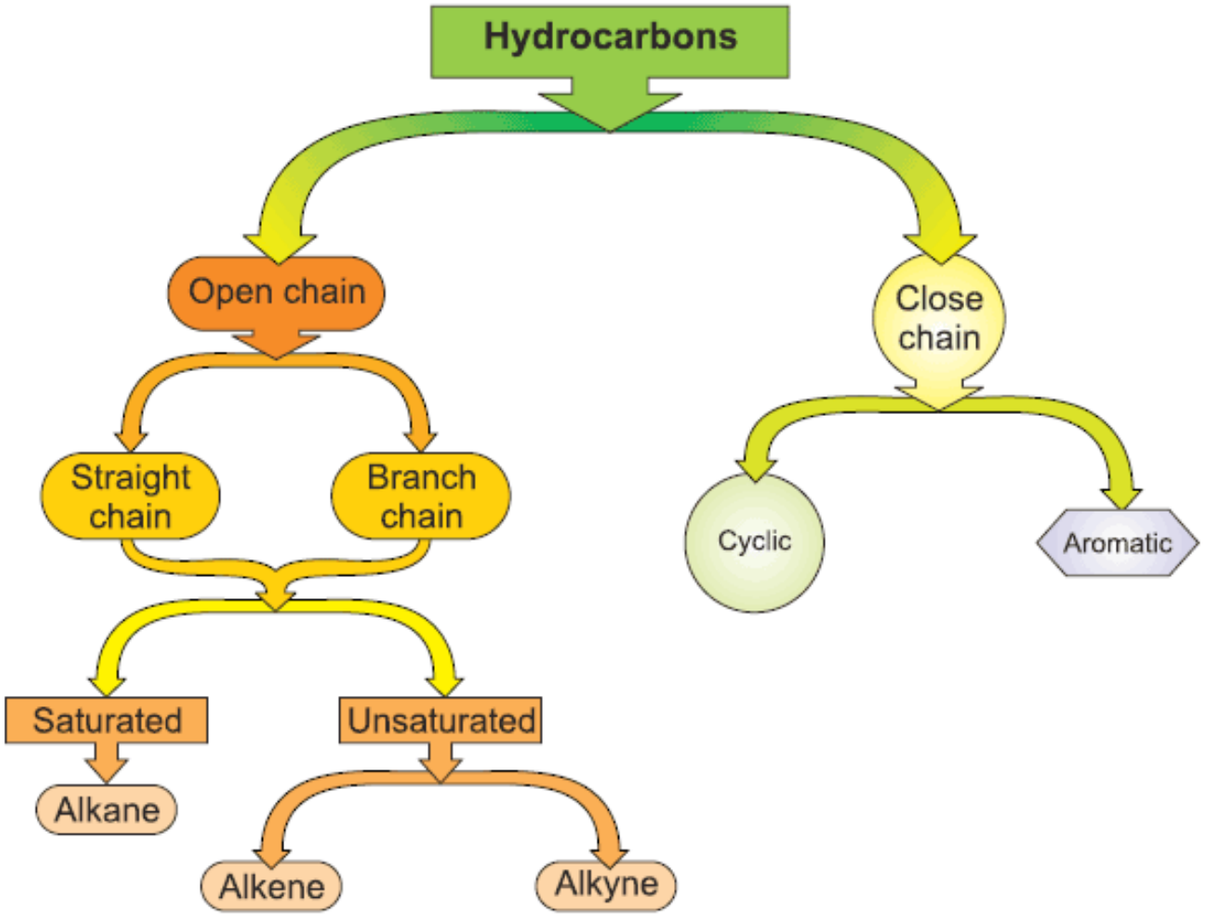
Cyclobutane



Cyclohexane

Test yourself 12.1

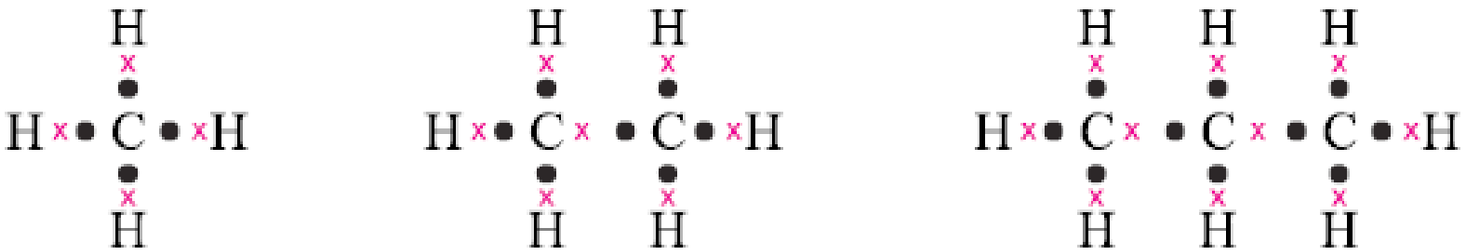
1. Why are hydrocarbons considered as parent organic compounds?
2. What is the difference between a straight and a branched chain hydrocarbons?
3. Give the general formulae of saturated and unsaturated hydrocarbons,
4. Define unsaturated hydrocarbons with examples.



