- The atmosphere has only 0.03% of carbon dioxide.
- The number of electrons lost or gained by an atom to complete its octet (or duplet) is called its valency. It depends on the number of valence electrons.
- The tendency to attain a completely filled outermost shell (i.e. noble gas configuration) by gaining or losing electrons is called reactivity.
- The shared pair of electrons belongs to the outer shells of both the atoms so as to attain noble gas configuration.
- The simplest molecule formed by sharing of electrons is hydrogen.
- The bonds which are formed by sharing of electrons between two atoms are known as covalent bonds.
- The compounds which are formed by sharing of electrons pair between two atoms are known as covalent compounds. E.g. $CH_4$, $H_2$, $O_2$, etc.
- The melting and boiling points of covalent compounds are low because their intermolecular forces are weak and less amount of energy is required to overcome these forces.
- The covalent compounds are generally poor conductors of electricity because the electrons are shared between atoms and no charged particles are formed in their solution.
- Carbon has three allotropes – graphite, diamond and Buckminster Fullerene.
- When a hydrogen atom is removed from an alkane, the group obtained is called an alkyl group.
- Saturated carbon compounds are usually not very reactive because the carbon-carbon single bonds are very strong.
- Unsaturated carbon compounds are very reactive than saturated carbon compounds.

Uses of graphite

1. It is used in lead pencils as it is soft and leaves black mark on the paper.
2. It, being a good conductor of electricity, is used in making electrode in the cells.

3. Powdered graphite is used as lubricant because it is very soft and can withstand at high temperature.

Uses of diamond

1. It is used in pencils for cutting glass etc because it is the hardest substance known.
2. It is used for making dies for drawing thin wires.
3. It is used in surgical tools.
4. It is used for making jewellery because of high refractive index.

Heteroatom In hydrocarbons, the elements like halogen, oxygen, etc replacing hydrogen is called heteroatom. They are also present in some groups.

| Graphite | Diamond |
|---|---|
| 1. Graphite has two dimensional structure | 1. Diamond is a three dimensional structure. |
| 2. oft and greasy. | 2. It is the hardest substance known. |
| 3. It is a good conductor of heat and electricity. | 3. It is the bad conductor of electricity but good conductor of heat. |
| 4. It is grayish black substance. | 4. It is transparent. |

Catenation The property of self linking of carbon atoms through covalent bonds to form long chains or rings is called catenation.

- Other element which shows the catenation property is silicon.
- The bonds formed between the carbon and other elements are very strong because small size of

carbon enables the nucleus to hold on to shared-pair of electron strongly.

Versatile nature of carbon

1. Catenation – self linking of carbon atoms to form long chains or rings.
2. Tetravalency –sharing of 4 electrons with other atoms of carbon or any other monovalent element.

Saturated Carbon Compounds Compounds of carbon which have only single bonds between the carbon atoms are called saturated carbon compounds.

E.g. methane, ethane, etc.

Unsaturated carbon compounds Compounds of carbon which have double or triple bonds between the carbon atoms are called unsaturated carbon compounds.

E.g. ethene, ethyne, etc.

Straight chain compounds Carbon compounds in which no carbon atom of the chain is linked to more than two other carbon atoms are called straight chain compounds.

E.g. methane, ethane, propane, etc.

Branched chain compounds Carbon compounds, in which at least one carbon atom of the chain is linked to three or four other carbon atoms are called branched chain compounds. E.g. 2-methylpropane.

Cyclic compounds Carbon compounds in which carbon atoms are arranged in a ring are called cyclic compounds. These are of two types –

1. Saturated cyclic compounds. E.g. cyclopropane, cyclobutane, cyclopentane, etc.
2. Unsaturated cyclic compounds. E.g. benzene. Hydrocarbons. The carbon compounds which contain only hydrogen and carbon are called

Hydrocarbons

- Hydrocarbons which contain only single bonds between the carbon atoms are called alkanes. Their general formula is $C_nH_{2n+2}$.
- Hydrocarbons which contain one or more double bonds between the carbon atoms are called alkenes. Their general formula is CnH2n.
- Hydrocarbons which contain one or more triple bonds between the carbon atoms are called alkynes. Their general formula is $C_nH_{2n-2}$.

