CARBON IN LIFE

Carbon is a primary component of all known life on earth, representing approximately 45-50% of all dry biomass. Carbon compounds occur naturally in great abundance on earth.

All life on earth depends on carbon (C). It's nearly biological compound that makes up our bodies, systems, organs, cells and organisms.

Carbon is found in many compounds including carbon dioxide in the earth's atmosphere, and dissolved in water bodies.

Hydrocarbons that form many fuels such as coal natural gas, and petroleum also contain carbon. It is found in all forms of life.

Carbon compounds

Carbon is one of the elements that can form various compounds. paper, pens, pencils, clothes, ink and furniture contain carbon.

It is an element in many products we use. The natural foods and drinks, clothes among others contain carbon.

Classification of carbon compounds

Carbon compounds can be grouped into 2 types ie

Organic compounds

Inorganic compounds

Questions

(a) What are:

(i) Organic compounds?

An organic compound is typically a chemical compound that has carbon- hydrogen bonds. Therefore hydrocarbons are organic compounds because they have carbon- hydrogen bonds in them. There are many organic compounds like alcohols eg ethanol, methanol etc.

(ii) Inorganic compounds?

An inorganic compound is typically a chemical compound that lack carbon-hydrogen bonds. Eg carbon dioxide and carbonates.

In carbon dioxide, the bond is between carbon and oxygen. Carbonates also have the bonds between carbon and oxygen. Examples include calcium carbide, calcium carbonate, carbon oxide, sodium carbonate etec.

(b) How are organic compounds different from inorganic compounds in terms of bonding atoms?

Differences between organic and inorganic compounds

Organic compounds	***Inorganic compounds***
Organic compounds are characterized by the presence of carbon atoms in them	*Most inorganic compounds do not have carbon atoms in them*
Organic compounds are said to be more volatile and also highly flammable.	*Inorganic compounds are not volatile and inflammable in nature*
They are insoluble in water	*They are soluble in water and insoluble in some organic solvents*
These compounds have the carbon-hydrogen bonds	*These compounds don't have carbon-hydrogen bonds in them*
Organic compounds are mainly found in living things	*These compounds are found in non-living things.*
In most of the solutions are poor conductors of heat and electricity	*In aqueous solutions, these are known to be god conductors of heat and electricity.*
These have relatively low melting and boiling points	*These have high melting and boiling points*
These are biological and more complex in nature	*These are of minerals and not much complex in nature*

(c) Give examples of both organic and inorganic compounds.

Examples of organic compounds include Fats, Nucleic acid, Sugars, Enzymes, Proteins, carbohydrates

Hydrocarbon fuels etc

Examples of inorganic compounds include salts, acids bases, oxides etc

(d) Why does carbon form many compounds?

- ***Carbon has the ability to form a variety of chains (straight and branched chains).***

Note. The ability of similar atoms to form to chains is called catenation. Other elements that catenate include sulphur, silicon, and boron. But they are not able to make a wide variety of chains as carbon.

- ***Carbon has the ability to form bonds of nearly equal stability with hydrogen, nitrogen, oxygen and the halogens though hydrogen is electropositive and the rest are electronegative.***
- ***Carbon has the ability to form 4 bonds leaving no unpaired valency electrons.***
- ***Carbon has the ability to form multiple bonds (double and triple bonds) or rings between its atoms and even with atoms of other elements.***
- ***Materials that are formed from carbon include graphite, carbon belts, carbon foam, carbon paper, carbon cloth, plastics, carbon fibre, charcoal, plants, and petroleum products.***

Classification of organic compounds

There are many organic compounds. They are named according to their group or chemical families. These families are called **homologous families** or **series**.

A homologous family is a family of organic compounds with similar chemical properties and shares the same general formula.

Each member in a homologous family resembles the others in the group (in one way although they may look differently)

However members of a homologous family share a similar suffix in their names.

When naming organic compounds, attention should be given to the number of carbon atoms present in a compound. A prefix (a group of letters placed at the start of a name) that corresponds to the number of carbon atoms is written first as shown in the table.