12.1 ALKANES

The simplest hydrocarbons are alkanes. In these compounds, all the bonds of carbon atoms are single that means valencies of carbon atoms are saturated. Therefore, they are least reactive. That is the reason, **alkanes are called paraffins** (para means less, and affins means affinity or reactivity).

Alkanes form a homologous series of compounds in which each successive member of the series differs by a CH_2 group but they have similar structures and similar chemical properties. The first member of the series is methane (CH_4), next ethane (C_2H_6), then next propane (C_3H_8) and so on as given in the previous chapter Table 11.3. The electron cross and dot structures of simple alkanes are presented as follows:



Sources of Alkanes

1.

1. The main sources of alkanes are petroleum and natural gas.
2. Methane forms about 85% of natural gas.
3. All the alkanes are obtained commercially by the fractional distillation of crude petroleum.
4. Marsh gas is formed by the bacterial decay of vegetable matter contains mostly methane.
5. Fuel gases obtained from coal gas contain alkanes in small amounts.
6. Methane occurs in gobar gas, sewage gas and biogas which are formed by the decomposition of cattle dung, excreta and plant wastes.

12.1.1 Preparation of Alkanes

As we know, alkanes form a series of homologous compounds. So, their methods of preparation and chemical properties are similar. Although, there are many methods of preparation, but only two methods are discussed here.

12.1.1.1 Hydrogenation of Alkenes and Alkynes

Hydrogenation *means addition of molecular hydrogen in alkenes and alkynes*. As we know, alkenes and alkynes are unsaturated compounds, so they have the capacity to add up atoms in them. This reaction is carried out in the presence of nickel catalyst at 250 °C to 300 °C. However, in the presence of catalyst platinum or palladium, the reaction takes place at room temperature, such as:

$$H_2C{=}CH_2 + H_2 \xrightarrow[250\text{-}300°C]{Ni} H_3C{-}CH_3$$

Similarly,

$$HC{\equiv}CH + H_2 \xrightarrow[250\text{-}300°C]{Ni} H_2C{=}CH_2$$

$$H_2C{=}CH_2 + H_2 \xrightarrow[250\text{-}300°C]{Ni} H_3C{-}CH_3$$

12.1.1.2 Reduction of Alkyl Halides

Reduction *means addition of nascent hydrogen.* In fact, it is a replacement of a halogen atom with a hydrogen atom. This reaction takes place in the presence of Zn metal and HCl.

$$CH_3Br + 2[H] \xrightarrow{Zn/dil.HCl} CH_4 + HBr$$

$$CH_3CH_2Br + 2[H] \xrightarrow{Zn/dil.HCl} CH_3{-}CH_3 + HBr$$

Physical Properties of Alkanes.

1. Alkanes form a homologous series of compounds. First four members of the series are gases. The alkanes consisting of C_5 to C_{10} are liquids while higher members of the series are solids.
2. They are nonpolar, therefore, they are insoluble in water but soluble in organic solvents.
3. The density of alkanes increases gradually with the increase of molecular size.
4. The melting and boiling points of alkanes increase regularly with the increase of molecular sizes. This is because of increase of attractive forces between the molecules of alkanes.
5. The alkanes become more viscous as their molecular sizes increase.
6. Alkanes become less flammable, i.e. more difficult to burn with the increase of molecular sizes.

12.1.2 Chemical Reactions

Alkanes are least reactive compounds being saturated hydrocarbons. However, they give reactions at high temperatures. Here we will discuss only two reactions of alkanes.

12.1.2.1 Halogenation

Alkanes give only substitution reactions. A reaction in which one or more hydrogen atoms of a saturated compound are replaced with some other atoms (like halogen) is called a substitution reaction. These reactions are a characteristic property of alkanes. Alkanes react fairly with halogens in diffused sunlight only. In dark there is no reaction. In direct sunlight, reaction is explosive and carbon is deposited.

$$CH_4 + 2Cl_2 \xrightarrow{\text{bright sunlight}} C + 4HCl$$

In diffused sunlight, a series of reactions take place and at each step one hydrogen atom is substituted by halogen atoms, so that all the hydrogen atoms are substituted one by one by halogen atoms.

$$CH_4 + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} CH_3Cl + HCl$$

Chloromethane

$$CH_3Cl + Cl_2 \xrightarrow{\text{sunlight}} CH_2Cl_2 + HCl$$

Dichloromethane

$$CH_2Cl_2 + Cl_2 \xrightarrow{\text{sunlight}} CHCl_3 + HCl$$

Trichloromethane
(Chloroform)

$$CHCl_3 + Cl_2 \xrightarrow{\text{sunlight}} CCl_4 + HCl$$

Tetrachloromethane
(Carbon tetrachloride)

12.1.2.2 Combustion

Alkanes burn in the presence of excess of air or oxygen to produce a lot of heat, carbon dioxide and water. This reaction takes place in automobile combustion engines, domestic heaters and cooking appliances. It is highly exothermic reaction and because of it alkanes are used as fuel.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{heat}$$

In the limited supply of oxygen, there is incomplete combustion. As a result, carbon monoxide is produced that creates suffocation and causes death.

$$3CH_4 + 2O_2 \longrightarrow 2CO + 2H_2O + \text{heat}$$

Uses of Methane and Ethane

(i) Natural gas that is chiefly methane is used as domestic fuel.
(ii) Compressed natural gas (CNG) is used as automobile fuel.