Functional group An atom or group of atoms present in a molecule which determines its functions or chemical properties is called a functional group. It is the most reactive site of a carbon compound.

Homologous series The family of organic compounds having same functional group, similar chemical properties and the successive members of which differ by $CH_2$ group is called a homologous series.

Characteristics of a homologous series

1. All the members can be represented by same general formula.
2. The molecular formulae of two successive members differ by $CH_2$ group or by 14u.
3. All the members have same functional group.
4. All the members show similar chemical properties.

- The melting and boiling points of the members of homologous series increase gradually because their molecular masses increase.

Allotropy The phenomenon in which one element exists in two or more forms having same chemical properties but different physical properties is called allotropy. The substances that show allotropy are carbon, sulphur, etc.

Allotropes The different forms of an element having same chemical properties but different physical properties are called allotropes.

Isomerism The phenomenon in which a compound can be represented by different structures having different properties is called isomerism.

Isomers The compounds which can be represented by different structures having different properties are called isomers.

IUPAC – International Union of Pure and Applied Chemistry.

Combustion The process of heating a substance strongly in the presence of excess of oxygen or air is called combustion.

- Carbon and carbon compounds release carbon dioxide, water and a large amount of heat and light on burning.

  $C + O_2 \longrightarrow CO_2$ + Heat and Light

  $CH_4 + O2 \longrightarrow CO_2 + H_2O$ + Heat and Light

  $C_2H_5OH + O_2 \longrightarrow CO_2 + H_2O$ + Heat and Light

- Saturated hydrocarbons generally give a clean blue flame because complete combustion of these substances takes place.
- Saturated hydrocarbons burn with a yellow flame with lots of black smoke due to the incomplete combustion of carbon contents.
- Condition in which saturated carbon compounds burn with sooty flame – If a saturated carbon compound is burnt in limited (insufficient) supply of air, it burns with sooty flame due to incomplete combustion.
- The gas/kerosene stoves used at homes have inlets for air so that a sufficient oxygen rich mixture is burnt to give a clean blue flame with a lot of heat.
- Sometimes bottoms of cooking vessels get blackened due to incomplete combustion of gas/kerosene. It means the holes are blocked. This problem can be removed by cleaning the burner by opening holes.
- The pollutants released in the environment by burning coal and petroleum are oxides of sulphur and nitrogen e.g. $SO_2$ , NO, $NO_2$ , etc.

- Combustion of hydrocarbons is regarded as oxidation reaction because during combustion, carbon is oxidised to $CO_2$ and hydrogen is oxidised to water by addition of oxygen.
- Only the gaseous substances produce flame on burning.
- Wood and charcoal are solid but they produce flame when ignited because when they are ignited the volatile substances present vaporize and burn with a flame in the beginning only.
- Fossil fuels The fuels formed by the dead animals and plants buried under the earth millions of years ago due to intense heat and pressure are called fossil fuels. E.g. coal and petroleum.
- When an alcohol is heated in the presence of alkaline $KMnO_4$ (or acidified $K_2 Cr_2 O_7$ ) then corresponding carboxylic acid is formed.

$$C_2H_5OH \xrightarrow{\text{Alk. } KMnO_4 + \text{Heat}} CH_3COOH$$

- Addition reaction The reaction which involves addition of two reactants to form a single product is called an addition reaction. Only unsaturated hydrocarbons perform addition reactions.

$$CH_2 = CH_2 + Cl_2 \longrightarrow CH_2Cl - CH_2Cl$$

- Industrial application of addition reaction Addition reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst to form vegetable ghee.

$$\text{Vegetable oil (liquid)} + H_2 \xrightarrow{\text{Ni (473K)}} \text{Ni (473K) Vegetable ghee (solid)}$$

Saturated fatty acids are harmful for health so oils containing unsaturated fatty acids should be used for cooking because Saturated fats increase the level of bad cholesterol (low density lipoprotein LDL) in blood which sticks to the walls of arteries and causes heart diseases.

Substitution reaction The reaction which involves direct replacement of an atom or group of atoms in an original molecule is called substitution reaction. Only saturated hydrocarbons perform substitution reactions.