Prefix	**Number of carbon atoms**
Meth	1
Eth	2
Prop	3
But	4
Pent	5
hex	6

Homologous families include;

- Alkanes
- Alkenes
- Alkynes
- Alcohols
- Carboxylic acids and others.

ALKANES

Members in this homologous family share a suffix "**ane**". The compounds have carbon-hydrogen atoms only with single bonds. Alkanes are saturated hydrocarbons because they contain only single bonds between carbon atoms.

Hydrocarbons are organic compounds that contain carbon and hydrogen atoms only.

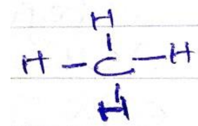
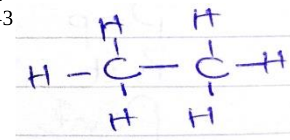
Activity

Writing names, chemical structures and general formula of alkanes.

Follow the example given and complete the table below.

No of carbon atoms	**Prefix**	**Suffix "ane"**	**Name**
1	Meth	ane	Methane
2	Eth	ane	Ethane
3	Prop	ane	Propane
4	But	ane	Butane

From the table, develop the chemical structure of the organic compounds.

No of carbon atoms	Name	Chemical structure
1	Methane	CH_4 or 
2	Ethane	CH_3CH_3 or 

The general formula of alkanes is $C_nH_{2n+1.}$

Properties of alkanes

The properties of alkanes are categorized into physical and chemical eg.

1. The first 4 members are gases, the next 12 are liquids and the rest are waxy solids at room temperature.
2. They are insoluble in water but soluble in organic solvents like tetracholoromethane.
3. They are less dense than water. Their density rise gradually with increasing molecular mass.
4. Alkanes burn in air (oxygen) forming carbon dioxide and water.

Alkanes + Oxygen $\longrightarrow$ Carbon dioxide + Water

In limited supply of oxygen, carbon monoxide and water are formed.

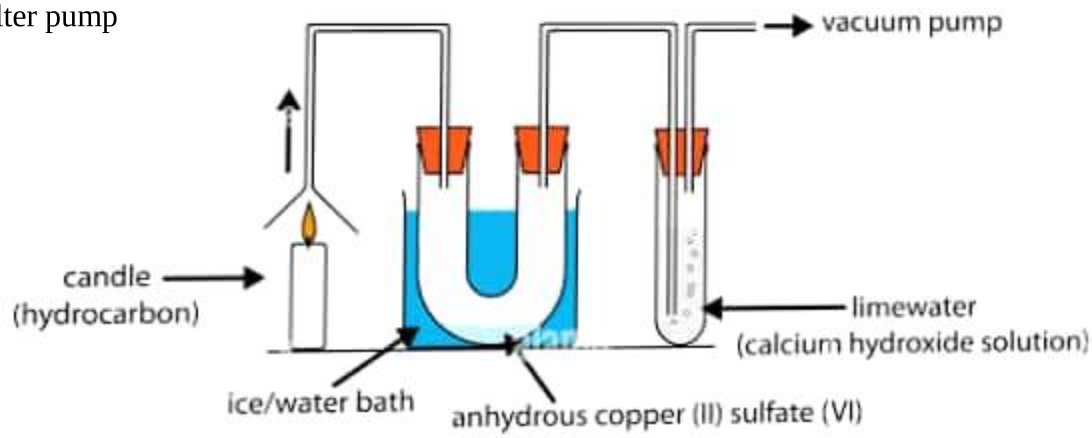
Alkanes + Oxygen $\longrightarrow$ Carbon monoxide + Water.

Activity

Investigating the ability of alkanes to burn.

What you need

Match box Funnel Beaker Cold water Delivery tube Rubber bung
Methane gas Conical flask Cobalt (II) chloride paper Calcium hydroxide solution
Filter pump



Procedures

- Arrange the apparatus as shown above in the figure.
- Strike a match stick and ignite methane gas which is an alkane.
- Observe carefully and note the colour of the flame, cobalt (II) chloride paper change and calcium hydroxide solution.

Questions

(a) With what colour of the flame does the alkane burn with?

