

# Hydrocarbons

## Long Answer Questions

**Q.1** What are hydrocarbons? Give their different classes depending upon their structure.

**Ans. 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 replacement of one or more hydrogen atoms by other atoms or group of atoms.

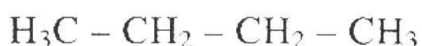
### Classification of Hydrocarbons

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

#### (i) Open chain or Aliphatic hydrocarbons

These are 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.

**Examples;**



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

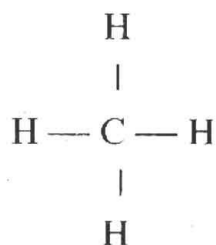
The compounds in which all the four valencies of carbon atoms are fully satisfied (saturated) by single bonds with other carbon atoms and hydrogen atoms are called saturated hydrocarbons. Saturated hydrocarbons are also called alkanes.

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).

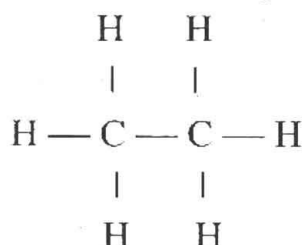
**Examples:**

Methane ( $\text{CH}_4$ ), ethane ( $\text{C}_2\text{H}_6$ ), propane ( $\text{C}_3\text{H}_8$ ) and butane ( $\text{C}_4\text{H}_{10}$ ) are all saturated

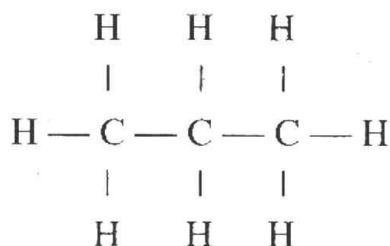
hydrocarbons because they contain only carbon-carbon single bonds, as shown below:



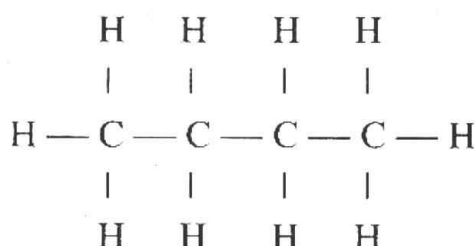
Methane



Ethane



Propane



Butane

### General Formula of Alkanes;

The general formula of alkanes is  $\text{C}_n\text{H}_{2n+2}$ , where  $n$  is the number of carbon atoms in one molecule of the alkane.

### (b) Unsaturated hydrocarbons:

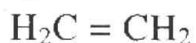
The hydrocarbons in which two carbon atoms are linked by a double or a triple bond are called unsaturated hydrocarbons.

#### Alkenes;

The compounds in which two carbon atoms are linked by a double bond are called alkenes.

#### Examples;

Ethene and propene.



Ethene



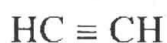
Propene

### General Formula;

These compounds have general formula  $\text{C}_n\text{H}_{2n}$  and functional group  $\text{>C}=\text{C}<$

#### Alkynes;

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



Ethyne



Propyne

### General Formula;

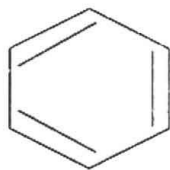
They have general formula  $\text{C}_n\text{H}_{2n-2}$  and functional group  $-\text{C} \equiv \text{C}-$

(ii) **Closed chain or Cyclic hydrocarbons:** Compounds having closed chain or rings of carbon atoms in their molecules are called closed chain or cyclic hydrocarbons,

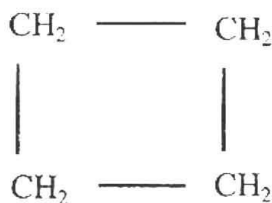
**Examples;**

Benzene ( $C_6H_6$ ), cyclobutane and cyclohexane.