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

| Functional group | Symbol/formula | Prefix/suffix | Compound name |
|---|---|---|---|
| Halo | -Cl, -Br, - I | Halo (prefix) | Haloalkane |
| Alcohol | -OH | -ol | Alkanol |
| Aldehyde | -CHO | -al | alkanal |
| Ketone | - CO - | -one | Alkanone |
| Carboxylic | -COOH | -oic acid | Alkanoic acid |

| Simplest compound | Common name | IUPAC name | Formula |
|---|---|---|---|
| Alcohol | Methyl alcohol | Methanol | CH3OH |
| Aldehyde | Formaldehyde | Methanal | HCHO |
| Ketone | Acetone | Propanone | CH3COCH3 |
| Carboxylic acid | Formic acid | Methanoic acid | HCOOH |
| alkane | Methane | Methane | CH4 |
| Alkene | Ethylene | Ethene | C2H4 |
| alkyne | Acetylene | Ethyne | C2H2 |

ETHANOL ($CH_3CH_2OH$ or $C_2H_5OH$)

Physical properties

1. It is liquid at room temperature.
2. It is colourless and has distinct smell and burning taste.
3. It is soluble in water in all proportions.

Chemical properties

1. It reacts with sodium to form sodium ethoxide and hydrogen gas.

$2CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2ONa + H_2$

2. It reacts with hot concentrated H2SO4 to give ethene.

$$CH_3CH_2OH \xrightarrow{\text{Hot Conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

USES

1. It is used in all alcoholic drinks like wine, beer, etc.
2. In the form of rectified spirit (95% alcohol + 5% water), it is used as an antiseptic for wounds.
3. It is used in medicines like tincture iodine, cough syrups, tonics etc because it is a good solvent.
4. In cold countries it is used as antifreeze in automobiles.

Harmful effects of ethanol

1. Consumption of its small quantity causes drunkenness.
2. It depresses the central nervous system which results in mental confusion and drowsiness.
3. It damages liver and kidney.
4. It decreases the sense of judgment and sense of timing.
5. It increases crime in the society.

Denatured alcohol To prevent the misuse of ethanol produced for industrial use, it is made unfit for drinking by adding poisonous substances like methanol, copper sulphate, etc. it is called denatured alcohol.

ETHANOIC ACID (acetic acid or vinegar, $CH_3COOH$)

Physical properties.

1. It is a colourless and pungent smelling liquid.
2. Its melting point is 290K so it often freezes during winter and looks like glacier. Therefore, it is also known as glacial acetic acid.

3. It is soluble in water in all proportions. 5% to 8% solution of Ethanoic acid in water is called vinegar.

Chemical properties

1. Reaction with alcohol. Ethanoic acid reacts with ethanol in the presence of an acid to give ester.

$CH_2COOH + C_2H_5OH$ Acid $CH_3COOC_2H_5 + H_2O$

2. Reaction with base. Ethanoic acid reacts with sodium hydroxide to give sodium ethanoate (sodium acetate) and water.

$CH_3COOH + NaOH$ $CH_3OONa + H_2O$

3. Reaction with carbonates and bicarbonates. Ethanoic acid reacts with carbonates and bicarbonates to salt carbon dioxide and water.

2CH3COOH + Na2CO3 2CH3COONa + CO2 + H2O

CH3COOH + NaHCO3 CH3COONa + CO2 + H2O

Esterification The reaction between a carboxylic acid and an alcohol to form an ester is called Esterification reaction.

$CH_2COOH + C_2H_5OH$ Acid $CH_3COOC_2H_5 + H_2O$

- The reaction between the ester and hot base to give original alcohol and carboxylic acid back is called saponification reaction because this reaction is used in preparing soaps.

$CH_3COOC_2H_5$ $NaOH$ $CH_2COOH + C_2H_5OH$

The product formed when a carboxylic acid reacts with an alcohol having the formula R-COO-R' is called an ester. Esters are sweet smelling substances. They are widely spread in nature. The

smell of fruits and flowers is due to the presence of esters. Esters are used as flavorings agents and in making perfumes.

Cleansing action of soap The molecules of soap are sodium or potassium salts of long chain of carboxylic acids. The hydrocarbon tail being hydrophobic reacts with oil or grease while the ionic end being hydrophilic reacts with water. As a result micelles are formed. They form an emulsion in water.