Yellow or blue flame

(b) Why did cobalt (II) chloride paper change the colour?

This is because the anhydrous cobalt (II) chloride in it became hydrated with water produced from the burning methane.

(c) What happened to calcium hydroxide solution? Give a reason for your answer.

Calcium hydroxide formed a white precipitate (turned milky). This is because the carbon dioxide produced from burning methane reacted with it to form calcium carbonate which is insoluble in water.

(d) Write a chemical equation that took place in (c).

Calcium hydroxide + Carbon dioxide $\longrightarrow$ Calcium carbonate + Water

$$Ca(OH)_2\ (aq) + CO_2\ (g) \longrightarrow CaCO_3(s) + H_2O\ (l)$$

(e) Write the equation for the combustion of methane gas in the experiment.

Methane + Oxygen $\longrightarrow$ Carbon dioxide + Water.

$$CH_4\ (g) + O_2(g) \longrightarrow CO_2\ (g) + H_2O\ (l)$$

5. Chlorination.

Alkanes undergo substitution reactions with halogens. A substitution reaction is a reaction in which an atom or group of atoms in a compound is or are replaced by other atoms.

For the case of alkanes, this is possible with halogens eg when sunlight shines on a mixture of methane and chlorine gas, the chlorine atom replaces hydrogen atoms in a chain reaction ie substitution reaction occurs as follows.

$$CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl$$

$CH_3Cl + Cl_2 \longrightarrow CH_2Cl_2 + HCl$

$CH_2Cl_2 + Cl_2 \longrightarrow CHCl_3 + HCl$

$CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$

This reaction occurs in bright sunlight and when chlorine is in excess.

ALKENES

Alkenes are solids, liquids or gases. Members in this homologous family share a suffix "**ene**". They include ethene, propene, butene and others.

They have the same general formula. Alkenes are more reactive than alkanes.

Alkenes are unsaturated hydrocarbons because some atoms are not fully bonded. This allows alkenes to react in in ways that alkanes cannot. The number of hydrogen atoms in an alkene is double the number of its carbon atoms.

Writing names, chemical structures and general formula of alkenes

1. Follow the example given and complete the table

No of carbon atoms	**Prefix**	**Suffix "ene"**	**Name**
2	Eth	ene	Ethene
3	Prop	ene	Propene
4	But	ene	Butene
5	pent	ene	pentene

2. Develop the chemical structure of the compounds in the table.

Alkene name	Molecular formula	Chemical structure
Ethene	C_2H_4	$CH_2=CH_2$
Propene	C_3H_6	$CH_3CH=CH_2$
Butene	C_4H_8	$CH_3CH=CHCH_3$

Properties of alkenes

(a) Physical properties

- ✓ The melting and boiling point of alkenes increase as the number of carbon atoms in the compounds increase.

- ✓ The first 3 members of alkenes are gases, the next 14 are liquids and the remaining alkenes are solids
- ✓ Alkenes are colourless and orderless
- ✓ They are insoluble in water but soluble in organic solvents like benzene
- ✓ Their densities are less dense than that of water

(b) Chemical properties of alkenes eg ethene

1. Combustion of ethene

Like other hydrocarbons , ethane burns in plenty of oxygen and in limited oxygen . the products of the reactions are different.

In plenty of oxygen, ethene burns in to produce carbon dioxide and water.

Ethene + Oxygen $\longrightarrow$ Carbon dioxide + Water

C_2H_4 (g) + O_2 (g) $\longrightarrow$ CO_2 (g) + H_2O (l)

In limited supply of oxygen, ethene burns to produce carbon monoxide and water.

Ethane + Oxygen $\longrightarrow$ Carbon monoxide + Water

C_2H_4 (g) + O_2 (g) $\longrightarrow$ CO (g) + H_2O (l)

Question

Explain why alkenes are more reactive than alkanes.

The presence of carbon-carbon double bond in alkenes that is weaker and hence easier to break than the single bonds in carbon- carbon chains of alkane.

2.(i) Reaction with bromine.

When ethene is passed through liquid bromine, the red liquid becomes colourles.