(iii) These gases are used in the manufacture of chemicals such as carbon black, methyl alcohol, ethyl alcohol, chloroform, carbon tetrachloride,formaldehyde and acetaldehyde.

These chemicals are used in daily life, such as carbon black is used in the manufacture of shoe polishes, printers ink and as a filler in rubber industry.Chloroform is used as a solvent for rubber, waxes, etc., and for anaesthesia.
Carbon tetrachloride is used as an industrial solvent and in dry cleaning.

Test yourself 12.2

1. Which is the simplest alkane?
2. Give the structural formula: isopentane and isobutane
3. Why the burning of alkanes require sufficient supply of oxygen?
4. What do you mean by halogenation? Give the reaction of methane with chlorine in bright sunlight.

Interesting Information

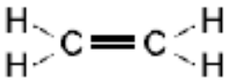
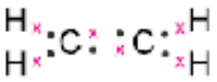
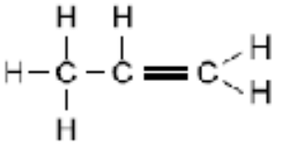
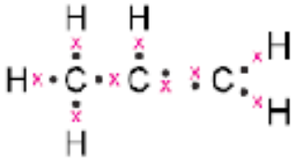
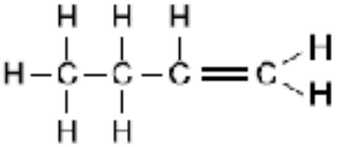
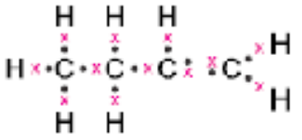
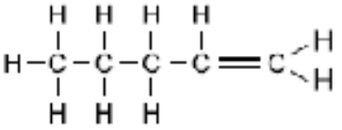
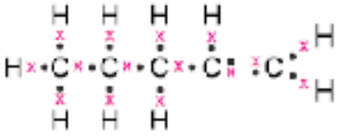
- Poke around with a stick in the muddy bottom of a pond or marsh. You may see bubbles coming up out of the mud. These bubbles are the hydrocarbon gas methane, which is also called 'marsh gas'. If you collect the gas in a jam jar you can set fire to it.
- Orchids produce alkanes to attract bees to pollinate their flowers.

12.2 ALKENES

The simplest alkene is ethene having formula C_2H_4. These compounds are also known as olefins (a Latin word meaning oil forming) because first members form oily products when react with halogens.

A few alkenes with their molecular, condensed, structural and cross and dot formulae are given in **Table 12.1.**

Table 12.1 Molecular, Condensed, Structural and Electronic Formulae of Alkenes

Name	Molecular formula	Condensed formula	Structural formula	Cross and dot formula
(i) Ethylene or ethene	C_2H_4	$H_2C = CH_2$		
(ii) Propylene or propene	C_3H_6	$H_3C - HC = CH_2$		
(iii) Butylene or butene	C_4H_8	$H_3C–H_2C–HC=CH_2$		
(iv) Pentene	C_5H_{10}	$H_3C–CH_2–CH_2CH=CH_2$		

Occurrence

(i) Alkenes being more reactive than alkanes, seldom occur free in nature.

(ii) Lower alkenes occur in coal gas in minute quantities.

(iii) Ethylene is present in natural gas sometimes to the extent of 20%.

(iv) Alkenes are produced in large amounts by cracking of petroleum.

12.2.1 Preparation of Alkenes

Alkenes are prepared by the removal of small atoms (H,OH,X) from the adjacent carbon atoms of the saturated compounds, so as to create a double bond between carbon atoms.

12.2.1.1 Dehydration of Alcohols

Dehydration is removal of water. Ethene is prepared by heating a mixture of ethanol and excess of concentrated sulphuric acid at 180°C. In first step, ethyl hydrogen sulphate is formed which decomposes on heating to produce ethene, which is collected over water.

$$CH_3\text{-}CH_2OH + H_2SO_4 \xrightarrow{180°C} CH_3CH_2\text{-}OSO_3H + H_2O$$

$$CH_3\text{-}CH_2OSO_3H \xrightarrow{heat} H_2C{=}CH_2 + H_2SO_4$$

12.2.1.2 Dehydrohalogenation of Alkyl Halides

On heating, ethyl bromide with alcoholic KOH, ethene is formed. Removal of hydrogen and halogen takes place from adjacent carbon atoms to create a double bond.

$$H_3C\text{-}CH_2\text{-}Br + KOH_{(alcoholic)} \longrightarrow H_2C{=}CH_2 + KBr + H_2O$$

Physical Properties of Alkenes

(i) The first member of the alkenes is ethene. It is a colourless gas with pleasant odour.
(ii) Alkenes are nonpolar, therefore, they are insoluble in water but soluble in organic solvents.
(iii) The first member of the series ethene is slightly less dense than air.
(iv) Alkenes are flammable hydrocarbons.
On complete combustion, they form carbon dioxide and water with release of energy. However, their flame is smokier than alkanes having a similar number of carbon atoms.
(v) Their melting and boiling points gradually increase with the increase of molecular sizes of the compounds in the series.

