**RATU NAVULA COLLEGE**

**WEEK 5 YEAR 12B : CHEMISTRY NOTES & ACTIVITIES**

**LESSON NUMBER: 54**

**STRAND: 4. MATERIALS**

**SUB-STRAND: 4.2. ORGANIC CHEMISTRY**

**LEARNING OUTCOME:**

Investigate the different classes and reactions of hydrocarbons

**Hydrocarbons** – compounds containing only hydrogen and carbon

**Aliphatic hydrocarbons** – include straight chain, branched chain and cyclic compounds (aromatic hydrocarbons)

**Saturated Hydrocarbons** – contain only C-C single bonds (Alkanes)

**Unsaturated hydrocarbons** – possess at least one C=C double or C≡C triple bond. (Alkenes)

**Natural Gas**

* is a mixture of hydrocarbons: 78% methane, ethane, propane and butane. It is sold as CNG (Crude Natural Gas) and is used as fuel in heating and cooking.
* LNG (Liquefied Natural Gas) is essentially methane and ethane while LPG (Liquid Petroleum Gas) consists mainly of propane and butane.

**ALKANES (or paraffins)**

**General Formula : CnH(2n+2) Names end with: -ane**

Alkanes are a homologous series

*[Homologous series: is a series where one member differs from each other by a single CH2 group]*

Methane, ethane, propane and butane are gases at room temperature. The rest are liquids. As the number of carbon atoms in alkanes increases, the melting point and boiling point also increase.

**Sources of Alkanes**

1. Alkanes occur in **abundance in petroleum (oil)** from which they may be separated to a large degree by **fractional distillation.**

2. Another source **of alkanes is natural gas**, consisting mainly of methane with small amounts of ethane, propane and butane. [**Natural gas, just like crude oil, is formed from the remains of marine organisms and other organic matter**]

3. **Biomass (material of biological origin such as wood, crop remains, livestock manure, aquatic plants, food processing waste and organic waste materials] can be used as an energy source**.

**Uses of Alkanes**

* important as fuels and as raw materials in the synthesis of other organic compounds.
* Methane 🡪 used for cooking and as heating fuel
* Propane 🡪 liquefies 🡪 used as a fuel as LPG
* Butane 🡪 liquefies more easily is used as a cooking fuel and in cigarette lighters
* C5-C10 alkanes 🡪 found in gasoline, used as an automotive fuel
* Heavier alkanes are found in diesel, kerosene and lubricating oils and in the paraffin which is used to make candles. The fuel for jet engines is kerosene whilst ships use fuel oils.
* Tractors and other machines run on petroleum fuels such as petrol, diesel and kerosene. Trains run on diesel fuels.
* Oil is a convenient raw material for the production of organic chemicals, for the manufacture of plastics, paints, pesticides, pharmaceuticals, synthetic rubber and detergents.

Naming Alkanes

Exercise 21:

Complete the following table

|  |  |  |  |
| --- | --- | --- | --- |
| # of Carbon atoms | Name | Formula | Structure |
| 1 | Methane | CH4 | GAS    H  H  H  C |
| 2 | Ethane | C2H6 |  |
| 3 | Propane |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| 6 |  |  |  |
| 7 |  |  |  |
| 8 |  |  |  |
| 9 |  |  |  |
| 10 |  |  |  |

**LESSON NUMBER: 55**

**STRAND: 4. MATERIALS**

**SUB-STRAND: 4.2 ORGANIC CHEMISTRY**

**LEARNING OUTCOME:**

IUPAC Naming

In an unbranched chain, the numbering of the carbon atoms can begin at either end of the chain:

E.g.

C

H

H

H

H

C

H

H

C

H

H

C

H

H

1

2

3

4

H

1

H

H

C

2

H

H

C

3

C

H

H

4

H

H

C

H

Steps to following in naming BRANCHED alkanes:

1. Identify the parent (longest chain) – Name it.
2. Identify the branches attached to the longest chain (branch/substituent is the group attached to the main chain) The substituent is named as a radical

|  |  |
| --- | --- |
| **Branch (# of C atoms)** | **Name** |
| 1 | Methyl- |
| 2 | Ethyl- |
| 3 | Propyl- |

1. Number the carbon atoms of the parent alkane, making sure that the branches are attached to the carbons with the *lowest numbers*.
2. If there are two or more substituent groups which are alike, therefore, prefixes di-(2), tri-(3) and tetra-(4) are used. If the two branches are different alphabetical order is followed in naming the substituents.