This acts as a distinguishing test between saturated and unsaturated hydrocarbons ie alkenes and unsaturated ones.

$H_2C{=}CH_2$ (g) + Br_2 (l) $\longrightarrow$ $BrCH_2CH_2Br$ (l)

1,2-dibromethane

(ii) Reaction with bromine water.

Bromine partially dissolves in water to form a solution called bromine water which contains hydrobromous and hydrobromic acid.

Br_2 (l) + H_2O (l) → HOBr (aq) + HBr (aq)

Since hydrobromic acid ia a volatile liquid (can easily vaporize) , hydrobromous acid remains in the solution to participate in the reaction with alkene.

$H_2C{=}CH_2$ (g) + HOBr (aq) → $BrCH_2CH_2OH$

2- Bromethanol

Therefore, when ethene is bubbled through bromine water, the red colour of bromine water turns colourless.

3. Reaction with hydrogen

Ethene combines with hydrogen if the 2 are passed over finely divided nickel catalyst at about 150^oc. Platinum catalyst is used at room temperature. The reaction is called catalytic hydrogenation.

$H_2C{=}CH_2$ (g) + H_2 (g) → CH_3CH_3 (g)

The reaction is applied in changing double bonds in vegetable oils into single bonds eg in margarine production.

The hardening of liquid oils into solid fats is called addition hydrogenation.

4. Polymerization of ethene.

Polymerization is a term from 2 greek words"polus" which means many and "meros" which means part.

Therefore, polymerization is the joining of small molecules to form a single large complex molecule. The small molecules are called monomers.

A monomer is a small molecule that is joined repeatedly to form a polymer.

A polymer is a large molecule with high molecular mass formed by joining the simple molecules called monomers.

When many ethene molecules are joined together, a polymer called polethene is formed. The conditions are

- Presence of a catalyst.
- High temperature
- High pressure.

n ($CH_2{=}CH_2$) → $-(CH_2 — CH_2)_n-$

Where n is the number of monomers.

Properties of polyethene

- It is a white waxy solid.
- It is less dense than water
- It is tough and insoluble in all solvents at room temperature
- It is a good electrical insulator.
- It does not rot, corrode or react with chemicals.

Uses of polyethene

- To make carrier bags, bottles , plates
- For making telephone cables
- For making dustbins, toys, carpets, bottles for milk

Question

(a) Explain how polyethene is dangerous in our environment**.**

Polyethene cause animal chocking.

They pollute the soil and water

They cause the blockage of channels, rivers and streams

They produce dangerous fumes when burnt

(b) How can the dangers you have identified be reduced.

Recycling the polyethene

Using alternative packaging materials like paper bags

Buying materials in bulk and fewer packaged products

ALCOHOLS OR ALKANOLS

In our local languages, alcohol is called by different names such as tonto, malwa, kwete, ntulire, waragi, ajono, among others.

Alcohols are systematically named as alkanols ie the name of a particular member is obtained by dropping the ending "**e**" of the corresponding alkane and replacing it with the suffix "**ol**"

Writing chemical formula, structure and general formula of alcohols

No of carbon atoms	**prefix**	**Suffix "ol"**	**Name**
1	Meth	Ol	Methanol
2	Eth	Ol	Ethanol
3	Prop	Ol	Propanol
4	But	ol	Butanol

Develop the chemical structure of compounds in the table above.

Name	Molecular formula	Structural formula
Methanol	CH_3OH	CH_3OH
Ethanol	C_2H_5OH	CH_3CH_2OH
Propanol	$C3H_7OH$	$CH_3CH_2CH_2OH$
Butanol	C_4H_9OH	$CH_3CH_2CH_2CH_2OH$

Note

- All alcohols end with suffix "ol"
- The general formula for alcohols is $C_nH_{2n+1}OH$ where n is the number of carbon atoms.
- Alcohol is an organic compound with a hydroxyl functional group on an aliphatic carbon atom. Because OH is the functional group of all alcohols, we often represent alcohols by the general formula RO, where R is an alkyl group.
- Alcohols are all derivatives of hydrocarbons in which one or more of the hydrogen atoms in the hydrocarbon have been replaced by the hydroxyl group.
- The hydroxyl group is responsible for imparting certain chemical and physical properties of the compounds.