When the surface of clothes is beaten or agitated, micelles are thrown away and the cloth is cleaned.

Micelle The cluster of about 100 – 200 molecules with hydrophilic ends on the surface of cluster and hydrophobic ends towards the centre, is called a micelle.

| Soaps | Detergents |
|---|---|
| Soaps are sodium salts of long chain carboxylic acids. | Detergents are sodium salts of long chain sulphonic acids. |
| Soaps do not form leather with hard water. | Detergents form leather with hard water. |
| Soaps are biodegradable. | They are non biodegradable. |
| Soaps do not have strong cleansing action. | They have strong cleansing action. |
| These are prepared from animal fats. | They are prepared from hydrocarbons of petroleum. |

Advantage of soaps over detergents Soaps are biodegradable so they do not produce pollution. While detergents being non biodegradable produce pollution.

Advantage of detergents over soaps Detergents can be used in hard water. Also, they have strong cleansing action. While soaps have weak cleansing action and they cannot be used in hard water.

Extra Knowledge

**Properties of Alkanes/ Alkenes/ Alkynes (10th Carbon and its compounds)**

**Properties of Alkanes/ Alkenes/ Alkynes**

(a) Alkanes are gas ($C_1$to $C_4$) ; liquid ($C_5$to $C_{17}$) and rest are solid at room temperature.

(b) The melting and boiling point of Alkanes increases with increase in number of C – atom in Alkanes.

Reason: Alkanes experience inter-molecular van der Waals forces. Stronger inter-molecular van der Waals forces give rise to greater boiling points of alkanes.

A straight-chain alkane will have a boiling point higher than a branched-chain alkane due to the greater surface area in contact.

Note: In Chemistry the Van der Waals forces include attractions and repulsions between atoms, molecules, and surfaces, as well as other intermolecular forces.

(c) The density of the alkanes usually increases with increasing number of carbon atoms

| Alkane | Formula | Density |
|---|---|---|
| Pentane | $C_5H_{12}$ | 0.626 (liquid) |
| Hexane | $C_6H_{14}$ | 0.659 (liquid) |
| Heptane | $C_7H_{16}$ | 0.684 (liquid) |
| Octane | $C_8H_{18}$ | 0.703 (liquid) |
| Nonane | $C_9H_{20}$ | 0.718 (liquid) |

(d) Solubility: Alkanes are generally insoluble in polar compound like water but dissolve in organic solvents (Non polar compound) like benzene. The liquid alkanes are good solvents for many other covalent compounds.

Reason: Alkanes do not conduct electricity, nor are they polarized by electricity. For this reason they do not form hydrogen bonds and are insoluble in polar solvents such as water.

(e) Reactivity: Alkanes are stable and less reactive than alkenes

Reason: This is because saturated hydrocarbons contain only single bonds which are very stable and difficult to break. On the other hand, unsaturated hydrocarbons contain pie bonds, which can be easily broken as they are more strained.

(f) Combustion: Alkanes are generally good combustible material due presence of the good percentage of Hydrogen.

Since Alkanes burn with non smoky and non sooty flame due to presence of the good percentage of Hydrogen, It is used as a fuel like LPG and CNG

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $2CH_4$ | + | $2O_2$ | ----------→ | $CO_2$ | + | $H_2O$ | + | Heat and light |
| $2C_2H_6$ | + | $7O_2$ | ----------→ | $4CO_2$ | + | $6H_2O$ | + | Heat and light |
| $C_2H_4$ | + | $3O_2$ | ----------→ | $2CO_2$ | + | $2H_2O$ | + | Heat and light |
| $2C_2H_2$ | + | $5O_2$ | ----------→ | $4CO_2$ | + | $2H_2O$ | + | Heat and light |
| $2CH_3\ CH_2OH$ | + | $3O_2$ | ----------→ | $2CO_2$ | + | $3H_2O$ | + | Heat and light |

However, if the supply of air or oxygen is not sufficient for complete combustion, carbon monoxide is formed. Carbon monoxide (CO) is highly poisonous.

| | | | | | | |
|---|---|---|---|---|---|---|
| $2CH_4$ | + | $3O_2$ | ----------→ | 2CO | + | $4H_2O$ |
| $2CH_4$ | + | $3O_2$ | ----------→ | 2CO | + | $4H_2O$ |
| $2C_4H_{10}$ | + | $9O_2$ | ----------→ | 8CO | + | $10H_2O$ |

Q. What is the difference between Oxidation and combustion?

Answer: Combustion is the complete oxidation of organic compound into carbon dioxide and water molecules in presence of oxygen gas while oxidation is the addition of oxygen in a organic compound or with an element the loss of electron from an atom or ion is also oxidation.

