11 Organic chemistry

Content

11.1 Alkanes

11.2 Alkenes

11.3 Alcohols

11.4 Carboxylic acids

11.5 Macromolecules

*The use of molecular models is recommended to enable students to appreciate the three-dimensional structures of molecules.

Learning outcomes

Candidates should be able to:

(a) state that the naphtha fraction from petroleum (crude oil) is the main source of hydrocarbons used as the feedstock for the production of a wide range of organic compounds

(b) describe the issues relating to the competing uses of oil as an energy source and as a chemical feedstock

11.1 Alkanes

(a) describe a homologous series as a group of compounds with a general formula, similar chemical properties and showing a gradation in physical properties as a result of increase in the size and mass of the molecules, e.g. melting and boiling points; viscosity

(b) describe the alkanes as a homologous series of saturated hydrocarbons with the general formula C_nH_{2n+2}

(c) draw the structures of branched and unbranched alkanes, C1 to C4, and name the unbranched alkanes, methane to butane

(d) define isomerism and identify isomers

(e) describe the properties of alkanes (exemplified by methane) as being generally unreactive except in terms of burning and substitution by chlorine

11.2 Alkenes

(a) describe the alkenes as a homologous series of unsaturated hydrocarbons with the general formula C_nH_{2n}

(b) draw the structures of branched and unbranched alkenes, C2 to C4, and name the unbranched alkenes, ethene to butene

(c) describe the manufacture of alkenes and hydrogen by cracking hydrocarbons and recognise that cracking is essential to match the demand for fractions containing smaller molecules from the refinery process

(d) describe the difference between saturated and unsaturated hydrocarbons from their structures and by using aqueous bromine

(e) describe the properties of alkenes in terms of combustion, polymerisation and their addition reactions with bromine, steam and hydrogen

(f) state the meaning of *polyunsaturated* when applied to food products

(g) describe the manufacture of margarine by the addition of hydrogen to unsaturated vegetable oils to form a solid product

11.3 Alcohols

(a) describe the alcohols as a homologous series containing the –OH group

(b) draw the structures of alcohols, C1 to C4, and name the unbranched alcohols, methanol to butanol

(c) describe the properties of alcohols in terms of combustion and oxidation to carboxylic acids

(d) describe the formation of ethanol by the catalysed addition of steam to ethene and by fermentation of glucose

(e) state some uses of ethanol, e.g. as a solvent; as a renewable fuel; as a constituent of alcoholic beverages

11.4 Carboxylic acids

(a) describe the carboxylic acids as a homologous series containing the $-CO_2H$ group

(b) draw the structures of carboxylic acids, methanoic acid to butanoic acid, and name the unbranched acids, methanoic to butanoic acids

(c) describe the carboxylic acids as weak acids, reacting with carbonates, bases and some metals

(d) describe the formation of ethanoic acid by the oxidation of ethanol by atmospheric oxygen or acidified potassium manganate(VII)

(e) describe the reaction of carboxylic acids from C1 to C4 with alcohols from C1 to C4 to form esters

(f) draw the structures of and name the esters formed from carboxylic acids (see 11.4 (b)) and alcohols (see 11.3 (b))

(g) state some commercial uses of esters, e.g. perfumes; flavourings; solvents

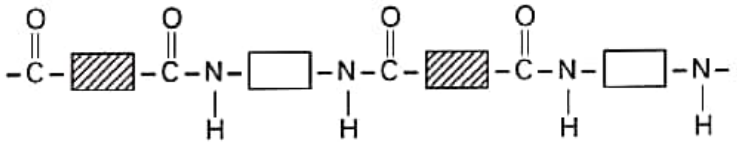
11.5 Polymers

(a) describe polymers as large molecules made from many small units called monomers, different polymers having different units and/or different linkages

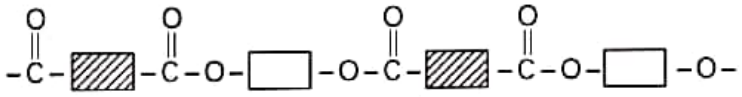
(b) describe the formation of poly(ethene) as an example of addition polymerisation of ethene as the monomer

(c) state some uses of poly(ethene) as a typical plastic, e.g. plastic bags; clingfilm

(d) describe nylon, a polyamide, and *Terylene*, a polyester, as condensation polymers, the partial structure of nylon being represented as



and the partial structure of *Terylene* as



(details of manufacture and mechanisms of these polymerisations are **not** required)

(e) state some typical uses of synthetic fibres such as nylon and *Terylene*, e.g. clothing; curtain materials; fishing line; parachutes; sleeping bags

(f) deduce the partial structure of the polymer product from a given monomer and vice versa

(g) describe the pollution problems caused by the disposal of non-biodegradable plastics

(h) identify proteins and complex carbohydrates (polysaccharides, e.g. starch) as natural polymers

(i) describe proteins as possessing the same amide linkages as nylon but with different monomer units

(j) describe fats as esters possessing the same linkages as *Terylene* but with different monomer units

(k) describe the hydrolysis of proteins to amino acids and complex carbohydrates (polysaccharides, e.g. starch) to simple sugars

Thursday 20th October, 20

Organic Chemistry

→ It is a branch of chemistry which deals with compounds carbon and hydrogen only (hydrocarbons) and their derivates.

Source of organic Compounds → fossil fuels ← Remains of dea plants & animals

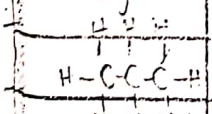
Fossil fuels

- Coal → Plants
- Crude oil (Petroleum) → Plankton (Micro-organism) → in ocean!
- Natural Gas → Plankton

Classification of Organic Compounds

- Hydrocarbons → Compounds made up of carbon & hydrogen only.
  - Saturated Hydrocarbons (Contain single covalent bond between carbon atoms) → alkanes
  - Unsaturated Hydrocarbons (Contain double or triple covalent bond between atleast one pair of carbon atoms) → alkenes, alkynes
- Derivatives of Hydroca → Compounds containing at least one element other than carbon & hydro E.g alcohols & carboxylic ac

e.g



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→ **Alkene**: Unsaturated hydrocarbons contain double covalent bond between carbon atoms.

→ **Alkyne**: Unsaturated hydrocarbons contain triple covalent bond between carbon atoms. (not in syllabus)

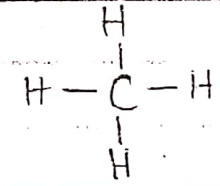
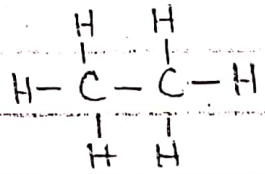
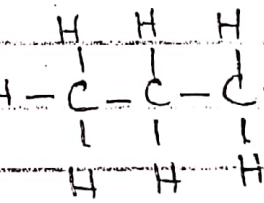
→ **Alkanes**: Saturated hydrocarbons contain single covalent bond between carbon atoms

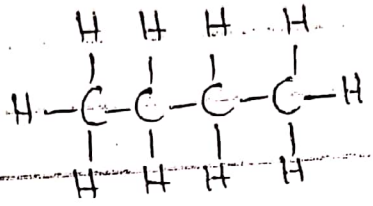
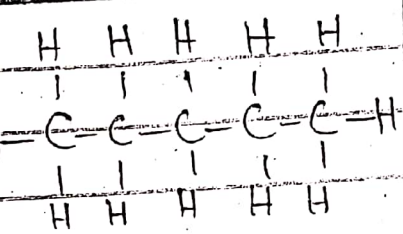
Naming of Alkanes

→ Named by suffixing '-ane' with the name of hydrocarbon

→ Their general formula is C_nH_{2n+2} where n = no. of carbon atoms.

Homologous series of Alkanes

Name	Structure	Formula	State
Methane		CH_4	Gas
Ethane		C_2H_6	Gas
Propane		C_3H_8	Gas

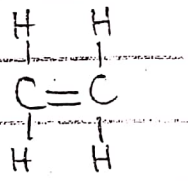
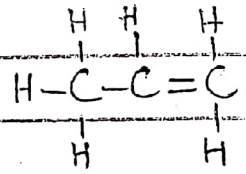
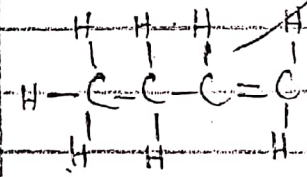
Butane		C_4H_{10}	Gas
Pentane		C_5H_{12}	Liquid

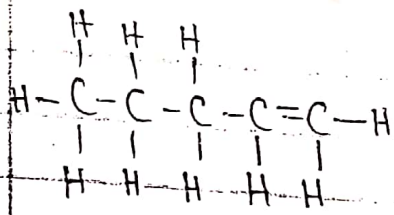
Naming of Alkenes :-

→ Named by suffixing '-ene' with the name of hydrocarbo

→ Their general formula is C_nH_{2n}

Homologous series of alkenes:

Name	Structure	Formula	State
Ethene		C_2H_4	Gas
Propene		C_3H_6	Gas
Butene		C_4H_8	Gas

Pentene		C_5H_{10}	Liquid

Alkyl Radicals

Radicals: Radicals are those substances which do not exist independently and are always found combined with other substances

→ Their general formula is C_nH_{2n+1}
→ They are named by suffixing '-yl' with the name of hydrocarbons

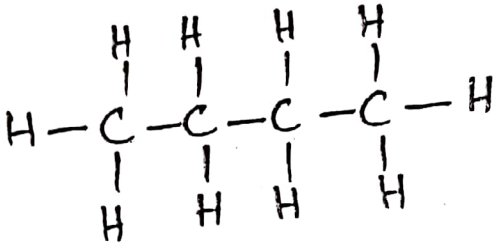
Homologous Series

Homo → Same
logous → Structure

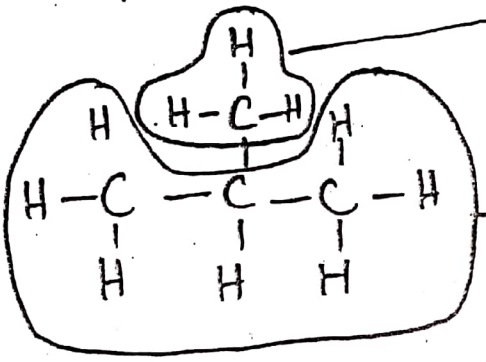
→ A series of compounds which can be represented by the same general formula.
→ Members of the homologous series have different physical properties
→ Members of the same homologous series have same chemical properties

Naming of Branched Chain Alkanes

C_4H_{10}



n-butane



C_4H_{10}

2-methyl propane

or

Iso-butane

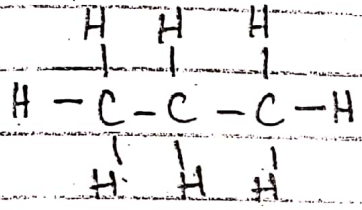
→ Those compounds which have same molecular formula but different structures are known as isomers.

→ Isomers have same chemical properties, but different physical properties.