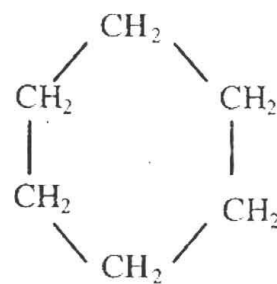
**Structures;**



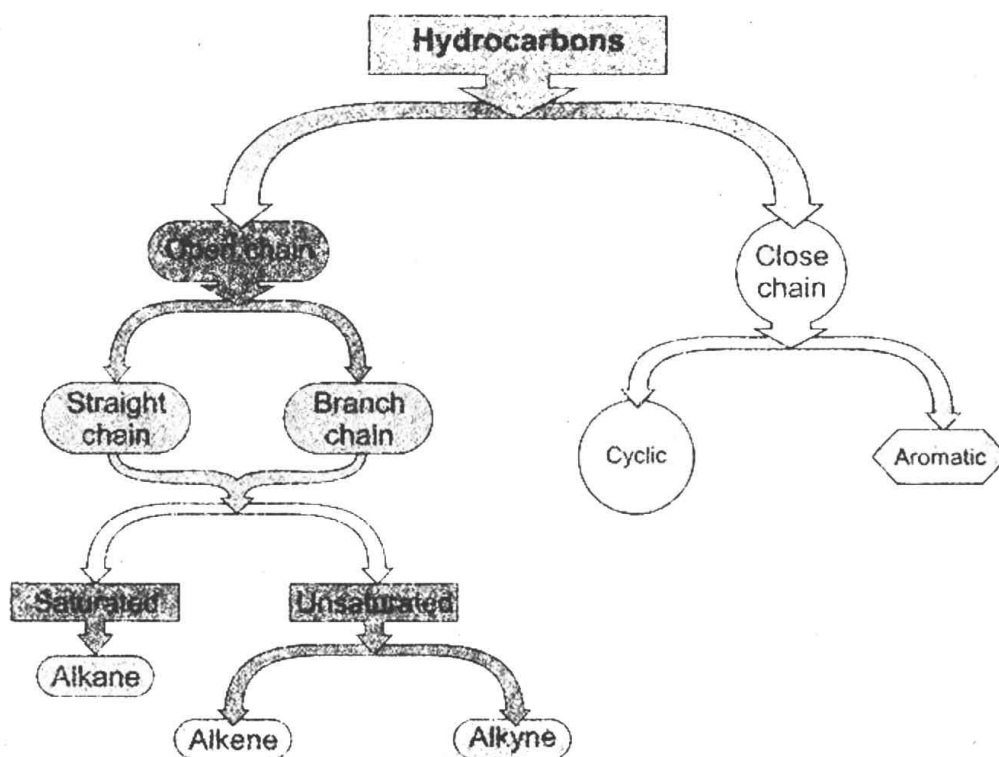
Benzene



Cyclobutane



Cyclohexane



## Q.2 Write the preparation of Alkanes

**Ans.** 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.

### (i) Hydrogenation of alkenes and alkynes

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

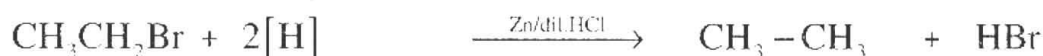


Similarly,



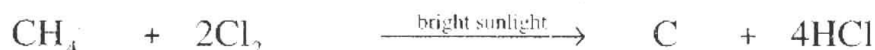
## (ii) Reduction of alkyl halides

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.



## Q.3 What type of reactions are given by alkanes? Explain with reference to halogenations of alkanes.

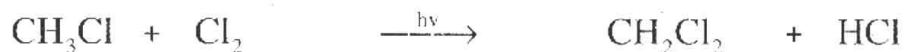
**Ans.** Alkanes give only substitution reaction. A reaction in which one or more hydrogen atoms of a saturated compound are replaced with some other atoms (like halogen) is called a substitution reaction. These reactions are a characteristic property of alkanes. Alkanes react fairly with halogens in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



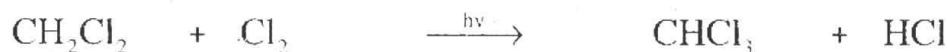
In diffused sunlight a series of reactions take place and at each step one hydrogen atom is substituted by halogen atoms so that all the hydrogen atoms are substituted one by one by halogen atoms.