12.2.2 Chemical Reactions

Alkenes are reactive compounds because the electrons of the double bond are easily available for reaction. These compounds have the tendency to react readily by adding other atoms, to become saturated compounds. As a result, the double bond is converted into a single bond that is more stable. Thus, addition reactions are characteristic property of unsaturated compounds. These are the reactions in which the products are formed by the addition of some reagents like H_2,Cl_2, etc., to an unsaturated organic compound. In the process, one of the bonds of a double bond gets broken and two new single bonds are formed.

12.2.2.1 Hydrogenation of Alkenes

Hydrogenation means addition of molecular hydrogen to an unsaturated hydrocarbon in the presence of a catalyst (Ni, Pt) to form saturated compound.

$$H_2C{=}CH_2 + H_2 \xrightarrow[250\text{-}300^\circ C]{Ni} H_3C{-}CH_3$$

On industrial scale, this reaction is used to convert vegetable oil into margarine (Banaspati ghee).

$$\text{Oil} + H_2 \xrightarrow{Ni} \text{Margarine (Banaspati ghee)}$$

12.2.2.2 Halogenation of Alkenes

Halogenation means addition of halogen like chlorine or bromine. Bromination of alkenes is very important reaction . When bromine water (a solution of bromine in water having red-brown colour) is added to ethene in an inert solvent like carbon tetrachloride, its colour is discharged at once.

$$H_2C{=}CH_2 + Br_2 \longrightarrow Br\text{-}CH_2\text{-}CH_2\text{-}Br$$

In the reaction, double bond of ethene is converted into a single bond by the addition of a molecule of bromine. *This reaction is used to identify the unsaturation of an organic compound.*

12.2.2.3 Hydrohalogenation of Alkenes

Dry gaseous hydrogen halides (HI, HBr and HC1) react with alkenes to produce alkyl halides.

$$H_2C{=}CH_2 + HX \longrightarrow H_3C\text{-}CH_2X$$

$$H_2C{=}CH_2 + HBr \longrightarrow H_3C\text{-}CH_2Br$$

The order of reactivity of hydrogen halides is HI > HBr > HCl

12.2.2.4 Oxidation of Alkenes with $KMnO_4$

Alkenes decolourize the pink colour of acidified dilute solution of potassium permanganate because the double bond electrons react with MnO_4^- ion, which further goes on to form MnO_2 and ethene glycol (1,2-ethanediol). Such as, there is addition of 2 two 'hydroxyl groups' at the double bond.

$$3CH_2{=}CH_2 + 2KMnO_4 + 4H_2O \longrightarrow \underset{\displaystyle OH\ \ OH}{3H_2C{-}CH_2} + 2MnO_2 + 2KOH$$

This reaction is also used to test the unsaturation in an organic compound.

Uses of Ethene (Ethylene)

Ethene is used:

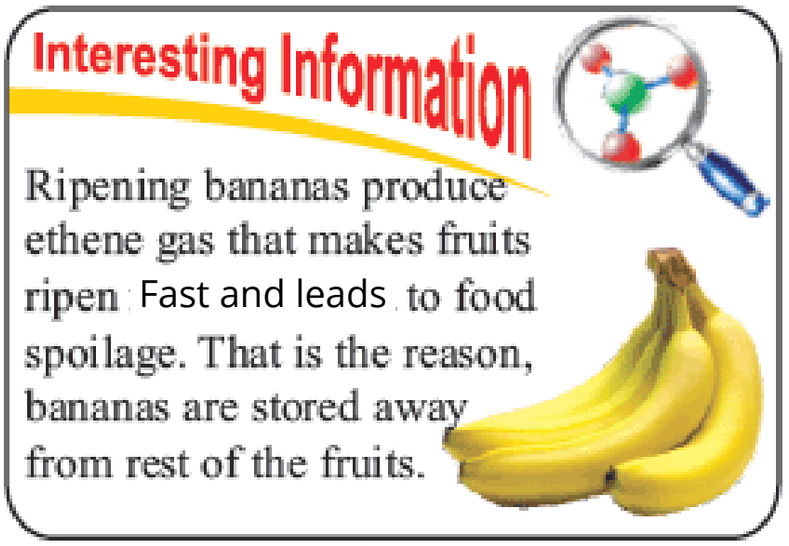
(i) for artificial ripening of fruits;

(ii) as a general anaesthetic;

(iii) for manufacture of polythene: Polythene is a plastic material used in packaging, toys, bags, etc;

(iv) as a starting material for the manufacture of a large number of compounds such as ethylene oxide, ethyl alcohol, ethylene glycol,diethyl ether, etc.; ethylene oxide is used as a fumigant, ethylene glycol is used as an anti-freeze, diethyl ether and ethyl alcohol are used as solvents and

(v) for making poisonous mustard gas which is used in chemical warfare.