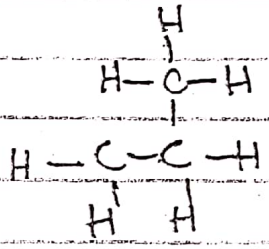
→ Every member of the homologous series differs from the next and previous member by a one CH_2 group or 14 units by mass + they have [illegible]

Naming Of Branched chained Alkanes and Isomers

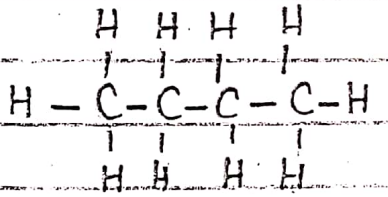
→ Branched chain hydrocarbons are those in which these is atleast one carbon atom which is directly bonded with 3 or 4 casbon atoms



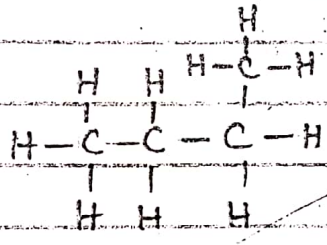
Propane
Straight chain



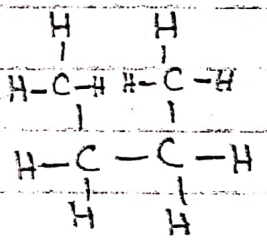
Propane
Straight Chain



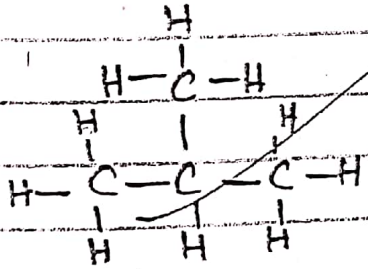
Butane
Straight Chain



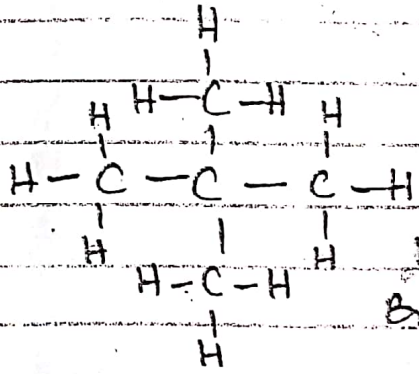
Butane
Straight Chain



Butane
Straight Chain



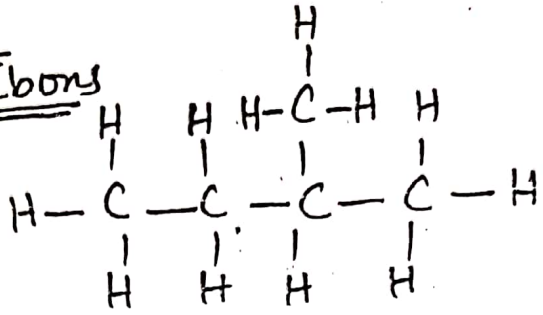
Butane
Branched Chain



Pentane
Branched Chain

(08)

Practice Naming of Hydrocarbons

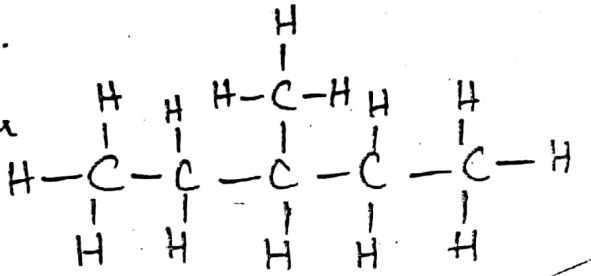


2-methyl butane
Iso-pentane

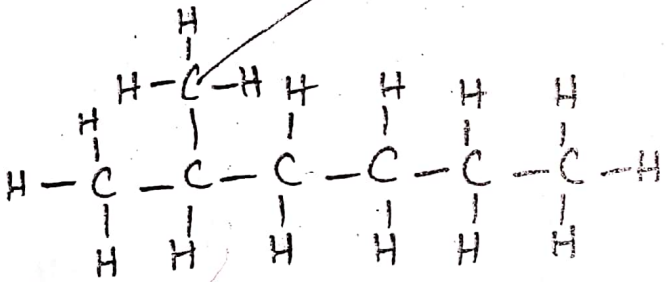
Isomers

Two or more compounds can be isomers of each other, one compound can never be an isomer alone.

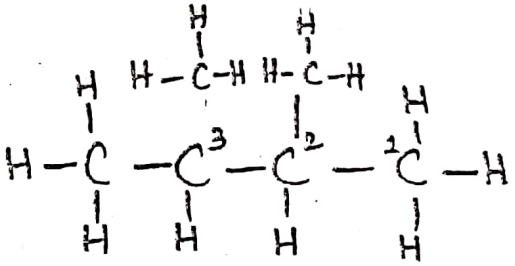
Isomers have same molecular formula but different structure.



Iso-hexane
3-methyl pentane

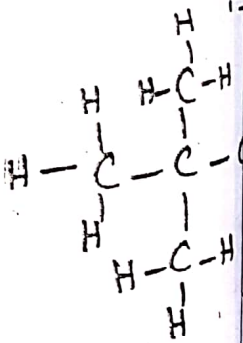


Iso-heptane
2-methyl hexane



2,3-dimethyl Butane

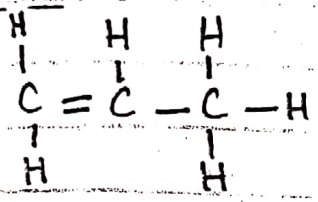
Isome



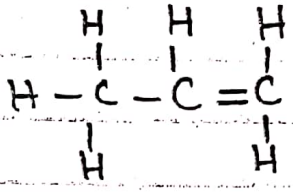
2,2-di
prop

Naming of Branched Chained Alkenes

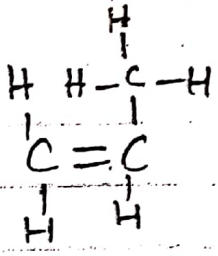
PROPENE



Propene
C_3H_6

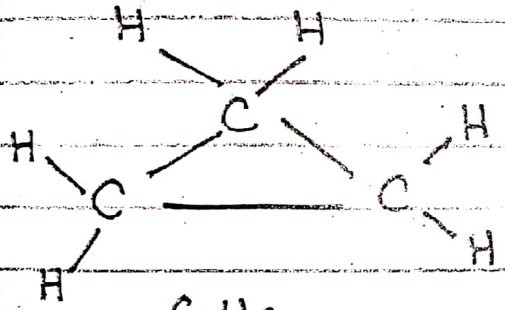


Propene
C_3H_6



Propene
C_3H_6

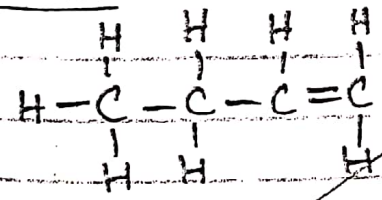
Isomer of propene



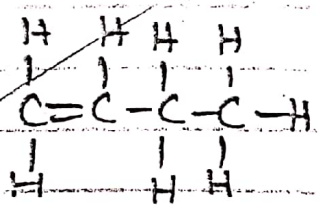
C_3H_6
Different structure
⇒ Cyclopropane

Not isomers of propene since they have the same molecular formula & also same structure!

BUTENE

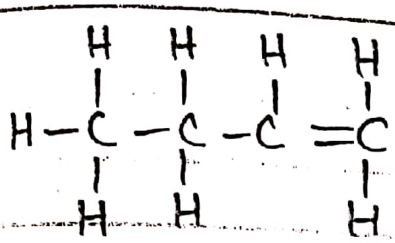


C_4H_8
Butene



C_4H_8
Butene

not isomers of each other!

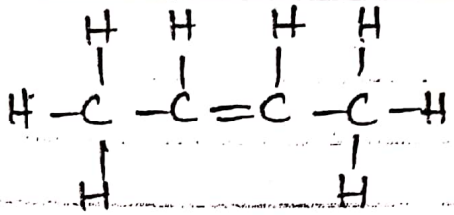


C_4H_8

1- Butene

But-1-ene

← Isomers →

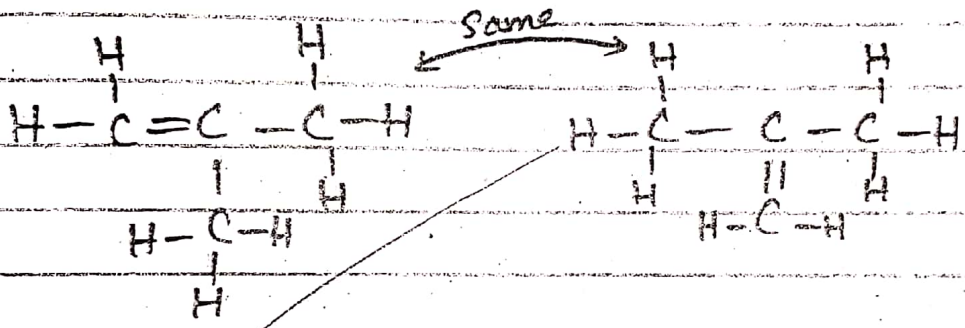


C_4H_8

2-Butene

But-2-ene

⇒ Only identification of isomers of alkenes is in syllabus! Their drawing & naming is not in syllabus!



2-methyl propene or iso-butene

C_4H_8

Trends in the physical properties of Alkanes & Alkenes

① Melting point Boiling point and density

Viscosity = density

M.P, b.p & density increases down the homologous series, due to the increase in chain length and increase in (intermolecular forces) vander waal's forces, which will need higher (greater) amount of energy to break

For ionic compounds there are electrostatic forces of

② Flammability or combustibility

Ability to combust is a physical property

Flammability or combustibility decreases down the

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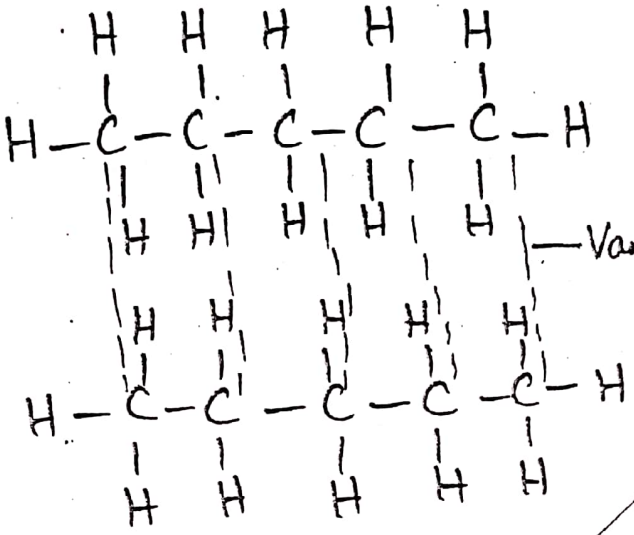
NOTE:-

- Covalent compounds have low mp & bp because of weak Van der Waal's forces which need lesser energy to break.
- Ionic compounds have higher m.p & b.p.



- Flammability or Combustibility

Inflammable = flammable

Ability of a substance to catch fire is flammability.

CH_4 (Methane) $\frac{12}{16} \times 100 = 75\%$

C_2H_6 $\frac{24}{30} \times 100 = 80\%$

Diesel: $C_{18}H_{38}$ (Octane): C_8H_{18} $\frac{96}{114} \times 100 = 84.2\%$

$C_{40}H_{82}$ $\frac{480}{562} \times 100 = 85.4\%$

C_2H_5OH $\frac{24}{44} \times 100 = 54.5\%$

C_2H_6	C_2H_4	C_2H_5OH
$\frac{24}{30} \times 100$	$\frac{24}{28} \times 100$	$\frac{24}{44} \times 100$
$= 80\%$	$= 85.7\%$	$= 54.5\%$

Highly Flammable (Lesser % by mass of carbon)

Least Flammable (Higher % by mass of carbon)

→ No gas is water soluble
→ 'Water soluble gases' means gases that react with water. Eg:-

$$NH_3 + H_2O \longrightarrow NH_4OH$$

→ Ionic compounds when dissolve in water, they form ions (e.g. $C_6H_{12}O_6$, C_2H_5OH)
→ Covalent compounds when dissolve in water, they do not form ions
(Most covalent compounds are insoluble in water! But not ALL)

~~(Most covalent compounds are insoluble in water except oils)~~

☒ ⇒ Coal, Oil are found underground → they float over water thats why we can extract them. (floats over water because are insoluble in water)

☑ ⇒ Organic Solvents are highly volatile

homologous series due to the increase in percentage by mass of carbon which will need greater amount of oxygen to combust.

→ NOTE:-
A substance with higher percentage by mass of carbon produces greater amount of energy when it completely combusts. For example :-
1 mole of diesel ($C_{18}H_{38}$) will produce greater amount of energy as compared to petrol (C_8H_{18}).

③ Solubility
Alkanes and Alkenes are insoluble in water but are soluble in organic solvents. For example :- Ethanol, petrol, kerosene etc because they are covalent compounds.