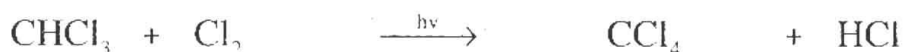
Chloromethane



Dichloromethane



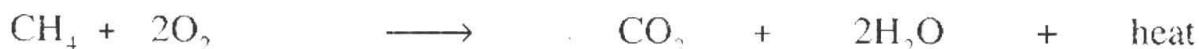
Trichloromethane  
(Chloroform)



Tetrachloromethane  
(Carbon Tetrachloride)

#### Q.4 Alkanes are a source of heat. Explain it.

Ans. 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.



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

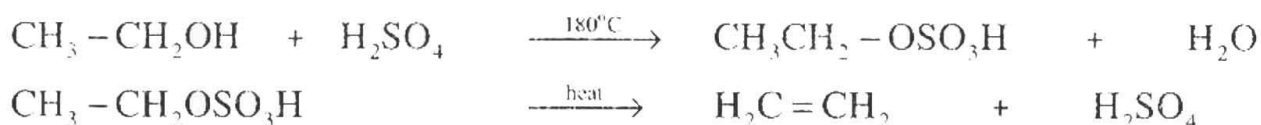


#### Q.5 Write the preparation of alkenes

Ans. 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.

##### Dehydration of alcohol

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.



##### 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.



#### Q.6 Write the Chemical reaction of Alkenes.

##### Ans. Chemical properties of alkenes

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.

##### Addition Reactions of Alkene

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

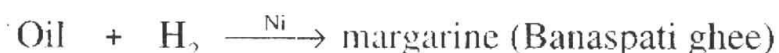
H<sub>2</sub>, Cl<sub>2</sub>, etc., to an unsaturated organic compound. In the process, one of the bonds of a double bond gets broken and two new single bonds are formed.

### (i) Hydrogenation

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



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



### Halogenations of alkenes

Halogenation means addition of halogen like chlorine or bromine. This reaction is used to identify the unsaturation of an organic compound.



### Hydrohalogenation of alkenes

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



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

### Oxidation of alkenes with KMnO<sub>4</sub>

Alkenes decolourise the pink colour of acidified dilute solution of potassium permanganate because the double bond electrons react with MnO<sub>4</sub><sup>-</sup> ion, which further goes on to form MnO<sub>2</sub> and ethene glycol (1,2 ethanediol). Such as, there is addition of two 'hydroxyl group' at the double bond.



### Q.7 Write the uses of ethene (Ethylene)

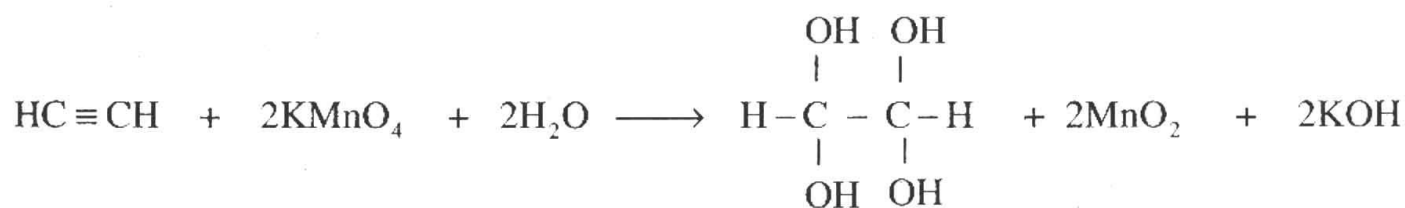
Ans. Ethene is used:

- for artificial ripening of fruits;
- as a general anaesthetic;
- for manufacture of polythene. Polythene is a plastic material used in packaging, toys, bags, etc;

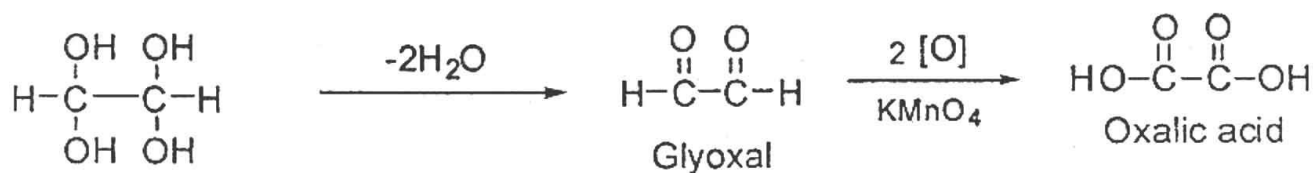
- (iv) as a starting material for the manufacture of a large number of compounds such as ethylene oxide, ethyl alcohol, ethylene glycol, diethyl ether, etc.; ethylene oxide is used as a fumigant, ethylene glycol is used as an antifreeze, diethyl ether and ethyl alcohol are used as solvents and
- (v) for making poisonous mustard gas which is used in chemical warfare.

**Q.8 Explain the oxidation of acetylene.**

**Ans.** Acetylene is oxidized by alkaline  $\text{KMnO}_4$  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.



**Q.9 Write the uses of acetylene.**

**Ans.**

- (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.

**Q.10 Briefly describe the preparation of alkynes.**

**Ans. Preparation of alkynes**

Alkynes are important hydrocarbons which have triple bond among their carbon atoms, alkynes are prepared by the following methods.

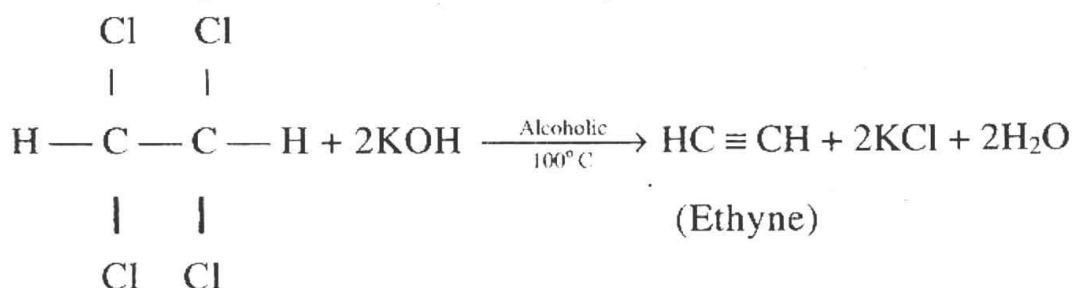
## 1. Dehydrohalogenation of Vicinal Dihalides:

### Dehydrohalogenation:

The process of removal of hydrogen and halogen from a compound is known as dehydrohalogenation.

### Procedure:

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.



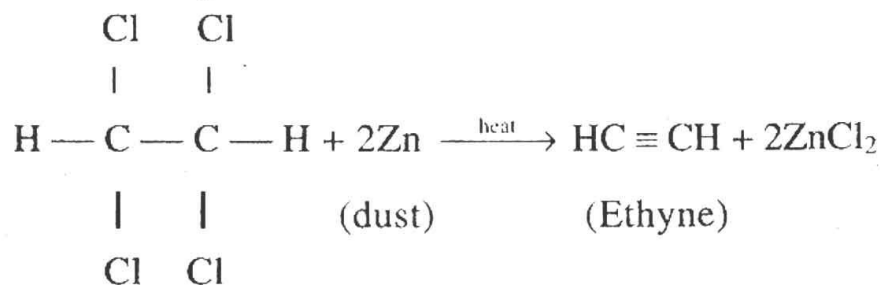
## 2. Dehalogenation of Tetrahalides;

### Dehalogenation:

The removal of halogen from adjacent carbon atoms is called as dehalogenation.