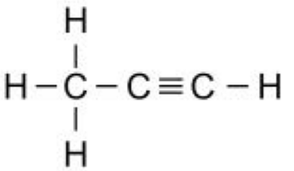
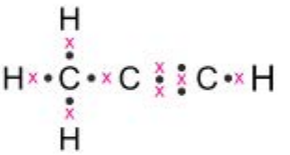
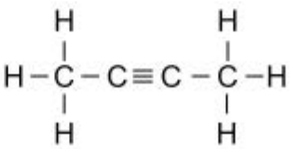
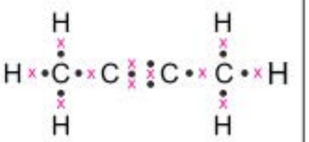
Testyourself 12.3

i. Why are alkenes reactive?
ii. How can you prepare propene from propyl alcohol?
iii. Give a test used to identify unsaturation of an organic compound.
iv. Give a few uses of ethene.

12.3 ALKYNES

The simplest alkyne is acetylene, with molecular formula C_2H_2. Alkynes are also called acetylenes because of the name of the first member of the series is acetylene.
Molecular, condensed, structural and dot and cross formulae of a few alkynes are given in Table 12.2.

Table 12.2 Molecular, Condensed, Structural and Electronic Formulae of Alkynes

Name	Molecular formula	Condensed formula	Structural formula	Cross and dot formula
(i) Acetylene (ethyne)	C_2H_2	$HC \equiv CH$	$H-C \equiv C-H$	
(ii) Methyl Acetylene (propyne)	C_3H_4	$H_3C-C \equiv CH$		
(iii) Dimethyl Acetylene (butyne)	C_4H_6	$H_3C-C \equiv C-CH_3$		

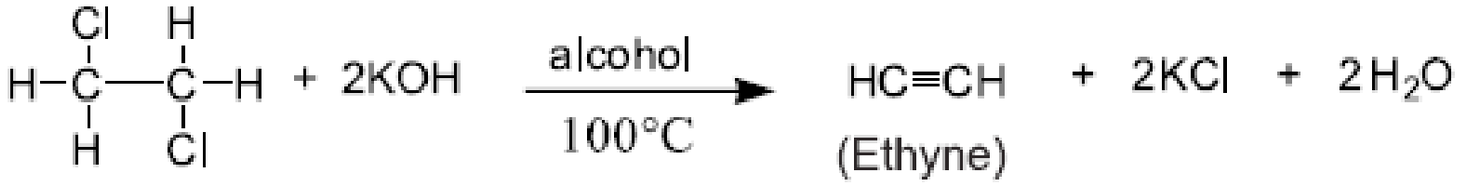
Occurrence: Acetylene does not occur free in nature. Traces of acetylene are present in coal gas (about 0.06%).

12.3.1 Preparation of Alkynes

Alkynes are prepared by the following methods.

12.3.1.1 Dehydrohalogenation of Vicinal Dihalides

When a vicinal dihalide is heated with alcoholic KOH, two hydrogen atoms along with two halogen atoms are removed from two adjacent carbon atoms with the formation of a triple bond between the adjacent carbons:



12.3.1.2. Dehalogenation of Tetrahalides

When alkyl tetrahalides are heated with Zinc dust, the elimination of halogen atoms takes place to form ethyne.

Physical Properties

1. Alkynes also form a series of compounds. Its first member is acetylene. It is a colourless gas with faint garlic odour.
2. Acetylene is slightly soluble in water but soluble in organic solvents such a benzene, alcohol, acetone, ether, etc.
3. Acetylene is slightly lighter than air.
4. Alkynes are also flammable. They produce smokier flames than those of alkanes and alkenes.

12.3.2 Chemical Reactions

Alkynes are reactive compounds because of presence of a triple bond. A triple bond consists of two weak bonds and a strong bond. When alkynes react with other substances, two weak bonds are readily broken one by one and addition takes place easily. The addition reactions of alkynes resemble those of alkenes.

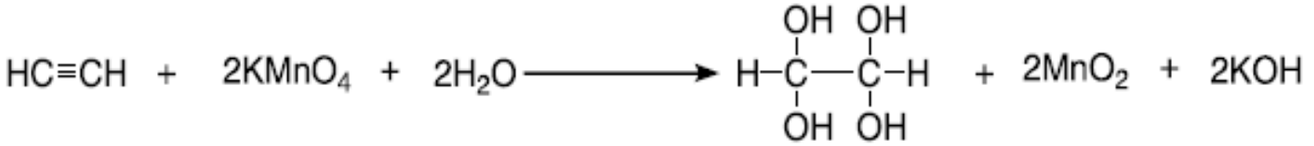
12.3.2.1 Addition of Halogen

Chlorine and bromine adds to acetylene to form tetrachloroethane and tetrabromoethane, respectively. When bromine water is added to acetylene, red-brown colour of bromine water is discharged rapidly due to formation of colourless tetrabromoethane.