Hence, all Oxidation reactions are not combustion reaction but all combustion reactions are Oxidation. Oxidation reaction does not involve heat where as combustion reactions do.

(g) Substitution reaction: Alkanes do not undergo addition reaction due to strong van der wall force but take part in substitution reaction:

Alkanes undergo substitution reaction because hydrogen attached to carbon easily replaced by atom more reactive than hydrogen like halo atom Cl , Br ,I etc.

$$CH4 + Cl_2 \xrightarrow[\text{Sunlight}]{\text{----------}} CH_3Cl + HCl$$

$$CH_4Cl + Cl_2 \xrightarrow[\text{Sunlight}]{\text{----------}} CH_2Cl_2 + HCl$$

$$\xrightarrow[\text{Sunlight}]{}$$

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

$CHCl_3 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$

If chlorine present in excess, then reaction does not stop in between but keep on reacting till it form carbon tetra chloride.

(h) Addition reaction:

Unlike alkane, generally alkene Undergo addition reaction with hydrogen gas in the presence of Palladium or nickel at (473 k) catalyst and gives saturated hydrocarbon.

Example: Ethene Undergo addition reaction with hydrogen gas in the presence of Palladium or nickel at (473 k) catalyst and gives saturated hydrocarbon Ethane

$CH_2 = CH_2 + H_2 \xrightarrow[473\ k]{Ni} CH_3 - CH_3$

Ethyne Undergo addition reaction with hydrogen gas in the presence of Palladium or nickel at (473 k) catalyst and gives saturated hydrocarbon Ethane . This reaction is known as Hydrogenation Reaction.

$CH_2 \equiv CH_2 + 2H_2 \xrightarrow{Pd} CH_3 - CH_3$

This addition reaction of hydrogen is helpful in converting vegetable Oil into saturated fat like vanaspati gee. This reaction is commonly called Hydrogenation of Oil. This test helps to distinguish between saturated and saturated fats.

Note: Butter contain saturated compound where as cooking oil contain unsaturated compound. If Alkaline $KMno_4$ added to both, pink color of $KMno_4$ disappear in cooking oil but remain in pink in butter.

$\text{Vegetable Oil} + H_2 \xrightarrow{Ni} CH_3 - CH_3$

Bromine and chlorine react with alkene to form vicinal dihalides (iodine does not undergo addition reaction under normal conditions).

$CCl_4$

$CH_2 = CH_2$ + $Cl_2$ ----------→ $CH_2$ - $CH_2$

Cl Cl

Ethene 1,2- Dichloroethane

$CCl_4$

$CH_2 = CH_2$ + $Br_2$ ----------→ $CH_3$ - CH - $CH_2$

Br Br

Ethene Bromine water 1,2-Dibromoethane

Bromine water test: Solution of Bromine in water is reddish brown in colour but 1, 2-Dibromoethane formed from the addition reaction is colourless. This helps us to identify unsaturated carbon compound. If an organic compound is unsaturated Solution of Bromine in water became colourless.

Note: In Alkanes, the four valencies of **carbon** atom are saturated and they have stable σ (sigma) bonds. Any nuleophile comes; one hydrogen atom is replaced to accommodate the nucleophile.

e.g. $CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$

In case of Alkene or Alkyne, **Carbon atom** has double or triple bonds. In this, one is stable σ (sigma) bond and the rests are unstable (or weak) π bonds. When nucleophile approaches to the carbon atom that has double or triple bonds, they easily break to accommodate it.

e.g., $H_2C=CH_2 + Cl_2 \longrightarrow H_2ClC\text{-}CH_2Cl$.

(i) Cracking (or pyrolysis):

When heated to a sufficiently high temperature in the absence of oxygen, alkanes decompose to produce hydrocarbons of shorter chain length. This reaction is called thermal cracking or pyrolysis.