### Procedure:

When alkyl tetrahalides are heated with zinc dust, the elimination of halides takes place to form ethyne.



## Q.11 Write the Chemical Properties of Alkynes:

### Ans. Chemical Properties of Alkynes

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

Following are the important chemical reactions of alkynes:

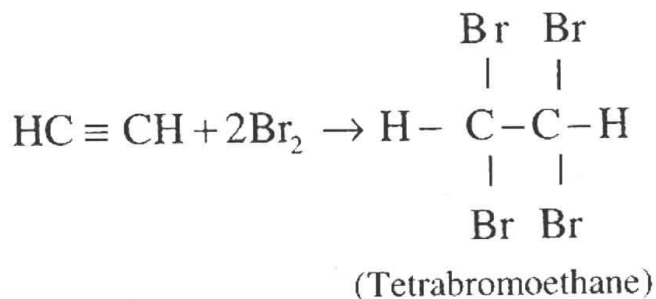
### 1. Addition of Halogen:

Chlorine and bromine adds to acetylene to form tetrachloroethane and tetrabromoethane, respectively.



## Procedure

When bromine water is added to acetylene, red brown colour of bromine water is discharged rapidly due to formation of colourless tetrabromoethane.

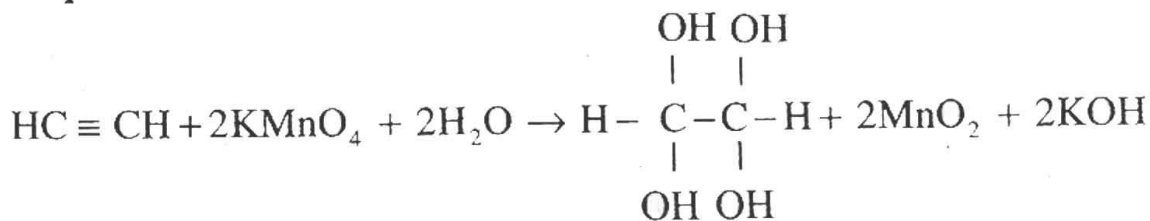


This reaction is used to identify the unsaturation of alkynes.

## 2. Oxidation with $\text{KMnO}_4$ :

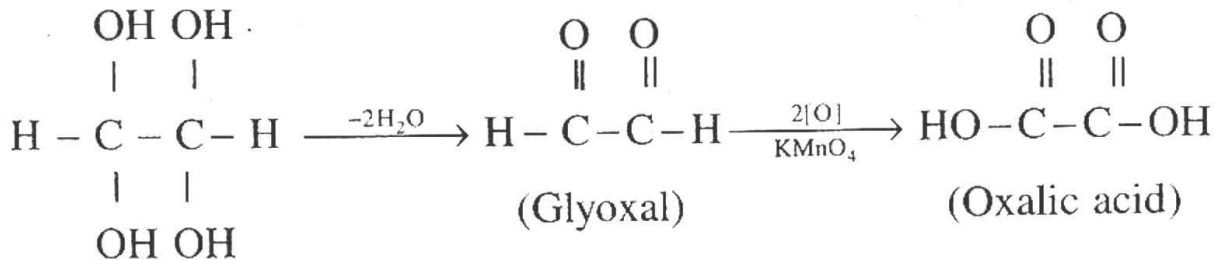
Ethyne is oxidized by alkaline  $\text{KMnO}_4$  and four hydroxyl groups add to the triple bond, such as;

### Chemical Equation



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

**Chemical Equation:**



**Q.12 Write a detail note on hydrocarbons as feed stock in industry.**

**Ans. Hydrocarbons as Feed Stock in Industry:**

Hydrocarbons are not only used as fuel in auto-mobiles or industries, they are also used as raw material in industry. It is explained as:

**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, chloroform, formic acid, carbon tetrachloride, ethylene butadiene, benzene, toluene etc.