E.g. Name the following alkane

BRANCH HAS 1 C ATOM

THE # OF C ATOM WHICH BRANCHES ARE ATTACHED

H

H

ALKANE – all single bonds

H

C

H

H

H

H

H

2,3 – dimethylhexane

H

C

C

C

H

C

6

5

C

C

4

3

2

1

H

H

H

H

H

H

H

C

6 C IN THE PARENT CHAIN

2 OF THE SAME SUBSTITUENT

H

Exercise 22: Name the following compounds:

1. 3.

H

H

C

H

H

H

C

H

H

C

H

C

H

C

H

H

H

C

H

H

H

C

H

H

H

H

C

H

H

C

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C

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C

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C

H

H

H

C

H

2. 4.

H

H

H

C

C

H

H

C

H

H

C

C

H

C

H

H

H

C

H

H

H

C

H

H

H

H

H

H

H

C

H

H

C

H

2. Write the structural formula of:

1. methylpropane 3. 2,3,4–trimethylheptane

2. 2-methyl-3-ethylhexane 4. 2-ethylpentane

**LESSON NUMBER: 56**

**STRAND: 4. MATERIALS**

**SUB-STRAND: 4.2 ORGANIC CHEMISTRY**

**LEARNING OUTCOME:**

Identify Isomers

**ISOMERS**

Isomers: compounds having the same molecular formula but different structural formulas:

H

H

H

C

H

C

H

C

H

H

H

C

E.g.

H

C

H

C

H

C

H

H

H

C

H

H

H

H

H

H

Butane (C4H10) 2-methylpropane (C4H10)

**Production of Methanol from Natural Gas**

Methane from natural gas is **converted to ‘synthesis gas’** (comprising of hydrogen, carbon monoxide and carbon dioxide). The stages in the process are:

1. Removal of S compounds from the natural gas
2. `the hydrocarbons are decomposed using **steam** and converted to synthesis gas

CH4(g) + H2O(g) 🡪 CO(g) + 3H2(g)

SYNTHESIS GAS

1. The synthesis gas is then **cooled, compressed, reheated and passed** through a **methanol converter containing a copper catalyst. The product from the converter is condensed as methanol, an alcohol.**

CO(g) + 2H2(g) 🡪(copper catalyst)🡪 **CH3OH(l)**

* **methanol together with ethanol are used as fuel extenders (e.g. M-15)**

Exercise 23: Draw Isomers of:

1. Pentane 2. Hexane 3. Heptane

**ALKENES**

**General formula: CnH2n Name ends with: -ene**

**Unsaturated hydrocarbons (contain a C=C bond)**

**Ethene Production**

1. **From alkane by steam cracking**

* heavier petroleum fraction is subjected to a high temperature (eg by mixing with steam and heating a 9000C for a short time) which splits up the larger molecule into smaller molecules by breaking C-C bonds.

e.g. C11H24 🡪 C9H20 + CH2 = CH2

undecane 🡪 nonane + ethene

**THERMAL CRACKING OF PARAFFIN**

CLAMP

o

POROUS POT/ BROKEN POT/ UNGLAZED PORCELAIN/ ALUMINIUM OXIDE

HEAT

GLASS WOOL SOAKED IN PARAFFIN

O

o

o

COLD WATER

- the vapours of paraffin pass through the pieces of broken pot or unglazed porcelain (which provide a high temperature large surface area for cracking to occur)and the gas formed can be collected over water.

- the long molecules and also the alkane molecules lose some hydrogen and become unsaturated alkanes

– CH2 – CH2 – 🡪 – CH = CH + H2

1. **By dehydration of ethanol**

* ethene is obtained by dehydration (removal of the elements of water) of ethanol

O

o

o

o

GLASS WOOL SOAKED IN ETHANOL

POROUS POT/ BROKEN POT/ UNGLAZED PORCELAIN/ ALUMINIUM OXIDE

HEAT

CLAMP

ETHENE

COLD WATER

- ethanol vapours pass over hot pieces of unglazed porcelain, broken pot, pumice stone or aluminium (III) oxide at about 4000C.