Properties of alcohols

(a) Physical properties.

- It is colorless
- It has a burning taste
- It is soluble in water
- It is hygroscopic substance

(b) Chemical properties.

These include combustion, and reactions with other substances.

(i) Combustion.

Ethanol burns in oxygen with blue flame to give carbon dioxide and water. The reaction is exothermic because it produces a lot of heat and therefore is used as a fuel.

$$2C_2H_5OH(l) + 7O_2 (g) \longrightarrow 4CO_2(g) + 6H_2O (l)$$

NB. The combustion of ethanol is complete if oxygen is in excess and incomplete if oxygen is limited supply.

(ii) Dehydration of alcohols.

When excess concentrated sulphuric acid is added to ethanol and the mixture heated to 180 ^oC, ethanol is dehydrated to ethene .

$$C_2H_5OH(l) \longrightarrow CH_2{=}CH_2 (g) + H_2O (l)$$

It's sometimes called elimination reaction because a molecule of water is eliminated from the alcohol to form an alkene.

Preparation of ethanol

Preparation of ethanol locally

Ethanol is preparation by fermentation of sugars in presence of yeast.

Fermentation is a process in which sugars are decomposed by enzymes into alcohol.

Cassava is crushed and heated in steam under pressure to extract starch

Starch is heated with malt at a temperature of 60^oC. Malt (partially sprouted barley) contains an enzyme diastase which hydrolyses starch to maltose.

Starch + water $\longrightarrow$ maltose

$$2C_6H_{10}O_5 + H_2O \longrightarrow C_{12}H_{22}O_{11}$$

Yeast is added at room temperature to the mixture and left to ferment for 2-3 days yeas contains 2 enzymes, maltase and zymase.

Maltase catalyzes the hydrolysis of maltose to glucose.

Maltose + water $\longrightarrow$ glucose

$$C_{12}H_{22}O_{11} + H_2O \longrightarrow 2C_6H_{12}O_6$$

Zymase catalyzes the breakdown of glucose to ethanol, carbon dioxide producing heat in the process.

Glucose $\longrightarrow$ ethanol + carbon dioxide + heat

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2\,CO_2 + \text{Heat.}$$

Crude ethanol produced can be purified by fractional distillation.

In Uganda (ankole) locally crude ethanol (known as tonto) can be obtained from;

Raw materials; bananas and sorghum.

Process of production

Juice is extracted from ripe bananas by squeezing them using spear grass leaves or bananas leaves.

The juice is filtered to remove any solid impurities.

The filtrate is then poured into a locally wooden container where it is mixed with ground roasted sorghum.

The container is covered and the mixture is allowed to ferment for 2 days.

The resulting solution is crude ethanol locally known as tonto. It's purified by fractional distillation.

Side effects and mitigations

Ethanol spills on the surface leading to falls and accidents. It can be mitigated by putting on PPEs

Hot surface burns during distillation leading to pain and injuries on the body. It can be mitigated by putting on PPEs.

Social benefits.

Employment opportunities, salary enhancement and improved standards of living

Uses of ethanol

- ✓ Used as a solvent for perfumes, vanishes paints.
- ✓ Used in manufacture of organic compounds like carboxylic acids
- ✓ Used in alcoholic drinks such as beers,wines and spirits.
- ✓ Used as a fuel.

<u>Question</u>

When ethanol reacts with conc. Sulphuric acid, a hydrocarbon T is formed.

(a) Give the name of the hydrocarbon.

(b) To which homologous family does the hydrocarbon T belongs?

(c) State the conditions necessary for the reaction to take place.

(d) Name the type of reaction that occurs.

Question

How is alcohol a problem in your community?

Weakening of the immune system.

Mental health problems including depression and anxiety.

Societal problems such as family breakup, job related problems and un employment.

Increased risks of injuries and accidents such as motor vehicle crashes, falls, drowning and burns.

Cancer of the breasts, rectum, liver, colon, mouth, throat and others.