## ii. Plastic Industry:

Hydrocarbons are used as raw materials for the preparation of a large variety of items used in daily life. Such as synthetic polymers, called plastics like polythene, polyester. So plastics are synthetic materials which 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) auto-mobile parts, electric and sewage items and a lot of other house hold items.

## iii. Rubber Industry:

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

## iv. Synthetic Fiber Industry:

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

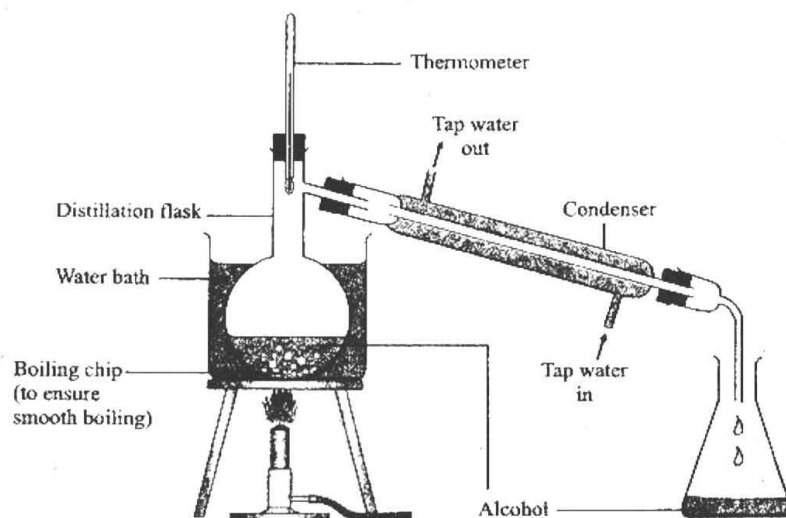
## v. Synthetic Detergents:

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

**Q.13 Describe an experiment by which you can determine the boiling point of alcohol.**

**Ans. 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 below:



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 temperatures does not change during the boiling process.

## Short Answer Question

**Q.1 Differentiate between saturated and unsaturated hydrocarbons.**

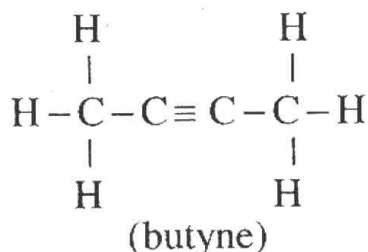
**Ans.**

Saturated Hydrocarbons	Unsaturated Hydrocarbons
The hydrocarbons in which all the four valencies of carbon atoms are fully satisfied (saturated) by single bond with other carbon atoms and hydrogen atoms are called saturated hydrocarbons	The hydrocarbons in which two carbon atoms are linked by a double or a triple bond are called unsaturated hydrocarbons
They are also called alkanes	They are also called alkenes and alkynes.
The general formula of saturated hydrocarbon is $C_nH_{2n+2}$	The general formula of alkenes is $C_nH_{2n}$ and alkynes is $C_nH_{2n-2}$
Examples $CH_4$ , $C_2H_6$ , $C_3H_8$	Examples $C_2H_4$ , $C_2H_2$

**Q.2 A compound consisting of four carbon atoms has a triple bond in it. How many hydrogen atoms are present it?**

**Ans.** There is six hydrogen atoms is presented in a compound containing the four carbon atoms has a triple bond in it.

Example



**Q.3 Why the alkanes are called paraffin?**

**Ans.** Alkanes are saturated hydrocarbons. In these compounds all the bonds of carbon atoms are single that mean valencies of carbon atoms are fully satisfied (saturated) therefore they are least reactive. That is the reason alkanes are called paraffin's.