Chemical Properties of Alkanes

① → Combustion Reactions:-
Those reactions in which a substance burns in the presence of oxygen to produce heat. For example :-

$$\underset{(g)}{CH_4} + 2\underset{(g)}{O_2} \longrightarrow \underset{(g)}{CO_2} + 2\underset{(g)}{H_2O} + \text{Heat}$$

→ (For combustion) → Inorganic compounds water & CO_2 are produced.

→ Combustion of hydrogen produces water only.

→ Combustion of coke produces CO_2 only.

$$2\,(C_4H_{10} + 6\tfrac{1}{2}O_2 \longrightarrow 4CO_2 + 5H_2O + \text{Heat})$$

$$2\,C_4H_{10} + 13\,O_2 \longrightarrow 8\,CO_2 + 10\,H_2O + \text{Heat}$$

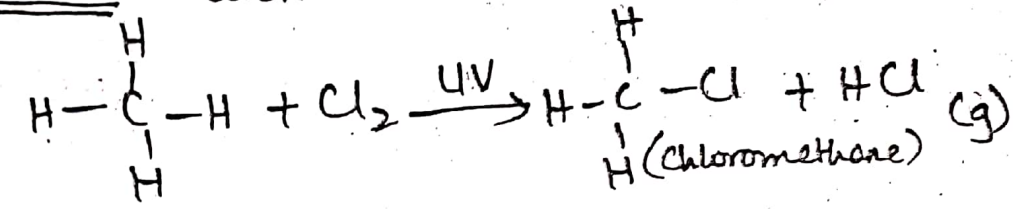
Substitution Reaction

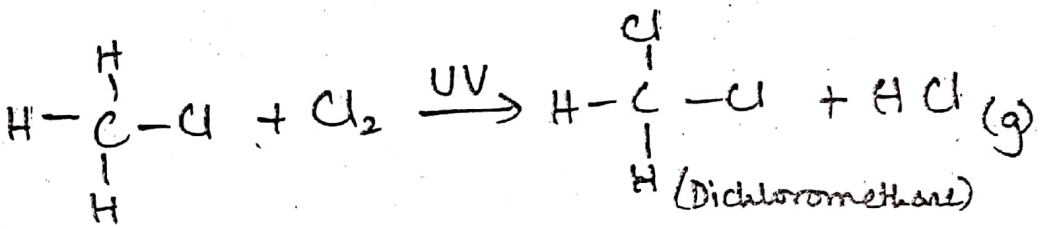
Q⇒ Why do alkanes undergo substitution reactions instead of addition reactions?

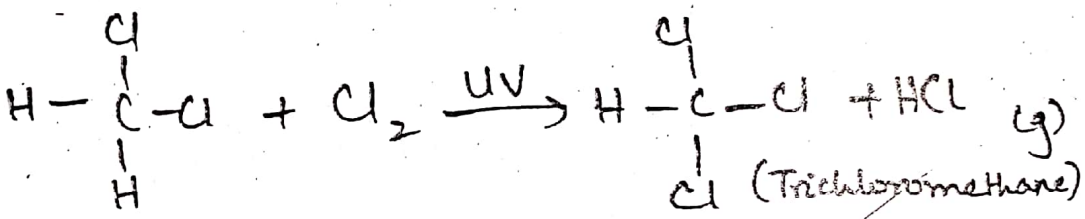
A⇒ Alkanes do not undergo addition reactions, rather substitution reactions occur because in alkanes there is single covalent bond b/w carbon atoms & carbon atoms are already bonded with four atoms. Thus, they cannot add any more atoms to their structure.

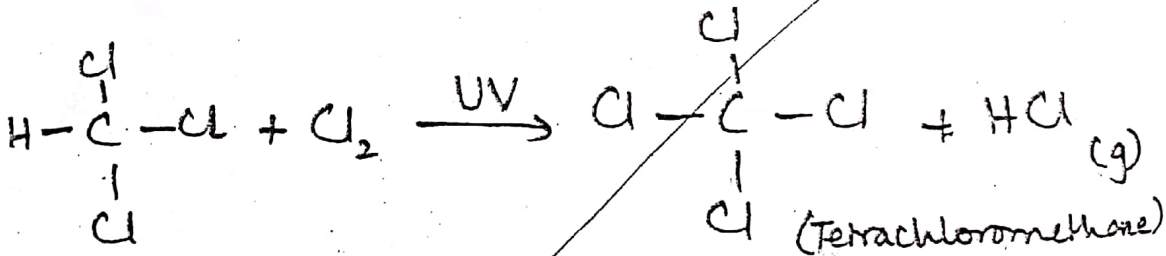
Chlorination

Diffused sunlight is used so reaction is slow









Overall Equation

$$CH_4(g) + 4Cl_2(g) \longrightarrow CCl_4(l) + 4HCl(g)$$

* $C_8H_{18} + 12\frac{1}{2} O_2 \longrightarrow 8CO_2 + 9H_2O + Heat$

$2\ C_8H_{18} + 25\ O_2 \longrightarrow 16\ CO_2 + 18\ H_2O + Heat$

Incomplete Combustion:
When there is a limited supply of oxygen.

$CH_4 + O_2 \longrightarrow CO_2\ (g) + CO\ (g) + H_2O\ (g) + Heat$

CO → poisonous gas, 5% of it in atmosphere causes death

Very limited supply of oxygen:-

$\hookrightarrow CH_4 + O_2 \longrightarrow CO_2\ (g) + CO\ (g) + C\ (s) + H_2O\ (g) + Heat$

⇒ In some cases, the greater % by mass of carbon ~~also~~ results is incomplete combustion. → smoky or sooty flame

② → Substitution Reaction

☆ $CH_4\ (g) + 4Cl_2\ (g) \xrightarrow{U.V} CCl_4\ (\ell) + 4\ HCl\ (g)$

☆ $C_2H_6 + Cl_2 \xrightarrow{UV} C_2H_5Cl + HCl$

$C_2H_5Cl + Cl_2 \longrightarrow C_2H_4Cl_2 + HCl$

$C_2H_4Cl_2 + Cl_2 \longrightarrow C_2H_3Cl_3 + HCl$

$C_2H_3Cl_3 + Cl_2 \longrightarrow C_2H_2Cl_4 + HCl$

$C_2H_2Cl_4 + Cl_2 \longrightarrow C_2HCl_5 + HCl$

$C_2HCl_5 + Cl_2 \longrightarrow C_2Cl_6 + HCl$

Overall Equation

$C_2H_6 + 6Cl_2 \xrightarrow{UV} C_2Cl_6 + 6HCl$

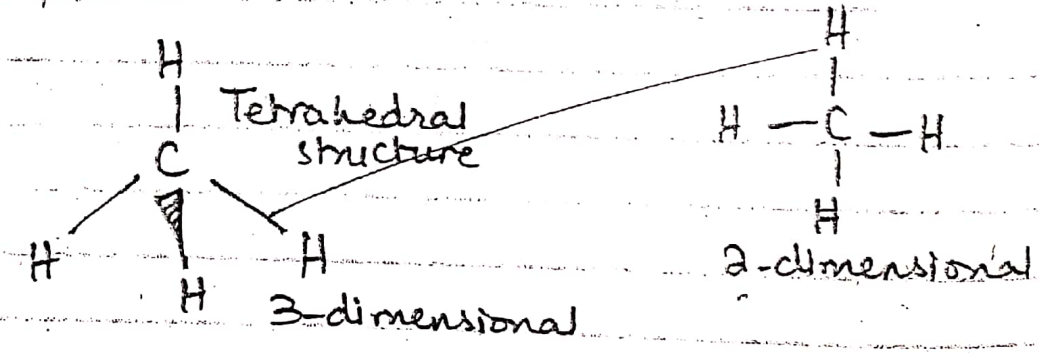
Gas of Argument
03/11/2011

Uses of Methane

→ Methane is used as domestic fuel for cooking and heating.

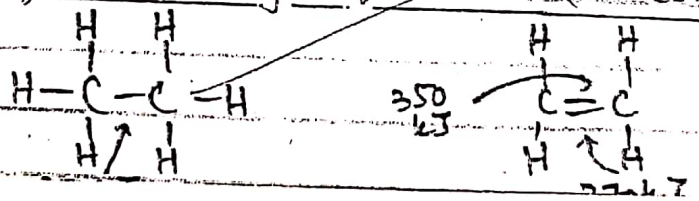
Structure of Methane

CH_4



Chemical Properties of Alkenes

① → High reactivity of alkenes (as compared to alkanes)



→ Alkenes are more reactive than alkanes due to the presence of double covalent bond between carbon atom which is weaker than single covalent bond.

(2) → **Combustion Reaction**

$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O + \text{Heat}$$

(3) → **Addition Reaction**

Those reactions in which two or more reactants combine to form a single product.

$$C_2H_4 + H_2 \longrightarrow C_2H_6$$

(Hydrogen; possible because of double covalent bond (3 atoms))

Alkenes undergo addition reactions due to the presence of double covalent bond between carbon atoms and all the carbon atoms are not bonded with four atoms, rather they are bonded with three atoms and can be bonded with one more atom.

(a) **Hydrogenation** (Addition of hydrogen)

☆ $C_2H_4 + H_2 \xrightarrow[\text{High temp.}]{Ni} C_2H_6$ (Nickel is used as a catalyst)

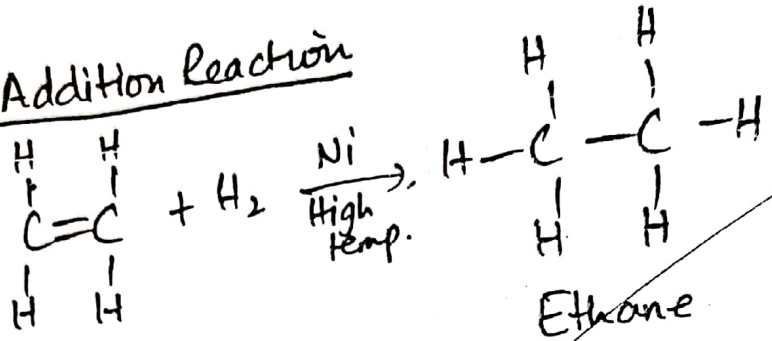
☆ $C_3H_6 + H_2 \xrightarrow[\text{High temp.}]{Ni} C_3H_8$

Application of hydrogenation reaction

$$\text{Vegetable oil} + H_2 \xrightarrow[\text{High temp.}]{Ni} \text{Margarine (Ghee)}$$

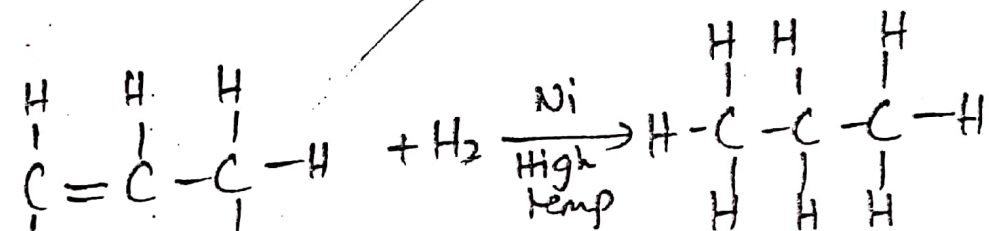
(Vegetable oil: more reactive, Poly unsaturated fat; Margarine: saturated fat (dense), less reactive; Alkanes)

Addition Reaction



Ethene.

Ethane



Propene

Propane

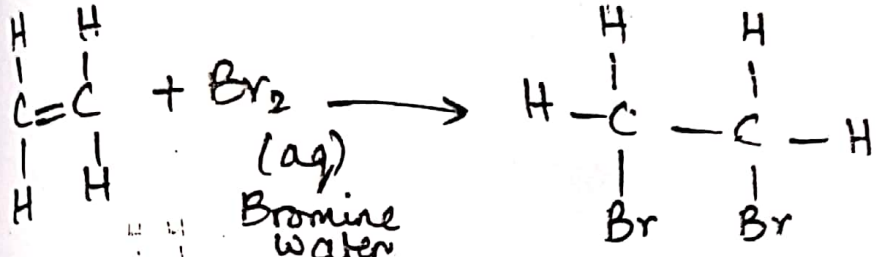
⇒ Compounds containing several double or triple covalent bonds (↓ b/w carbon atoms) are called polyunsaturated.