- ethene gas is collected over water

CH3CH2OH(g) 🡪 conc H2SO4 🡪 C2H4(g) + H2O(l)

ethanol ethene

**\*concentrated H2SO4 acts as a dehydrating agent.**

**ADDITION REACTIONS TO C=C**

1. **Reaction of ethene with bromine**

H

C

Br

H

H

C

Br

H

H

H

C

H

Br

Br

+

C

H

Ethene bromine (Br2) 🡪 1,2-dibromoethane

*colourless gas brown colourless gas*

- when ethene is bubbled through bromine water, it is decolourised (becomes colourless)

🡪 **TEST FOR UNSATURATION**

1. **Reaction of ethene with chlorine**

H

H

H

H

+

Cl

Cl

C

C

H

C

H

C

Cl

Cl

H

H

Ethene Chlorine (Cl2) 🡪 1,2-dichloroethane

*colourless oily liquid*

* requires sunlight
* this reaction is used industrially, and dichloroethane formed is heated under pressure, where it breaks down into hydrogen chloride and chloroethene (vinyl chloride), from which PVC is made.

H

H

H

C

H

H

+

HCl

C

H

C

H

C

Cl

Cl

Cl

vinyl chloride/ chloroethene

1. **Reaction of water with ethene(hydration)**

* manufacture of ethanol

H

C

H

H

C

H

H

H

C

H

H

C

H3PO4

H2O

OH

on silica

+

H

ethene(g) + steam(g)  🡪 ethanol(g)

- ethene and steam, at high temperature and pressure are passed over a catalyst of phosphoric acid on silica (silicon dioxide) or celite.

Exercise 24:

Draw the structures and write the molecular formula of

1. ethene 2. propene 3. butene

4. pentene 5. Hexane

1. Name the following alkenes

1. 2.

H

H

H

C

C

H

C

H

H

H

C

H

H

H

H

H

C

C

H

C

C

H

H

H

H

C

H

C

H

H

H

3.

H

H

C

H

H

H

H

C

C

H

C

C

H

C

H

H

H

H

C

H

H

**Lesson 55**

**POLYMERISATION**

***Polymers* –** are long chain molecules made by joining together many small molecules (called monomers)

**Polymerisation** – involves the building up of giant molecules by successive addition reaction between alkene molecules

1. **Ethene to Polyethylene (polyethene)**

Polyethene is made by subjecting ethene to very high pressure (200 atmospheres) in the presence of a catalyst

+

H

H

C

H

H

C

+

H

H

C

H

H

C

+

H

H

C

H

H

C

+

H

H

C

H

H

C

…

…

+

HIGH PRESSURE + CATALYST

C

H

H

C

H

H

C

H

H

C

H

H

C

H

H

C

H

H

C

H

H

C

H

H

…

…

* a lot of ethene combine to form one long linear molecule of polyethene
* this is an example of addition polymerisation (successive linking together of unsaturated monomers)
* the product is a single large molecule containing only one kind of monomer molecule

1. **Industrial preparation of PVC**

PVC = polyvinylchloride / polychloroethene

- made from vinylchloride/chloroethene monomer. The processes are as follows:

1,2-DICHLOROETHANE

Cl

H

H

C

+

Cl

Cl

H

H

C

H

H

C

Cl

H

H

C

- the product is then heated under pressure where it breaks down into chloroethene (vinyl chloride) and hydrogen chloride:

Cl

H

C

H

H

C

HCl

+

Cl

H

H

C

Cl

H

H

C

hydrogen chloride is removed by dissolving in water and then vinyl chloride is heated in the presence of a peroxide initiator to form polyvinylchloride:

…

…

+

+

H

C

H

H

C

+

H

C

H

H

C

+

H

C

H

H

C

+

H

C

H

H

C

Cl

Cl

Cl

Cl

H

H

H

H

H

H

H

H

…

…

C

C

C

C

C

C

C

C

Cl

H

Cl

H

Cl

H

Cl

H