For example, when octane is heated to 6500C in the absence of oxygen, it forms ethene and exane.

6500C

C8H18 -------> C6H14 + C2H4

Octane Hexane Ethene

In this process, vapour of higher alkanes is passed through a hot metal tube ($500^0C$ – $700^0C$).

Propane on cracking gives,

$C_3H_{8ca}$ $\xrightarrow{\Delta}$ $C_3H6 + H_2$

$CH_4 + C2H_4$

Cracking of hexane gives butane and ethane.

$C_6H_{14}$ $\xrightarrow{\Delta}$ $C_4H_{10} + C_2H_4$

Cracking is used to convert some of the less volatile fraction of petroleum containing high moleculer mass into compounds of lower molecular masses of higher volatility. Such hydrocarbons with lower molecular masses are more suitable as fuels for automobiles.

$C_{16}\ H_{34}$ $\rightarrow$ $C_8H_{18}$ + $C_8H_{16}$

n - Hexadecane n-octane octene (unsaturated)

Q. What's the difference between cracking and Pyrolysis?

Pyrolysis: The decomposition of a compound on heating in absence of air is known as pyrolysis.

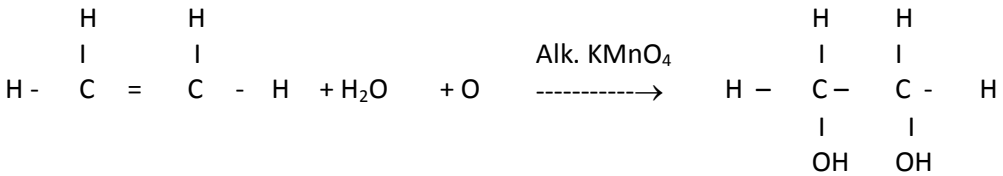
Cracking: is the breakdown of large organic compounds by use of a catalyst and low temperature to form fewer different compounds

Q. In cracking will the decomposed hydrocarbon always be a saturated and a unsaturated hydrocarbons? Can they both be either unsaturated or saturated hydrocarbons?

Cracking is defined as the process of breaking or decomposition of large hydrocarbons into smaller compounds. This process is widely used in the petroleum industry. Usually, we get a mixture of alkane and alkenes by the process of cracking of hydrocarbons. This is because the bonds in the hydrocarbons can be cleared in any way. As a result, we will not get alkane and alkene exclusively but a mixture of both.

(j) Oxidation: The chemical reaction in which oxygen added to substance is called oxidation of substance. The substance which donate oxygen to other substance during chemical reaction is called oxidizing agent like $K_2Cr_2O_7$, HNO3 and $KMnO_4$ . Alkane on oxidation produces heat and light known as combustion.

(a) Ethene on treating with alkaline $KMnO_4$ oxidized to Ethylene Glycol




Ethene Ethylene Glycol

(b) Ethyne on treating with alkaline $KMnO_4$ oxidized to Oxalic Acid

$$H-C\equiv C-H \quad \xrightarrow[+4O]{\text{Alk. KMnO4}} \quad \begin{matrix}COOH\\ |\\ COOH\end{matrix}$$

Ethyne — Oxalic Acid

(c) Ethanol on treating with alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ oxidized to Ethanoic Acid.

During oxidation of Ethanol alkaline $KMnO_4$ losses its purple colour .

$$CH_3CH_2OH \xrightarrow[+4O]{\text{Alk. KMnO4 + Heat}} CH_3COOH$$

Ethanol — Ethanoic Acid

Ethanol is highly inflammable and catches fire readily. This is why during oxidation it should never be heat directly on a burner. it should be heated on a water bath.

1. Ethanol ($C_2H_5OH$)

Ethanol or ethyl alcohol or simply alcohol is one of the most important members of the family of alcohols.

Physical properties

(i) Ethanol is a clear liquid with burning taste.

(ii) Its boiling point is 351K which is higher than corresponding alkane.

(iii) It is completely miscible with water in all proportions.

Chemical properties

(i) Dehydration

(a) Intra molecular dehydration :

Ethanol, when heated with excess conc. $H_2SO_4$ at 443 K undergoes intra molecular dehydration (i.e. removal of water within a molecule of ethanol).