⇒ Vegetable oil is more reactive due to the presence of double covalent bond b/w carbon atoms which makes it easy to digest. That's why it is more recommendable.

=, For alkenes the no. will be representing the position of double bond;

Halogenation Reaction

Bromination



Bromine water

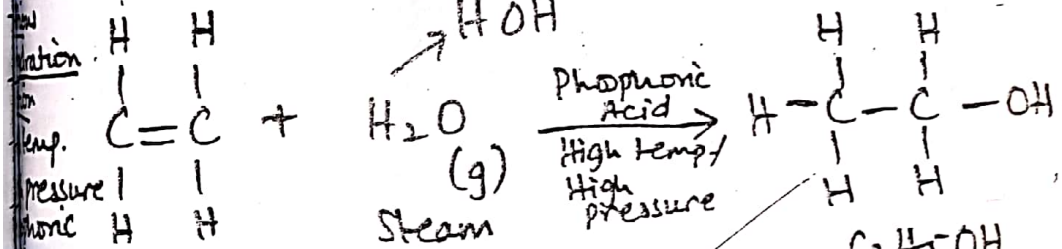
Orange red colour turns colourless after reaction

1,2 - dibromoethane

Bromine water = aqueous bromine

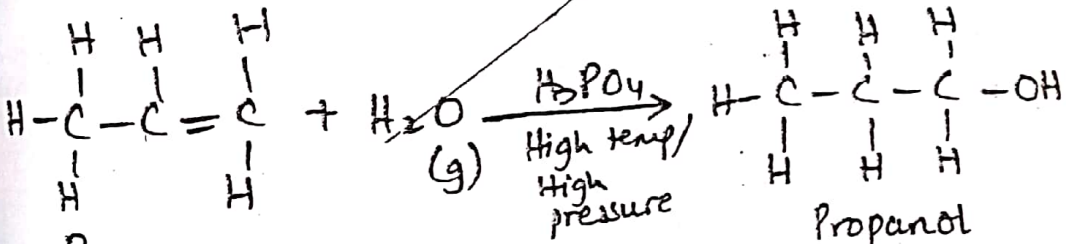
⇒ Chlorine is more reactive than Bromine, so bromine cannot react with alkanes under normal sunlight

Hydration Reaction



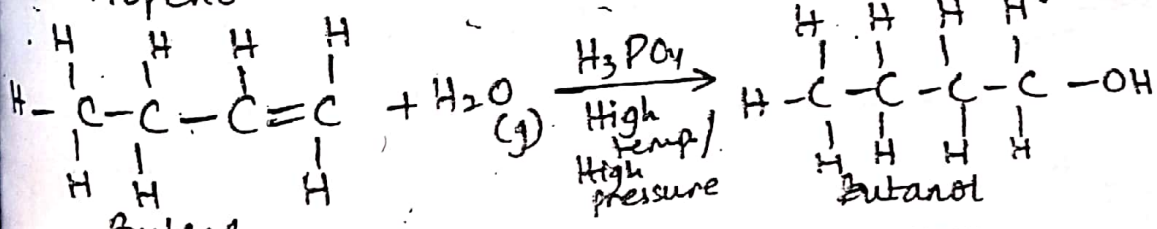
Ethene

Ethanol



Propene

Propanol



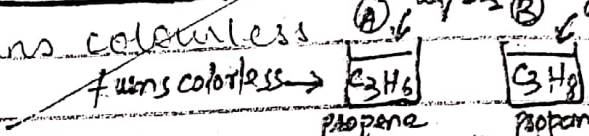
Butene

Butanol

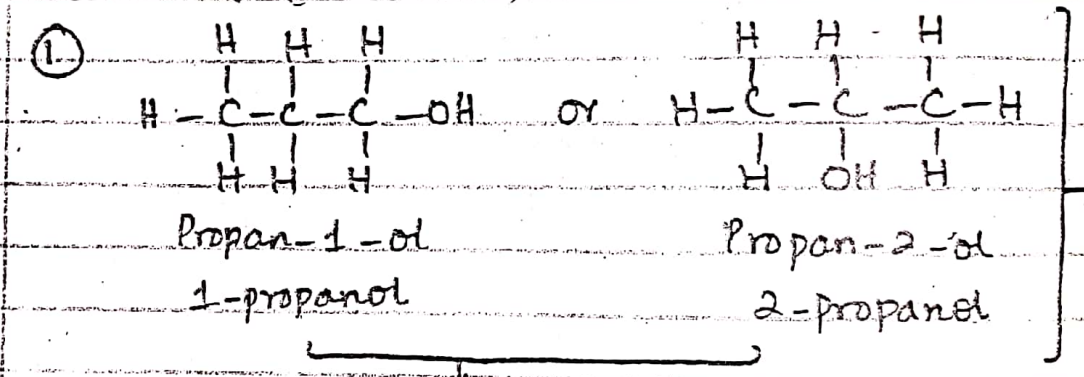
(b) Halogenation Reaction (Addition of halogens)

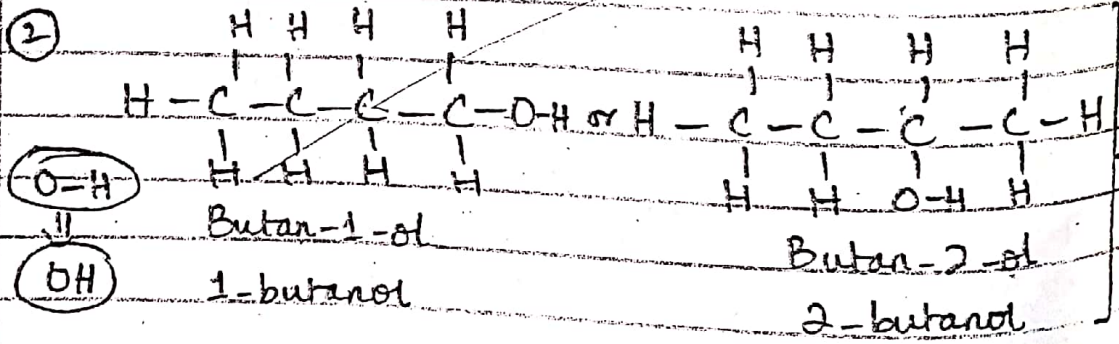
Bromination (Addition of Bromine)

Application of Bromination Reaction (addition Reaction)
Bromination reaction can be used to distinguish an alkane from an alkene. In alkanes, orange red colour of bromine water remains unchanged, but in alkenes it turns colourless.



(c) Hydration Reaction (Addition of water)
Alkenes react with steam to form their respective alcohols (or alkanol)





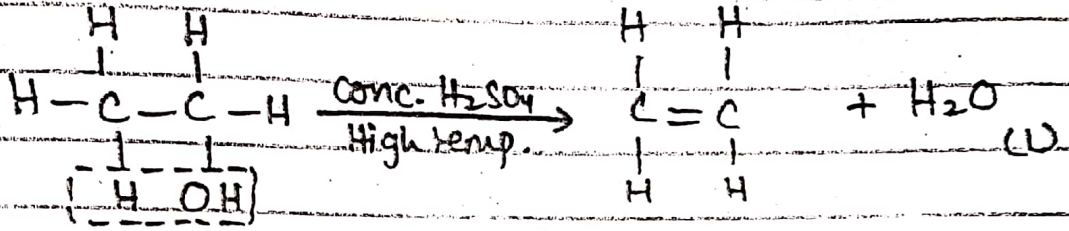
Preparation of Alkenes

① By cracking (commercial preparation) :

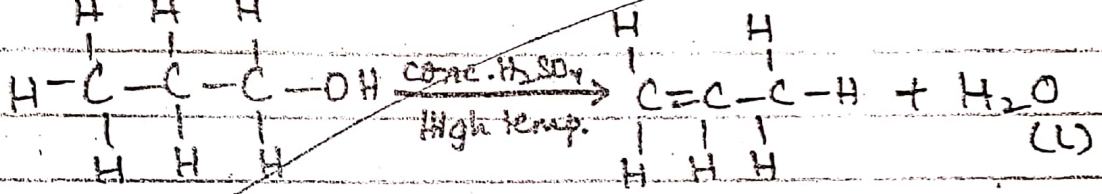
② By the dehydration of alcohols (or alkanols) (Laboratory)

Dehydration of Alcohols

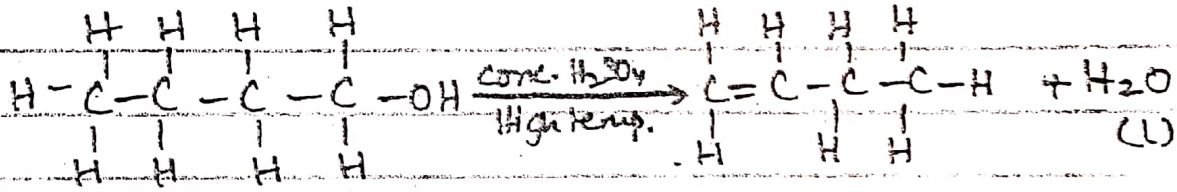
⊗ ⇒ Remove OH and then H from its neighbouring carbon.

① 

Ethanol — Ethene

② 

Propanol — Propene

③ 

Butanol — Butene

Refining of Petroleum (or Crude Oil)

Refining:

A process by which an impure substance is converted to it's pure or less impure form.

Dehydration

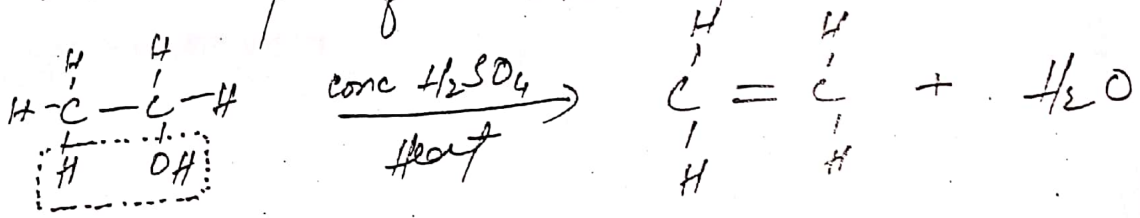
① ⇒ Conc. H_2SO_4 is a very good drying agent.

⇒ After some time, it will become dilute since the water it is removing will be added to it.

② ⇒ High temp.

☆ ⇒ H_2SO_4 is a good drying agent and dehydrating agent. It also removes chemically combined H_2O.