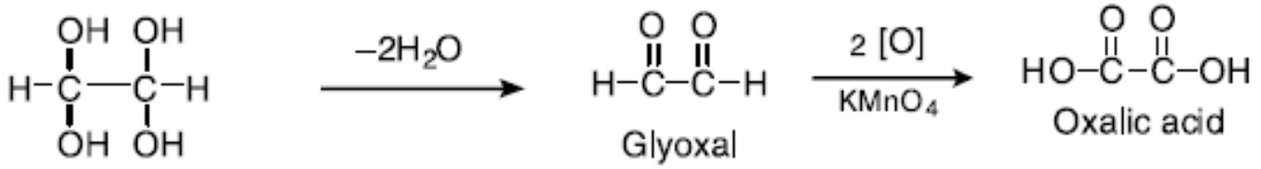
This reaction is used to identify the unsaturation of alkynes.

12.3.2.2 Oxidation with $KMnO_4$.

Ethyne is oxidized by alkaline $KMnO_4$. And four hydroxyl groups add to the triple bond, such as:



This intermediate product eliminates water molecules to form glyoxal, which is further oxidized to form oxalic acid.



Uses of Acetylene

(i) Acetylene produces oxy-acetylene flame with oxygen. It is a highly exothermic reaction. Heat released is used for welding purposes.

(ii) Acetylene is used to prepare other chemicals, such as alcohols, acetaldehyde and acids.

(iii) It is used for the ripening of fruits.

(iv) It is used for the manufacturing of polymer products like polyvinyl chloride, polyvinyl acetate and synthetic rubber like neoprene.

(v) It is polymerized to form benzene, which is used as raw material to form a variety of organic compounds.

Test yourself 12.4

i. Why the alkynes are called acetylenes? ii. How is tetrabromoethane prepared from acetylene? iii. How can you prepare acetylene from tetrachloroethane? iv. What is the difference between glycol and glyoxal? v. Write the formula of oxalic acid.	

Hydrocarbons as Fuel

The main constituents of fuels (coal, petroleum and natural gas) are hydrocarbons. When hydrocarbons are burnt in air the reaction is called combustion. It is highly exothermic reaction, i.e. it produces a lot of heat. The basic combustion reaction is

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + heat$$

The heat energy thus produced is used to meet needs of energy in homes, transportation, as well as in industries.

Hydrocarbons as Feed Stock in Industry

Hydrocarbons are not only used as fuel in automobiles or industries, they also act as raw materials in many industries.

(i) Petrochemical Industry:

The organic compounds prepared from hydrocarbons (petroleum and natural gas) are called petrochemicals. Some of the important petrochemicals are, methyl alcohol, ethyl alcohol, formic acid, chloroform, carbon tetrachloride, ethylene, butadiene, benzene, toluene, etc.

(ii) Plastic Industry:

Hydrocarbons are used as raw materials for the preparation of a large variety of synthetic polymers, called plastics like polythene, polyester. These can be given any shape when soft and on hardening make a durable article to be used in common life. For example, crockery items (cups, glass, jug, plates, spoons) furniture items (chair, table, stool) automobile parts,electric and sewages items and a lot of other household items.

(ii) Rubber Industry:

Hydrocarbons are used to prepare synthetic rubber. Such as, acetylene is used to prepare butadiene rubber used for making footwear, tyres and toys. Similarly, a good quality rubber neoprene is prepared from chloroprene.

(iv) Synthetic fibre Industry:

Hydrocarbons are used to prepare synthetic fibres like nylon, rayon, polyesters. These fibres have better qualities like greater strength, good elasticity, resistance to wear and tear. So clothes made of synthetic fibres are long lasting than that of natural fibres.

(v) Synthetic detergents:

Long chain hydrocarbons obtained from petroleum are used to make synthetic detergents and washing powders. These detergents are sodium salts of alkyl hydrogen sulphate. These detergents have better and stronger cleaning properties than that of soaps. They can be used even in hard water.