$CH_3CH_2OH$ -------Conc.H2SO4/443K-----> $CH_2 = CH_2 + H_2O$

(b) Inter molecular dehydration :

When excess of alcohol is heated with conc. H2SO4 at 413K two molecules condense by losing a molecule of water to form ether (i.e. removal of water from two molecules of ethanol).

C2H5- OH + HO- C2H5 -------Conc.H2SO4/413K----> C2H5-O-C2H5 (Diethyl ether)+H2O

(ii) Reaction with sodium :

Ethanol reacts with sodium metal to form sodium ethoxide and hydrogen gas.

$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa$ (sodium ethoxide) $+ H_2 \uparrow$

(iii) Oxidation:

Ethanol is oxidized to Ethanoic acid with alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$

$CH_3CH_2OH \xrightarrow{\text{Oxidation}} CH_3COOH$ (Ethanoic acid) $+ H_2O$

During this reaction, orange colour of $K_2Cr_2O_7$ changes to green. Therefore, this reaction can be used for the identification of alcohols.

(iv) Esterificaiton :

Ethanol reacts with ethanoic acid in the presence of conc.$H_2SO_4$ (catalyst) to form ethyl ethanoate and water. The compound formed by the reaction of an alcohol with carboxylic acid is known as ester (fruity smelling compound) and the reaction is called esterification.

$C_2H_5OH + CH_3COOH \xrightarrow{\text{conc.}H_2SO_4} CH_3COOC_2H_5$ (Ethyl ethanoate) $+ H_2O$

(v) Dehydrogenation :

When the vapour of ethanol is passed over reduced copper catalyst at 573 K, it is dehydrogenated to acetaldehyde.

$CH_3CH_2OH \xrightarrow{Cu/573K} CH_3CHO$ (Acetadehyde) $+H_2$

Ethanol is used

1. As an anti-freeze in automobile radiators.
2. As a preservative for biological specimen.
3. As an antiseptic to sterilize wounds in hospitals.
4. As a solvent for drugs, oils, fats, perfumes, dyes, etc.
5. In the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol),rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured sprit (ethanol mixed with pyridine).
6. In cough and digestive syrups.

Evil effects of consuming alcohol

• If ethanol is consumed, it tends to slow down metabolism of our body and depresses the central nervous system.

• It causes mental depression and emotional disorder.

• It affects our health by causing ulcer, high blood pressure, cancer,brain and liver damage.

• Nearly 40% accidents are due to drunken drive.

• Unlike ethanol, intake of methanol in very small quantities can cause death.

• Methanol is oxidized to methanal (formaldehyde) in the liver and methanol reacts rapidly with the components of cells.

• Methanal causes the protoplasm to get coagulated, in the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.

2. Ethanoic acid ($CH_3COOH$)

Ethanoic acid is most commonly known as acetic acid and belongs to a group of acids called carboxylic acids. Acetic acid is present in many fruits and sour taste of fruits is because of this acid.

1. Preparation of Ethanoic acid

Ethanol on oxidation in the presence of alkaline potassium permanganate or acidified potassium dichromate gives Ethanoic acid.

$CH_3CH_2OH$ (Ethanol) ------ Oxidation ------> $CH_3COOH$ (Ethanoic acid) + $H_2O$

2. Physical properties

(i) Ethanoic acid is a colourless liquid and has a sour taste.

(ii) It is miscible with water in all proportions.

(iii) Boiling point (391 K) is higher than corresponding alcohols, aldehydes and ketones.

(iv) On cooling, pure ethanoic acid is frozen to form ice like flakes. They look like glaciers, so it is called glacial acetic acid.

3. Chemical properties

(i) Ethanoic acid is a weak acid but it turns blue litmus to red.

(ii) Reaction with metal

Ethanoic acid reacts with metals like Na, K, Zn, etc to form metal Ethanoate and hydrogen gas.

$2CH_3COOH + Zn$ ----------> $(CH_3COO)_2 Zn + H_2 \uparrow$

$2CH_3COOH + 2Na$ ----------> $2CH_3COONa + H_2 \uparrow$

(iii) Reaction with carbonates and bicarbonates.

Ethanoic acid reacts with carbonates and bicarbonates and produces brisk effervescence due to the evolution of carbon dioxide.