For example from alcohol



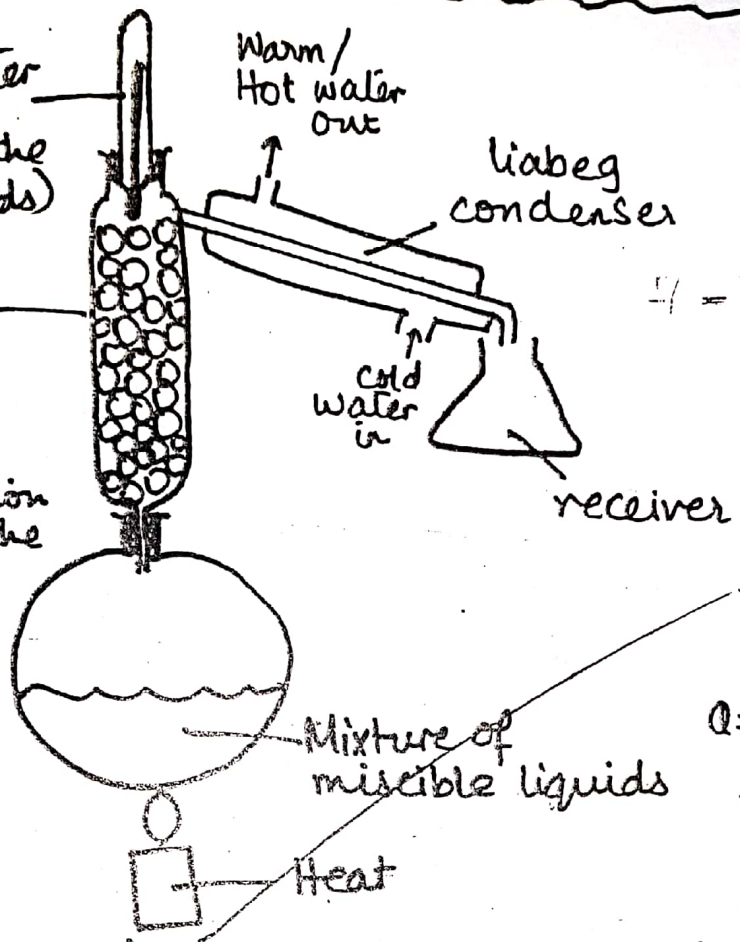
From Sugar

$$C_6H_{12}O_6 \xrightarrow[\text{Heat}]{\text{Conc } H_2SO_4} 6C + 6H_2O$$

↑ Black solid

$$C_{12}H_{22}O_{11} \xrightarrow{\quad} 12C + 11H_2O$$

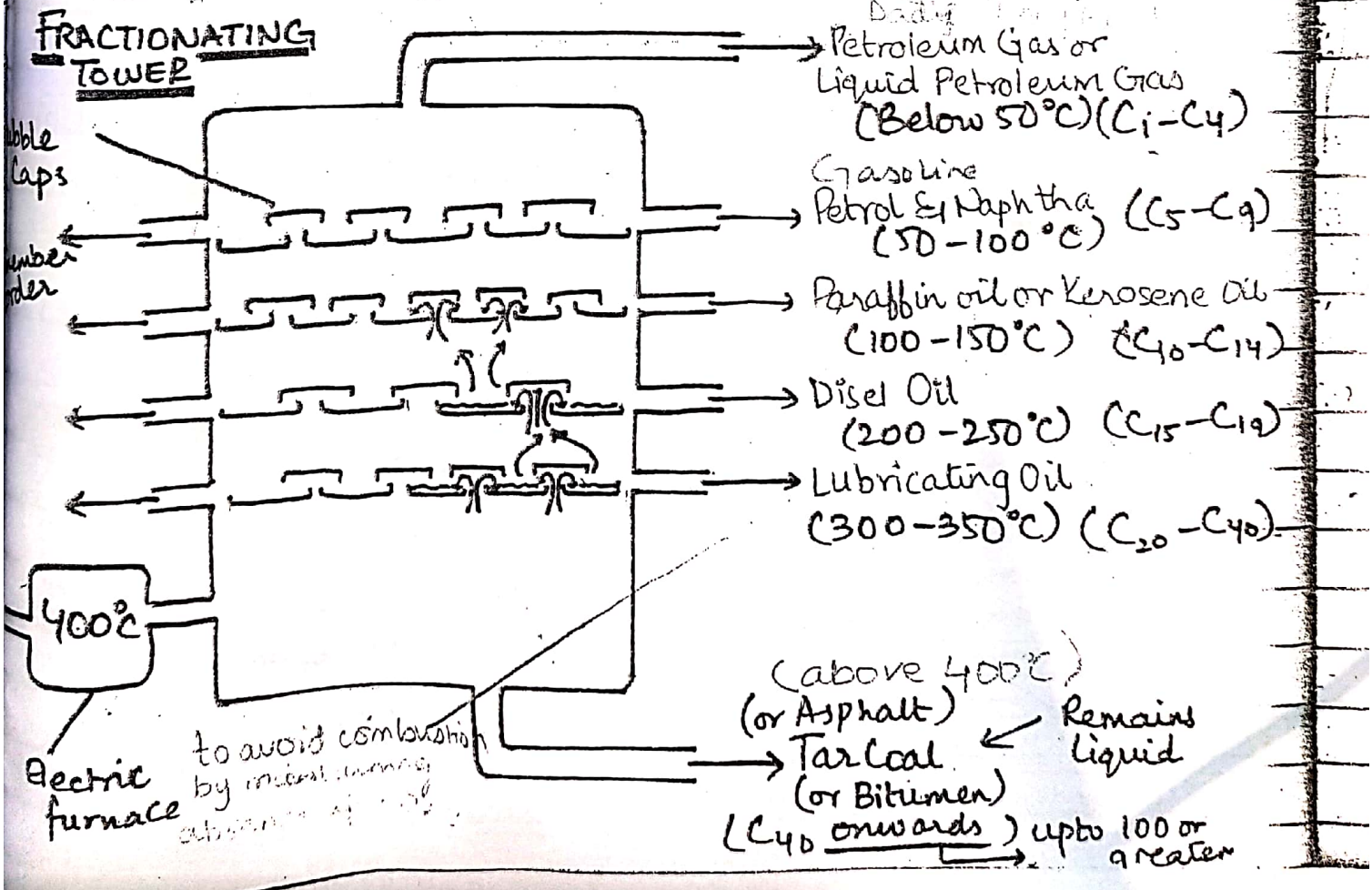
Fractional Distillation in a Laboratory



Oil Refinery

Q⇒ Why electric furnace is used?
To maintain absence of oxygen that can cause crude oil to catch fire.

Fractional Distillation in an Oil Refinery



Fractional Distillation

A process by which a mixture of miscible liquids is separated into its components due to the difference in their boiling points.

principal on which fractional distillation takes place.

Q⇒ Describe fractional distillation (or refining) of petroleum (or crude oil). (3)

A⇒ ① → Crude oil is refined by fractional distillation.

② → During the process crude oil is heated upto to 400° and is introduced from the lower part of the fractionating tower.

③ → Different fractions are separated with the help of bubble caps due to the difference in their boiling point. Heavier fractions with higher boiling point are condensed in the lower part whereas the lighter fractions with lower boiling points are condensed the upper part of the fractionating tower.

Uses of Important Fractions of Petroleum

① → Petroleum Gas or Liquid Petroleum Gas (LPG) :-
Used as a fuel for cooking and heating.

② → Petrol (Gasoline) :-
Used as fuel in automobiles (car, bike etc)

③ → Naphtha :-
Used as feedstalk (raw material) in petrochemical

industries.

④ → Paraffin or Kerosene Oil :-
Used as jet fuel.

⑤ → Disel Oil :-
Used as fuel for heavy vehicles (trucks, lorries etc)

⑥ → Lubricating Oil :-
Used as a lubricant in machines and engines

⑦ → Tar Coat :-
Used for road surfacing or carpeting.

Uses of Naphtha

→ Naptha is used in cracking to increase the yeild of petrol.
→ Naphtha is used as feedstalk (raw material) in petro-chemical industry.

Petro-chemical Industry

Industries using raw material obtained from petroleum are called petrochemical industries.
For example: plastic, rubber, cosmetics, pesticides, drugs, paint, varnish, glue, adhesives etc

⇒ Higher b.p → Greater chances of condensation

⇒ Lower b.p → Baled → Lesser chances of condensation

Greatest demand ←
- LPG
- Petrol or Gasoline C_5-C_9 → 10-15% yeild
- Naphtha C_7-C_{10}
- Kerosine Oil or Paraffin oil
- Disel Oil

} 40% yeild (Useful fractions)

Minimum demand but highest yeild
- Lubricating oil
- Tarcoal, Asphalt or Bitumen → 60% yeild (Less useful fractions)

Octane (C_8 – C_{18})

⊛ ⇒ Liquids with higher boiling point has strong intermolecular forces which develops faster on condensation

⊛ ⇒ Stronger forces will take lesser time [illegible]

Cracking

Breakdown of long chained hydrocarbons to small chain or medium chain hydrocarbons by heating them to a high temperature. (02)

Purpose of cracking

To convert less useful hydrocarbons to more useful hydrocarbons. For e.g.: to increase the yeild of petrol

Conditions of cracking

1. → High temperature
2. → Absence of oxygen
3. → High pressure
4. → Catalyst (Al_2O_3 Aluminium oxide or SiO_2 Silica or Silicon dioxide or porcelain chips) — ONLY used for cracking.

Cracking of hydrocarbons containing less than 8 carbon atoms

Purpose: To make useful alkenes e.g. ethene & propene

$C_7H_{16} \longrightarrow C_3H_6 + 2C_2H_4 + H_2(g)$

Alkane — (Propene) (Ethene) — Hydrogen → Biproduct

$C_6H_{14} \longrightarrow 3C_2H_4$ or $2C_3H_6 + H_2(g)$

$C_5H_{12} \longrightarrow C_3H_6 + C_2H_4 + H_2(g)$

$C_4H_{10} \longrightarrow 2C_2H_4 + H_2$

Cracking of Hydrocarbons containing more than 8 carbon atoms

Purpose: To increase yield of petrol which is mainly octane (C_8)

$C_{10}H_{22} \xrightarrow{\text{cracking}} C_8H_{18} + C_2H_4$
(Octane) (Ethene)

$C_{11}H_{24} \xrightarrow{\text{cracking}} C_8H_{18} + C_3H_6$
(Octane) (Propene)

$C_{12}H_{26} \xrightarrow{\text{cracking}} C_8H_{18} + 2C_2H_4$
(Octane) (Ethene)

Among the alkenes, the useful alkenes are ethene and propene → used in petrochemical industry

$C_{13}H_{28} \xrightarrow{\text{cracking}} C_8H_{18} + C_2H_4 + C_3H_6$
(Octane) (Ethene) (Propene)

Best Answer! Greater demand.

$C_{14}H_{30} \xrightarrow{\text{cracking}} C_8H_{18} + 2C_3H_6 \text{ or } 3C_2H_4$
(Octane) (Propene) (Ethene)

$C_{15}H_{32} \xrightarrow{\text{cracking}} C_8H_{18} + C_3H_6 + 2C_2H_4$
(Octane) (Propene) (Ethene)

$C_{16}H_{34} \xrightarrow{\text{cracking}} C_8H_{18} + 4C_2H_4$
(Octane) (Ethene)

$C_{17}H_{36} \xrightarrow{\text{cracking}} C_8H_{18} + 3C_3H_6 \text{ or } C_3H_6 + 3C_2H_4$
(Octane) (Propene)

$C_{18}H_{38} \xrightarrow{\text{cracking}} C_8H_{18} + 5C_2H_4$
(Octane) (Ethene)

16/11/2011

Titration

... Acidified $KMnO_4$ & aq $FeSO_4$

aq $FeSO_4$
colourless or Green
... appears to be ...

acidified $KMnO_4$
Purple or Pink.
In lab when we see colour change, it will appears to be Pink since it will be very dilute.

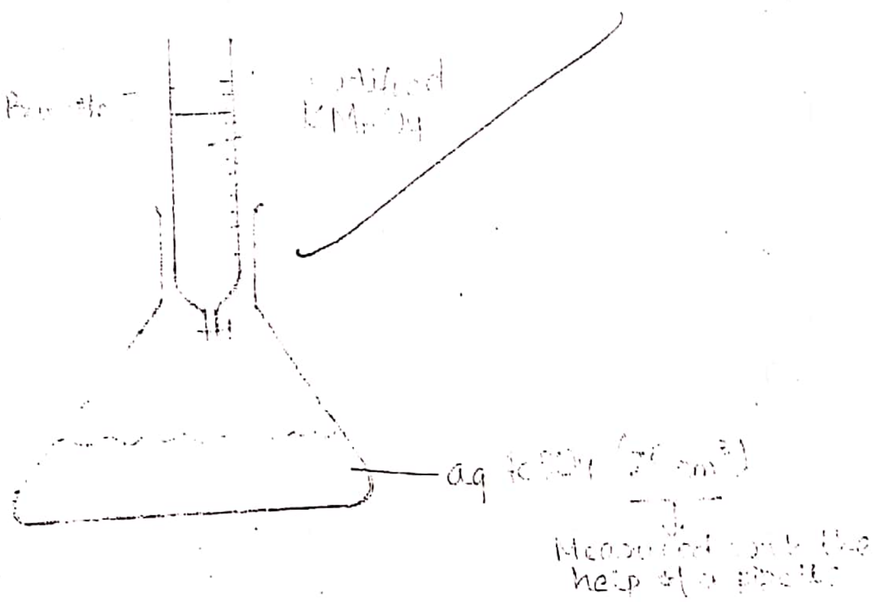
⇒ End Point of this titration means that nomore aq $FeSO_4$ will be present in the conical flask.