High blood pressure,heart diseases and stroke.

Miscarriages among pregnant women.

Question.

What do you think can be done to reduce alcohol abuse?

Avoiding alcohol altogether

Reaching out for help if the drinking is out of control

Avoiding mixing alcohol with medications.

Making sure that children and young people don't have access to alcohol.

Avoid drinking as a way of dealing with emotions and stress.

Sensitizing children and young people the problems associated with drinking alcohol.

CARBOXYLIC ACIDS OR FATTY ACIDS

Fatty acids are building blocks of fats in our bodies and in the food we eat. During digestion, the body breaks down fats into fatty acids, which can be absorbed into the blood.

Fatty acids are carboxylic acids with long straight chains which are either saturated or unsaturated.

Carboxylic acids are unsaturated organic compounds with a general formula $C_nH_{2n+1}COOH$, where n is greater or equal to one ie $n \geq 1$ and it represents the number of carbon atoms.

In this homologous family, a carboxyl group,-COOH is the functional group.

Naming carboxylic acids

They are named by replacing the suffix "**e**" in the corresponding alkanes with "**oic**".

No of carbon atoms	Prefix	Suffix	Name
1	Meth	oic	Methanoic
2	Eth	oic	Ethanoic
3	Prop	oic	Propanoic
4	But	oic	Butanoic

Writing the structural formulae of carboxylic acids

Name of the compound	Formula of the compound	Structure of the compound
Methanoic acid	CH_2O_2	HCOOH
Ethanoic acid	$C_2H_4O_2$	CH_3COOH
Propanoic acid	$C_3H_6O_2$	CH_3CH_2COOH

Question

(a) Suggest the natural materials which contain alkanes

Biogas and Natural gas.

(b) Why are most fossil fuels rich in alkanes?

Fossil fuels are formed from remains of dead plants and animals which are carbon containing materials

CRUDE OIL

Crude oil is a mixture of many alkanes which include;

- Natural gas such as methane, ethane, propane, and butane.
- Petrol (gasoline)
- Kerosene (paraffin)
- Diesel
- Lubricating oil, Paraffin wax, Vaseline etc.

These products of crude oil vary in composition as shown below; gases 2%, Naphtha 34%, kerosene 11%, petrol 21% and diesel 31%.

The fractions are important as summarized in the table.

Fraction	Uses
Natural gas	Fuel for cooking and lighting
Petrol	Fuel for running vehicles Fuel component for jet engines Solvent for greases and insecticides
Diesel	Fuel for diesel engines, trains and boats
Fuel oil	Fuel for domestic heating and lighting up furnaces
Lubricating oil	Lubrication in machine parts
Paraffin wax, Vaseline and bitumen	Making Vaseline, greases and candles. Road and run way surfacing.

Formation of crude oil

Natural oil is a mixture of oils as mined from the ground or rocks.

Fossil fuel was created millions of years ago from remains of algae and planktons that fell to the bottom of the sea or oceans.

They combined with mud and then were covered by layers of sediments.

Intense heat and pressure acted on the remains for the millions of years.

They turned to waxy substances and finally became liquid oil due to pressure and heat acting on them.

Naturally occurring underground liquid fuel is known as ***crude oil*** or ***unrefined petroleum***.

Crude oil contains many impurities, including sulphur compounds, nitrogen compounds, heavy metals etc.