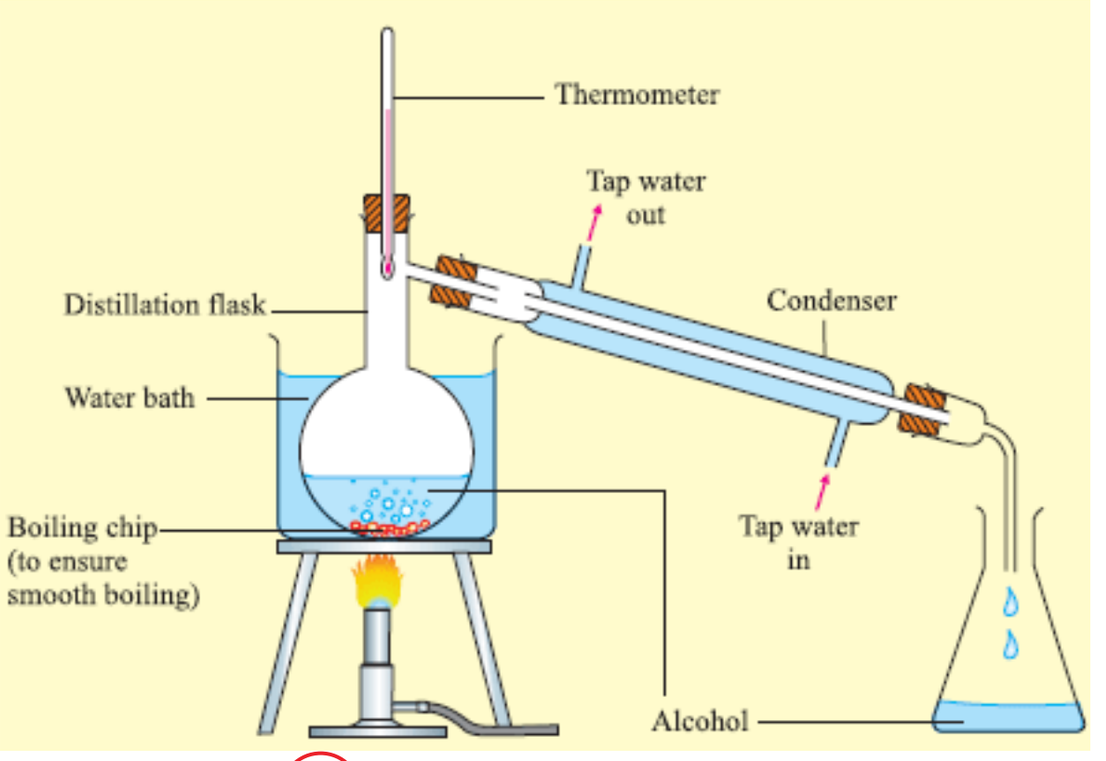
Key Points

- Hydrocarbons are organic compounds of carbon and hydrogen elements. They are alkanes, alkenes and alkynes.
- Open chain hydrocarbons are classified as saturated and unsaturated.
- Saturated hydrocarbons consist of each carbon atom having its tetravalency fully satisfied by single bonds. They are called alkanes and have general formula C_nH_{2n+2}.
- Unsaturated hydrocarbons consist of double and triple bonds. Compounds consisting of double bonds are called alkenes. They have general formula C_nH_{2n}. While compounds consisting of triple bond are called alkynes. They have general formula C_nH_{2n-2}.
- Alkanes are named with respect to number of carbon atoms ending with a suffix 'ane'.
- Alkanes are prepared by hydrogenation of alkenes or alkynes and reduction of alkyl halides.
- The important reactions of alkanes are combustion and halogenation. Combustion of alkanes produce a lot of energy that is the reason alkanes are used as fuel.
- Alkenes are prepared by dehydration of alcohols and dehydrohalogenation of alkyl halides.
- Alkenes give important reactions like halogenation and oxidation. Oxidation of alkene produces important compound, glycol.
- Alkynes are prepared by the dehydrohalogenation of vicinal dihalides and dehalogenation of tetrahalides.
- Important reaction of acetylene is oxidation that produces oxalic acid.

SKILLS:

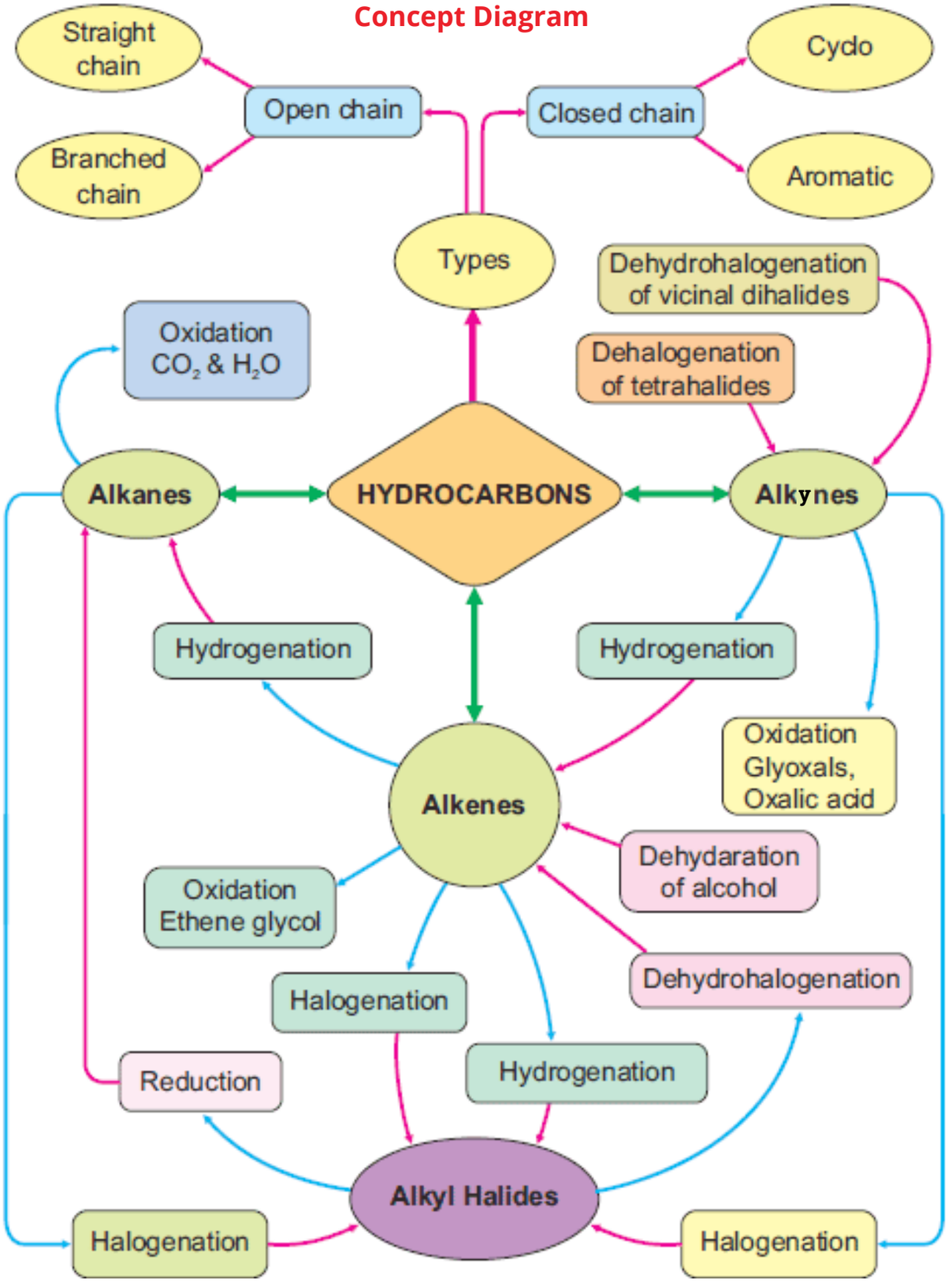
Boiling point of alcohol

The boiling point of an alcohol (ethyl alcohol) at normal atmospheric pressure can be determined by using a set up as shown in figure.



When alcohol is heated, temperature rises up until it reaches upto 78°C. From there onward, even the heating process goes on but the temperature remains constant. This is the boiling point of alcohol. It is to be noted that temperature does not change during the boiling process.

Concept Diagram



Short Questions

1. Differentiate between saturated and unsaturated hydrocarbons.
2. A compound consisting of four carbon atoms has a triple bond in it. How many hydrogen atoms are present in it?
3. Why are the alkanes called 'paraffins'?
4. What do you know about hydrogenation of alkenes?
5. How are alkyl halides reduced?
6. Why are the alkanes used as fuel?
7. How can you prepare ethene from alcohol and ethyl bromide?
8. Identify propane from propene with a chemical test.
9. Why are the alkenes called 'olefins'?
10. Why alkane can't be oxidized with $KMnO_4$ solution?
11. What are the addition reactions? Explain with an example.
12. Justify that alkanes give substitution reactions.
13. Both alkenes and alkynes are unsaturated hydrocarbons. State the one most significant difference between them.
14. Write the molecular, dot and cross and structural formula of ethyne.
15. Why are hydrocarbons soluble in organic solvents?
16. Give the physical properties of alkanes.
17. How can you identify ethane from ethene?
18. Why colour of bromine water discharges on addition of ethene in it?
19. State one important use of each:

    (i) Ethene (ii) Acetylene

    (iii) Chloroform (iv) Carbon tetrachloride

Extensive Questions:

1. What type of reactions are given by alkanes? Explain with reference to halogenations of alkanes.
2. Alkanes are a source of heat. Explain it.
3. Prepare the following as directed:

    (i) ethane from ethene;

    (ii) acetylene from tetrahalide;

    (iii) carbon tetracholride from methane;

    (iv) ethylene glycol from ethene;

    (v) 1,2-dibromoethane from ethene and

    (vi) glyoxal from acetylene

4. Explain the oxidation of acetylene.

5. Write balanced chemical equations for the following reactions. Also, name the products that are formed.

(i) A mixture of ethyne and hydrogen is passed over heated nickel

(ii) Ethyne is treated with chlorine

(iii) Ethyne is burnt in air

(iv) Ethyne is passed through bromine water

6. Explain briefly:

(i) Why butane undergoes substitution reactions?

(ii) There are millions of organic compounds.

(iii) Acetylene undergoes addition reactions in two stages.

(iv) Alkynes are more reactive than alkanes.