$FeSO_4$ always ... in the ... flask
... acidified ... is always ... in the ...

COLOUR CHANGE AT THE END-POINT

Colourless to Purple/Pink
or
Green to Purple/Pink

⇒ Colour change refers to the ... in the ... flask. As soon as $KMnO_4$ falls in flask, it turns colourless. The change in colour at the end point is when $FeSO_4$ ... that is
Colourless → Pink



Tuesday 15th November

Lab Activity

Titration

Oxidising Agent = Acidified $KMnO_4$

Reducing Agent = Aqueous $FeSO_4$

not needed!

Acidified aq $KMnO_4$ (Purple or Pink)

Aq $FeSO_4$ (Green) or colourless

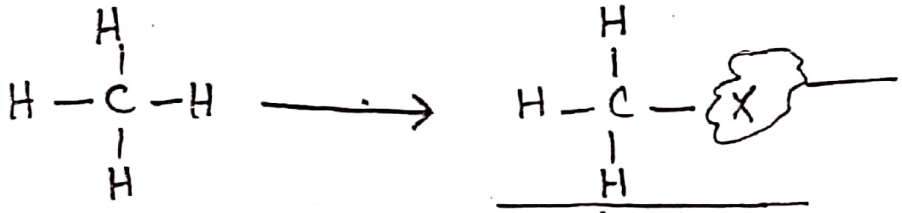
Only in titration because solution is very dilute

Titration

1st Reading = 27.6 cm^3

2nd Reading = 27.5 cm^3

Alcohols & Carboxylic Acids



Functional Group' is an atom or group of atoms that determine the properties of a compound

derivative of hydrocarbon

Types of Functional Groups

Name	Formula	Structure	Name of compound containing functional group
Hydroxyl Group	$-OH$	$-O-H$	Alcohols
Carboxylic acid Group	$-COOH$	$-C(=O)-O-H$	Carboxylic Acids
Ester Group	$-COO-$	$-C(=O)-O-$	Esters
Amine Group	$-NH_2$	$-N(H)-H$	Amines
Amide Group	$-CONH$	$-C(=O)-N(H)-H$	Amides

Members of the same homologous series have similar chemical properties because they have the same functional group.

Wednesday 15 November

Organic Chemistry

Cracking of hydrocarbons containing less than 8 carbon atoms (continuation)

$C_3H_8 \longrightarrow C_3H_6 + H_{2(g)}$

$C_2H_6 \longrightarrow C_2H_4 + H_{2(g)}$

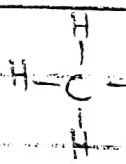
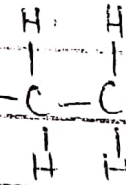
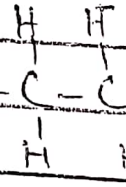
$CH_4 \longrightarrow C + 2H_{2(g)}$

Alcohols & Carboxylic Acids

Naming of Alcohols

→ Named by suffixing "ol" after replacing "e" of alk

→ Their general formula is $C_nH_{2n+1}OH$ $C_nH_{2n+2}O$

Name	Formula	Structure (Displayed Formula)	State
Methanol	CH_3OH		Liquid
Ethanol	C_2H_5OH		Liquid
Propanol	C_3H_7OH		Liquid

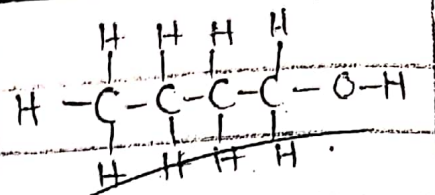
Alcohol → Carboxylic Acid.

Oxidation Reaction

→ When we add acidified $K_2Cr_2O_7$ (oxidising agent)
it will turn from orange to green.

+

Heat / warm / boil / reflux.

Butanol	C_4H_9OH		Liquid

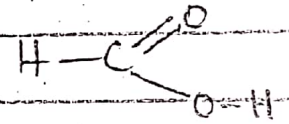
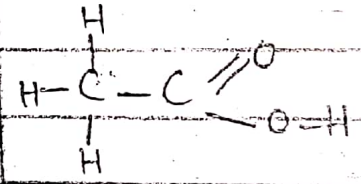
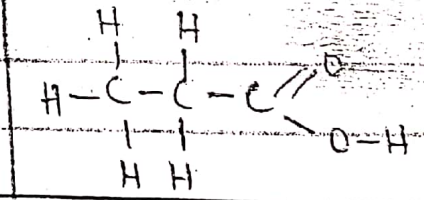
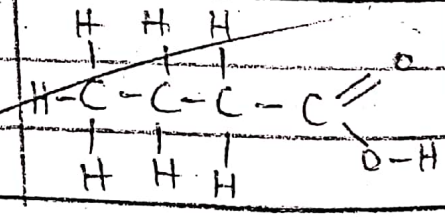
Naming of Carboxylic Acids

→ Named by suffixing "oic acid" after replacing "e" of alkane

→ Their general formula is $C_nH_{2n+1}COOH$

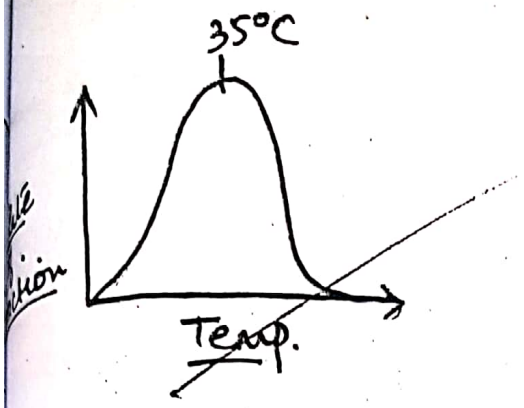
$C_nH_{2n}O_2$

Homologous Series of Carboxylic Acids

Name	Formula	Structure	State
Methanoic Acid	$HCOOH$		Liquid
Ethanoic Acid	CH_3COOH		Liquid
Propanoic Acid	C_2H_5COOH		Liquid
Butanoic Acid	C_3H_7COOH		Liquid

Trends in the physical properties of alcohols and carboxylic Acids

next page!!



Alcohols & Carboxylic Acids

Physical Properties

→ Mp, b.p & density increases on going down the homologous series. This is due to an increase in chain length of the molecules. Therefore there is an increase in the Vander waal's forces, which will need greater amount of energy to breake.

→ Flammability or combustibility decreases down the homologous series. This is due to an increase in percentage by mass of carbon which will need greater amount of oxygen to combust completely.

NOTE

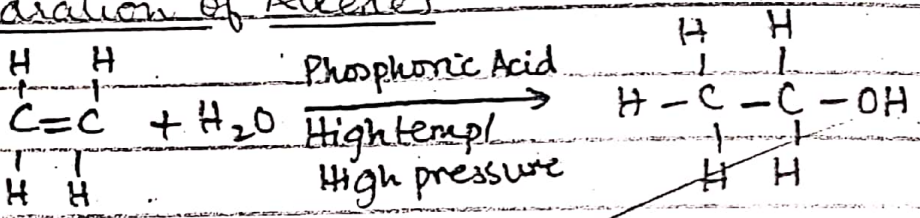
A substance which has greater % by mass of carbon, produces greater energy when it combusts completely.

→ They show similar trends in melting points, boiling points, density and flammibility, which are shown by alkanes and alkenes.

→ Unlike alkanes and alkenes, alcohols and carboxylic acids are soluble in water + organic solvents.

Preparation of Alcohols

① → By Hydration of Alkenes



② → Fermentation (only ethanol can be prepared by fermenta

$$C_6H_{12}O_6 \xrightarrow[\text{Absence of } O_2,\ \text{Optimum temp. } (20\text{–}35^\circ C)]{\text{Yeast}} 2C_2H_5OH + 2CO_2$$

(aq) (aq) (g)

Sugar

20–40°C — Fermented Liquor

→ Yeast is a biological catalyst & it speeds up the chemical reaction.

→ Absence of oxygen is required because yeast need anaerobic conditions and it is also present to prevent oxidation of ethanol to ethanoic acid. → reducing agent.

→ Optimum temperature of 20–35 °C is required because below this temperature yeast becomes inactive & above this temperature, yeast is denatured (killed).

→ Resulting mixture is a mixture of ethanol and

water and is called fermented liquor, which is separated by fractional distillation.

Uses of Ethanol

① → Ethanol is used in alcoholic beverages for drinking

② → " " " as a fuel in racing cars

③ → " " " " a solvent to dissolve organic compounds for e.g paint, glue etc. + perfumes & deodrants

Advantages of using Ethanol as fuel

→ On combustion it produces lesses amount of pollutant gases as it undergoes complete combustion which is due to the lesser percentage by mass of carbon as compared to fuel fossil fuels

→ It is a renewable source of energy while fossil fuels are non-renewable sources of energy. because ethanol is prepared from sugarcane

Disadvantages of using Ethanol as fuel

→ Ethanol is more expensive than fossil fuels

⇒ Majority of the covalent compounds are insoluble in water & those which are soluble, do not form ions when they dissolve in water (Acids are an exception)

Non-Alkaline Nature of Alcohols!

Activity	C_2H_5OH in water	NaOH in water
Red Litmus	No change	Turns blue
Electrolysis	Non-conductor	Conductor
NH_4Cl (aq)	No reaction	NH_3 (damp litmus paper turns blue) → Pungent smell

Alcohols are not alkaline in nature as they don't produce hydroxide ions when dissolved in water.

Tuesday 22nd November, 2011

Organic Chemistry

Chemical Properties of Carboxylic Acids

① → Organic acids are weaker acids than mineral acids (inorganic acids)

Ionization in water

☆ $CH_3COOH_{(l)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$

(Ethanoic acid) (Ethanoate ion)

☆ $HCOOH_{(l)} + H_2O_{(l)} \rightleftharpoons HCOO^-_{(aq)} + H^+_{(aq)}$

(Methanoic acid) (Methanoate ion)

☆ $C_2H_5COOH_{(l)} + H_2O_{(l)} \rightleftharpoons C_2H_5COO^-_{(aq)} + H^+_{(aq)}$

(Propanoic acid) (Propanoate ion)

② → Reaction with metals

☆ $Mg_{(s)} + 2CH_3COOH_{(aq)} \longrightarrow (CH_3COO)_2Mg_{(aq)} + H_{2(g)}$

(Magnesium Ethanoate)

☆ $Zn_{(s)} + 2C_3H_7COOH_{(aq)} \longrightarrow (C_3H_7COO)_2Zn_{(aq)} + H_{2(g)}$

Zinc Butanoate

③ → Reaction with metal carbonates

☆ $CaCO_{3(s)} + 2CH_3COOH_{(aq)} \longrightarrow (CH_3COO)_2Ca_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

(Ethanoic acid) (Calcium Ethanoate)

☆ $Na_2CO_3 + 2C_3H_7COOH \longrightarrow 2C_3H_7COONa + H_2O + CO_2$
(s) (aq) (aq) (l)
(Butanoic Acid) (Sodium Butanoate)

⑥ → Reaction with metal Oxide

☆ $MgO + 2CH_3COOH \longrightarrow (CH_3COO)_2Mg + H_2O$
(s) (aq) (aq) (l)
(Ethanoic Acid) (Magnesium Ethanoate)

☆ $CuO + 2HCOOH \longrightarrow (HCOO)_2Cu + H_2O$
(s) (aq) (aq) (l)
(Methanoic Acid) (Copper(II) Methanoate)

☆ $Al_2O_3 + 6C_2H_5COOH \longrightarrow 2(C_2H_5COO)_3Al + 3H_2O$
(s) (aq) (aq) (l)
(Propanoic Acid) (Aluminium Propanoate)

⑦ → Reaction with metal hydroxide

☆ $NaOH + HCOOH \longrightarrow HCOONa + H_2O$
(aq) (aq) (aq) (l)
(Methanoic Acid) (Sodium Methanoate)

☆ $KOH + C_3H_7COOH \longrightarrow C_3H_7COOK + H_2O$
(aq) (aq) (aq) (l)
(Butanoic Acid) (Potassium Butanoate)

☆ $NH_4OH + C_3H_7COOH \longrightarrow (C_3H_7COO)NH_4 + H_2O$
(aq) (aq) (aq) (l)
(Butanoic Acid) (Ammonium Butanoate)

Esterification

Neutralisation Reaction

$NaOH + HCl \longrightarrow NaCl + H_2O$

Esterification Reaction

(Ethanol)

(Ethanoic Acid)

Ester Group (functional group)

conc. H_2SO_4 is used as a catalyst!