2CH3COOH + Na2CO3 ----------> 2CH3COONa + CO2 ↑ + H2O

CH3COOH + NaHCO3 ----------> CH3COONa + CO2 ↑ + H2O

(iv) Reaction with base

Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water

CH3COOH + NaOH ----------> CH3COONa + H2O

(v) Decarboxylation (Removal of CO2)

When sodium salt of Ethanoic acid is heated with soda lime (Solid mixure of 3 parts of NaOH and 1 part of CaO) methane gas is formed

$CH_3COONa$ ------NaOH / CaO-------> $CH_4 \uparrow + Na_2CO_3$

Ethanoic acid is used

1. For making vinegar which is used as a preservative in food and fruit juices.
2. As a laboratory reagent.
3. For coagulating rubber from latex.
4. In the preparation of dyes, perfumes and medicine.

**Important Questions**

Question: Why does Ethanoic acid called glacial acetic acid? (Imp.)

Ans. On cooling, pure Ethanoic acid is frozen to form ice like flakes. They look like glaciers, so it is called glacial acetic acid.

Question: Why is the conversion of ethanol to ethanoic acid an oxidation reaction? (Imp.)

Ans. When ethanol is oxidized, hydrogen is removed from its molecule and oxygen is added so as to form ethanoic acid. Thus, conversion of ethanol into acetic acid is an oxidation reaction.

Question: A mixture of ethyne and oxygen is burnt for welding. Can you tell why a mixture of ethyne and air is not used? (Imp.)

Ans. Ethyne has only two hydrogen atoms and two carbon atoms in its molecule. It burns in air with a sooty flame, because the oxygen from air is insufficient to burn the carbon completely. Thus, pure oxygen is used which completely burns carbon and hydrogen and produces a very hot flame.

Question: Why is the conversion of ethanol to Ethanoic acid considered an oxidation reaction?

Ans. Conversion of ethanol to Ethanoic acid is considered an oxidation reaction since it involves:

(i) addition of oxygen to the ethanol molecule

(ii) removal of hydrogen from the ethanol molecule

Q. An organic compound burns with a sooty flame. Is it saturated or unsaturated compound? Justify

Answer: it is unsaturated compound. Unsaturated compound have low percentage of hydrogen so incomplete combustion takes palace and produce sooty flame.

Q. (a) Differentiate between saturated and unsaturated hydrocarbons. Write any tow points of difference.
(b) Why are carbon compounds (i) poor conductors of electricity (ii) have low melting and boiling points?
(c) Name the simplest hydrocarbon and write its formula

Ans: (a) Compounds of carbon, which are linked by only single bonds between the carbon atoms are called saturated compounds. Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated compounds.
Saturated hydrocarbons will generally give a clean flame without soot while unsaturated carbon compounds will give a yellow flame with lots of black smoke and soot on combustion.
(b)(i) carbon compounds are poor conductors of electricity because they do not have any free electrons or an overall electric charge
(ii) Carbon compounds have low melting and boiling points this is because the weak intermolecular forces break down easily.
(iii) The simplest hydrocarbon is methane $CH_4$

Q. (a) Explain with the help of chemical equation the following properties of carbon compounds-
(i) Combustion (ii) Oxidation

(b) How do saturated and unsaturated hydrocarbons can be differentiated on the basis of their combustion?
(c) What are oxidizing agents ?

Answer: (i) carbon compounds burns in oxygen to give carbon dioxide along with the release of heat and light.
For example : $C + O2 \rightarrow CO2$ + heat and light : $CH4 + O2 \rightarrow CO2 + H2O$ + heat and light
$CH3CH2OH + O2 \rightarrow CO2 + H2O$ + heat and light
(ii) Carbon compounds easily oxidised on combustion or in the presence of oxidising agents like Alkaline potassium permanganate or acidified potassium dichromate. For example : alcohols are converted to carboxylic acids .
$CH3 - CH2OH \xrightarrow[Heat]{\text{Alkaline } KMnO\ 4} CH_3COOH$

(b) Saturated hydrocarbons will generally give a clean flame without soot while unsaturated carbon compounds will give a yellow flame with lots of black smoke and soot on combustion.
(c) Any substances that add oxygen to others substance is called oxidising agents.