High temp.

$+ H_2O$ (g)

CH_3COO → Alkanoate → Ethanoate

C_2H_5 → Alkyl → Derived from alcohol part → Ethyl

NAME ⟹ Ethyl Ethanoate

i, $HCOOC_4H_9$: Ester (Butyl Methanoate)

ii, $HCOOC_2H_5$: Ester (Ethyl Methanoate)

iii, C_4H_9COOH : Carboxylic Acid

iv, C_2H_5COOH : Propanoic Acid

Wednesday 23rd November 20

Organic Chemistry

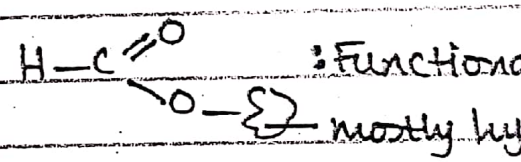
Esterification Reaction

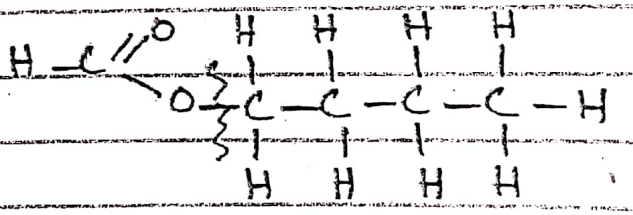
When an alcohol reacts with a carboxylic acid, it forms ester and water. This reaction is called esterification reaction.

Q⇒ HCO_2 / HCOO

$HCOOC_4H_9$

Draw the structure and write the name of this compound. Write the name of the reactant which has formed this compound.





Butyl Methanoate

Name of reactants: Butanol, Methanoic Acid

Uses of Esters

① → Esters are used as artificial flavours in juices because of their sweet smell

② → They are used in perfumes because of their pleasant fragrance

③ → They are used as solvents to dissolve organic compounds.

10th January, 2012

Polymers & Macromolecules

Poly (many) mers (units)

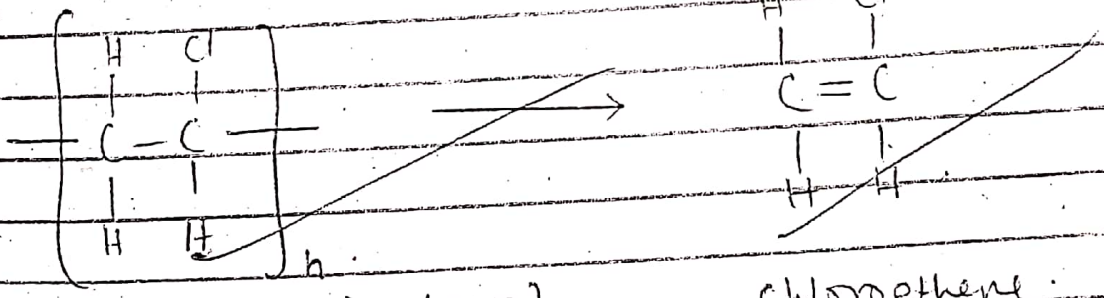
→ When large number of small molecules combine, they form a big molecule. This big molecule is called polymer.

→ Small molecules are called monomers.

Macromolecules

→ A giant molecule made up of a large no. of atoms covalently bonded together.

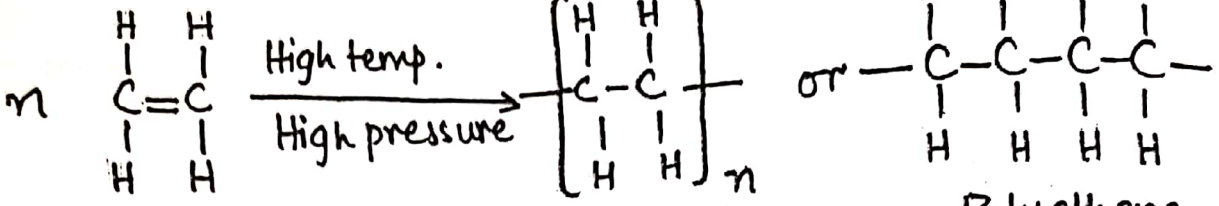
→ All polymers are also macromolecules but not all macromolecules are polymers. For example, diamond graphite and silica are macromolecules but not polymers.



Polyvinyl chloride (PVC)
Polychloroethene

Chloroethene

Polyethene



Ethene

Polyethene (1 repeating unit)

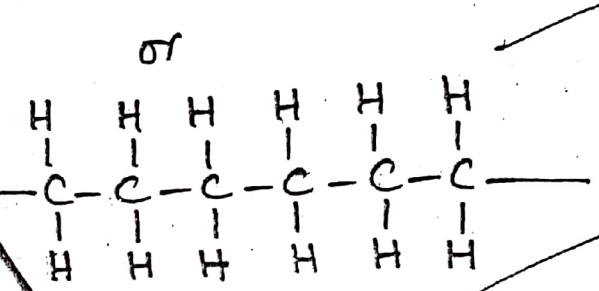
Polyethene (2 repeating units)

Types of Polymers

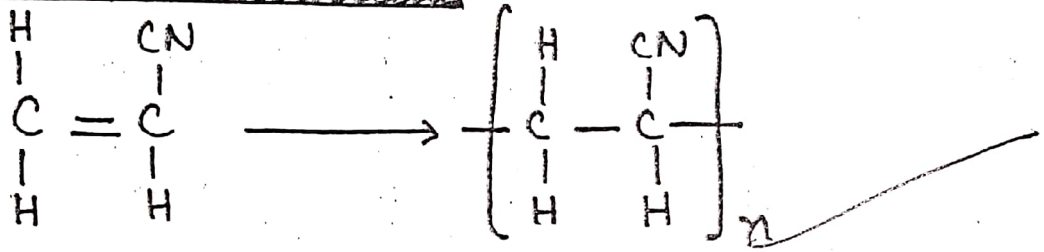
Addition Polymers
- → No by-product is formed.
- → Only unsaturated organic compounds are involved

E.gs: Polyethene etc

Condensation Polymers
- → A by-product is formed which is water
- → Both saturated & unsaturated organic compound are involved.

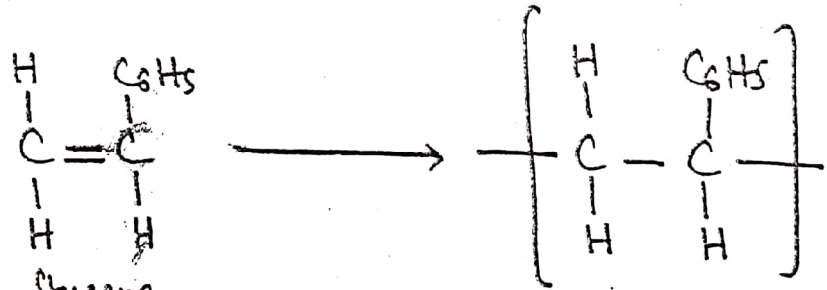


Polyethene (3 repeating units)



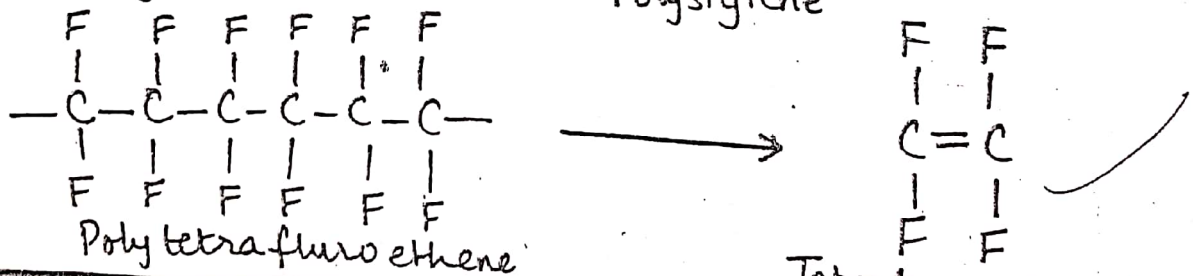
Acrylonitride

Polyacrylonitride



Styrene

Polystyrene

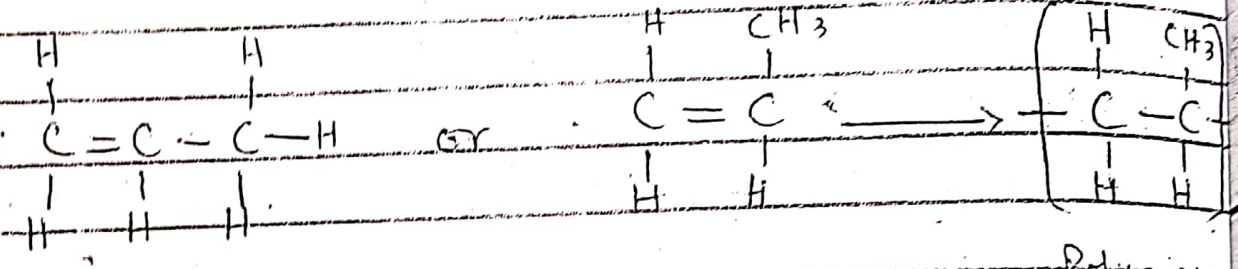


Polytetrafluoroethene

Tetrafluoroethene

Polymers

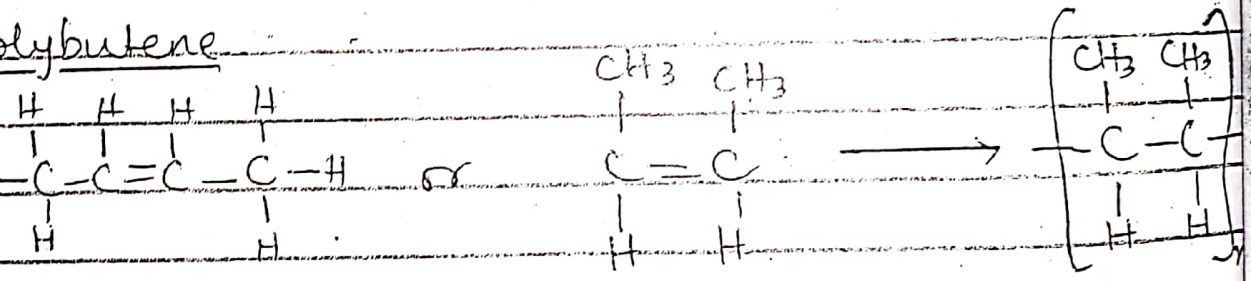
Polypropene



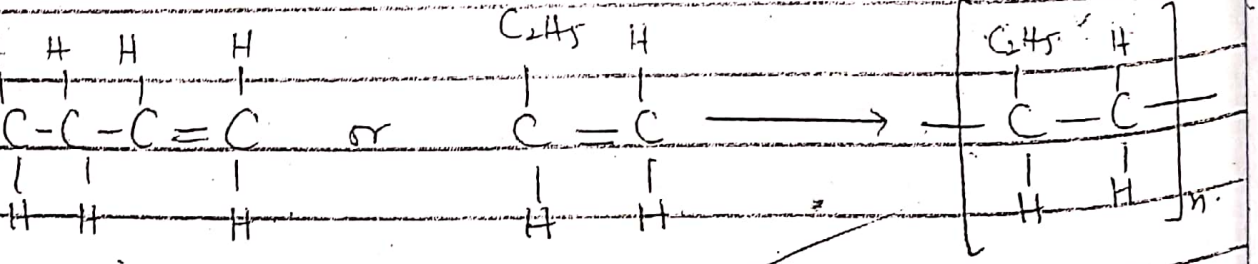
Propene — Polypropene

→ Polyethene is used in making plastic bags, plastic sheets and cling films

Polybutene



2-Butene — Polybutene



1-butene — Polybutene

Advantages of plastics or polymers

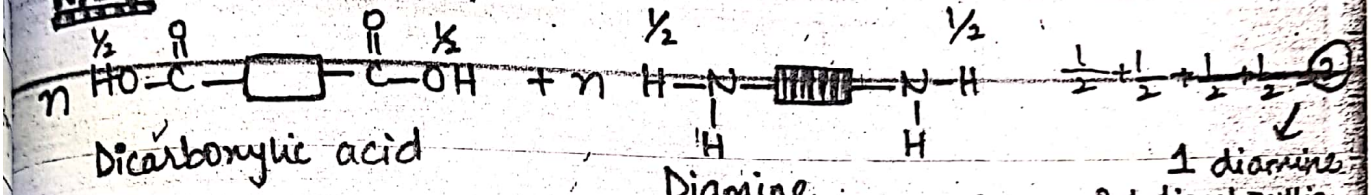
① → cheapes

Natural fibre
cotton, wool, silk

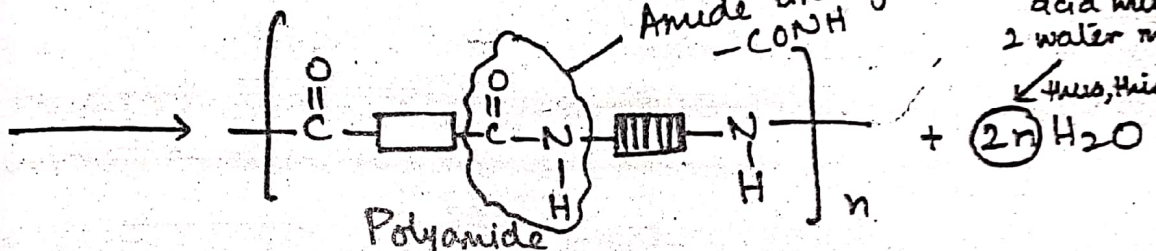
Condensation Polymers

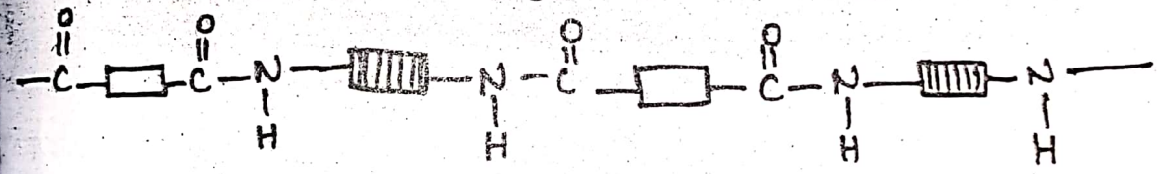
- Synthetic
  - Nylon
  - Terylene (Polyester)
- Natural
  - fats
  - proteins
  - carbohydrates

NYLON (It is a synthetic fibre)



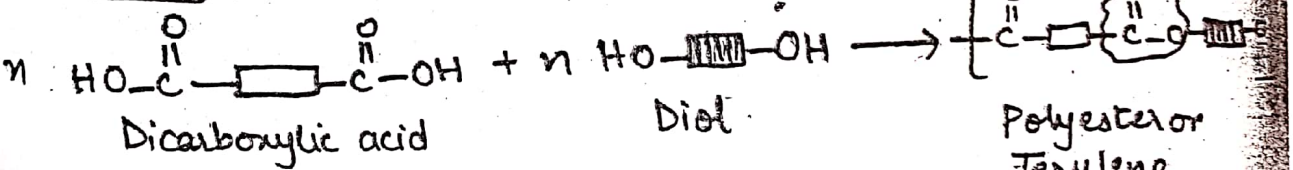
1 diamine & 1 dicarboxylic acid will make 2 water molecules
Thus, this

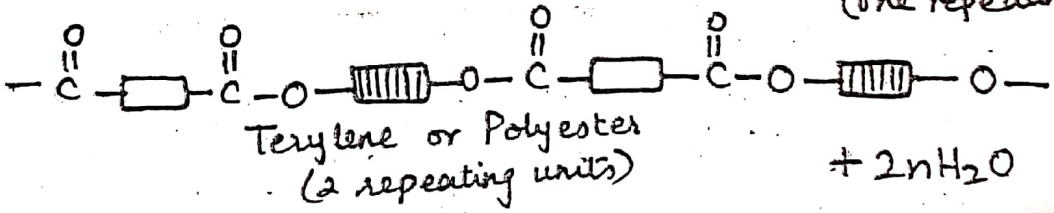




Polyamide or Nylon (two repeating units)

TERYLENE (It is an ester)





(Insulator)
② → non-conductors of electricity and heat.
③ → Can easily be coloured
④ → easy to mould or shape.
⑤ → light weight.
⑥ → transparent.
⑦ → Plastics are resistant to corrosion.

Disadvantages of plastics

① → Plastics cause litter problems.
② → They block drains and sewers
③ → They need more landfill sites to dump. This is because plastics are non-biodegradable, that is they cannot be decomposed by bacteria.

Advantage of disposing plastic by heating

① → On burning plastics produce heat energy which can be used to produce electricity

Disadvantage of disposing plastics by heating

① → On burning, plastics produce toxic or poisonous fumes which pollute the environment

Uses of nylon

→ It is used in clothing, sleeping bags, ropes, parachute, fishing nets, fishing lines, tents

Uses of Terylene/polyester

→ It is used in clothing, ~~fishing nets, fishing line, tents~~

Q ⇒ Write the advantage of using nylon in fishing nets other than strength. 45

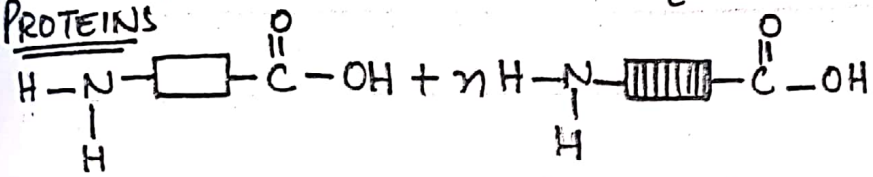
A ⇒ When wet, it floats on water and helps in catching fish.

Disadvantage of using nylon in fishing nets

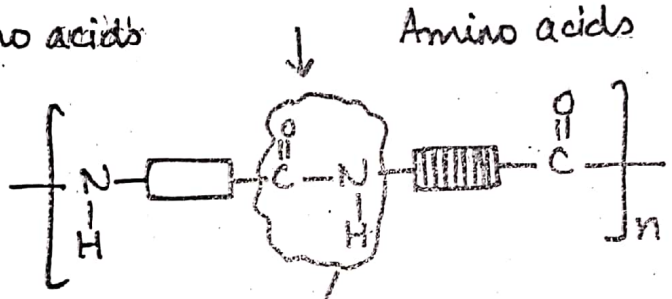
A ⇒ It is non-biodegradable, thus causes litter problems & will need more landfill sites to dump.

Natural Condensation Polymers

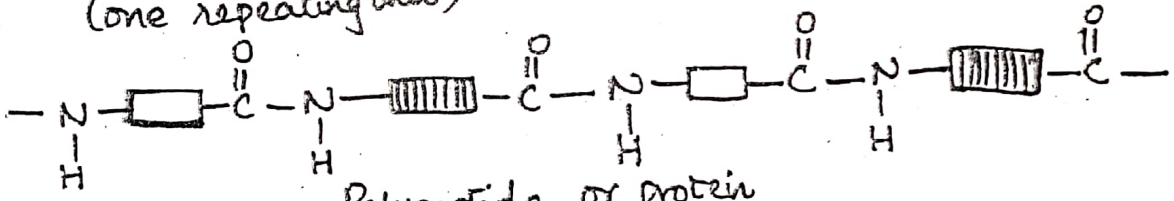
PROTEINS



Amino acids Amino acids



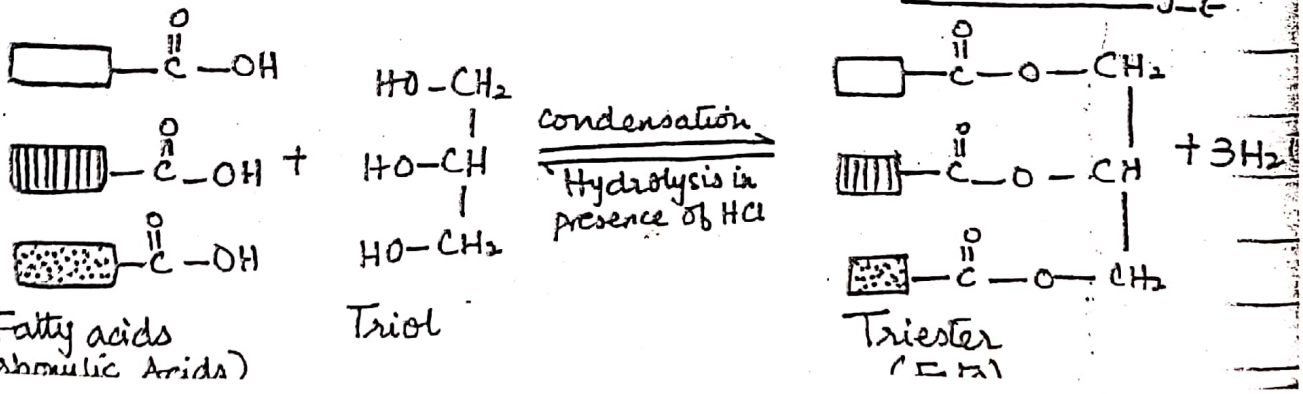
Polypeptides or proteins (one repeating unit) Peptide linkage



Polypeptide or protein (two repeating units)

FATS

⇒ 3 ester linkages



Fatty acids (Carboxylic Acids) Triol Triester (Fat)

~~Parachute, umbrella~~ and ropes. It is also used for making sails in boats and fixwater hoses, curtains sails, pillow cases,

Natural Condensation polymers

① → Proteins

Made up of amino acids

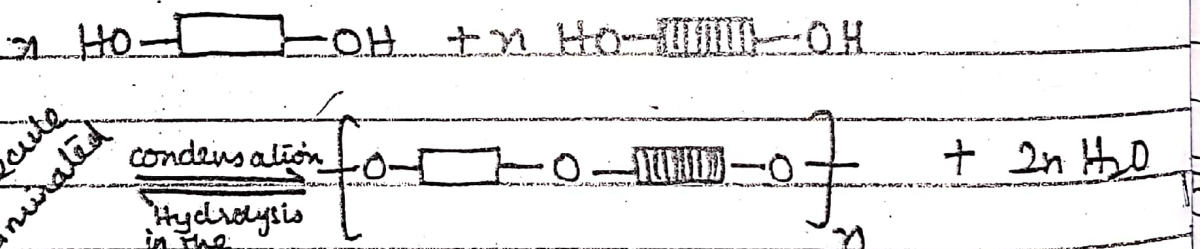
② → Fats

Fats are esters.

③ → Starch (Carbohydrates)

$C_6H_{12}O_6 + C_6H_{12}O_6 \rightarrow C_{12}H_{22}O_{11} + H_2O$

Glucose Glucose Maltose



Starch (Carbohydrate)
Two repeating unit

$n C_6H_{12}O_6 \xrightarrow[\text{Hydrolysis in the presence of HCl}]{\text{Condensation}} (C_6H_{10}O_5)_n + n H_2O$