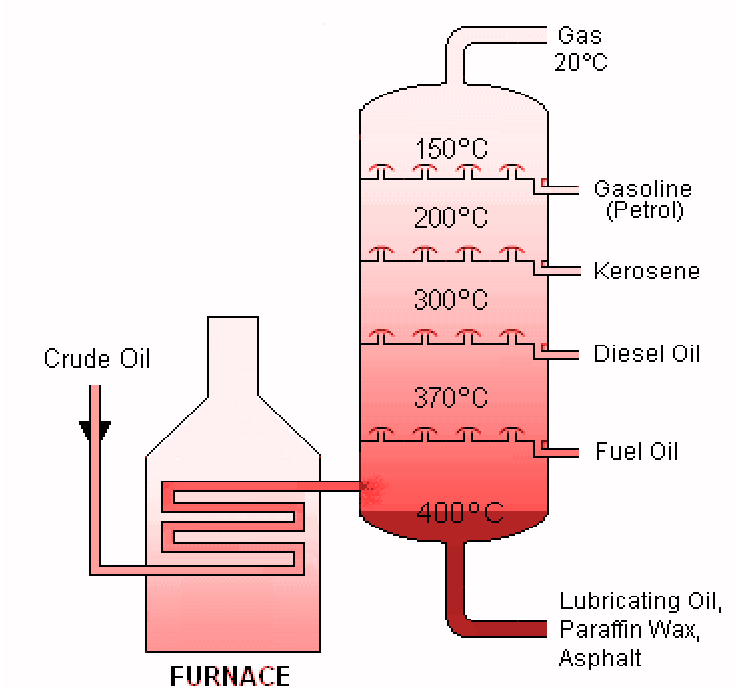
Separating components of crude oil

The different alkanes that make up crude oil can be separated by ***fractional distillation***. This is based on the boiling points of different components.

After the removal of impurities mainly sulphur compounds. It is heated until when most of it vaporizes.

The vapour is passed into the bottom of the tall fractionating tower. The fractionating tower is divided into several compartments each cooler than the one below it.

During fractional distillation, the fraction of petroleum that is most volatile settles at the top and the non- volatile heavy oil runs out from the bottom of the column shown in the figure.



Natural gas

Natural gas is a naturally occurring mixture of gaseous hydrocarbons consisting of primarily methane in addition to various smaller amounts of other higher alkanes such as ethane, propane, butane.

A natural gas is obtained from gas deposits which are almost found everywhere around the world. In other places, a natural gas moves into large rocks and spaces between layers underlying rocks.

It is also found in tiny spaces of sand, stones and other sedimentary rocks. Deposits of crude oil also contain a good percentage of natural gases. Some other natural gas deposits are found on offshores of oceans and deep under the ocean floor.

How is natural gas formed?

Natural gas was formed hundreds of millions of years ago.

Remains of plants and animals decomposed when exposed to intense heat and pressure.

The energy originally obtained by plants from the sun and animals from plants is stored in form of chemical bonds in the gas. The gas built up into the thick layers on the earth's surface and ocean floors. The layers were buried under sand, silt and rock.

Activity

(a) From which materials is natural gas formed.

Remains of plants, animals and ancient marine micro-organisms.

(b) Which processes are involved in the formation of natural gas?

Decomposition of organic matterunder intense heat and high pressure in absence of air.

(c) Why is natural gas formed during the formation of petroleum?

As pressure and heat change some of carbon-hydrogen rich materials into coal, some into oil (petroleum), some materials are changed into natural gas.

Bio-Gas

The term bio-gas is made of two words; ‘bio’ which refers to organic matter and gas.

Bio- gas is composed of;

- Methane
- Carbon dioxide
- Ammonia
- Hydrogen sulphide.

Making bio- gas

Raw materials; organic waste, water.

Process of production

Organic wastes are put in a container and mixed wth some little water.

The container is covered tp prevent aerial oxidation.

The container and contents are maintained at a temperature between 25-30 ^oC.

Anaerobic bacteria breakdown the organic matter to finally methane, ammonia, hydrogen sulphide, carbon dioxide and nitrogen gases.

Side effects and mitigations

Fire outbreak in case of leakage on pipes. It can be mitigated by sealing off the pipes.

Poisonous fumes in case of any leakage on the pipes. It can be mitigated by wearing personal protective equipment (PPEs)

Social benefits

Biogas is used for cooking and lighting since it is a renewable gas.

The solid bi-product is used as a fertilizer to increase farmer’s farm production hence better standards of living.

Bio- gas is odourless, however it may have some little smell of rotten eggs due to the presence of hydrogen sulphide. It burns with a blue or yellow non-sooty flame.

The solid bi-product is used as a fertilizer since it contains high nitrogen content.

Bio-gas is used for cooking and lighting purposes.

Advantages of bio-gas production.

- It is cheap to produce.
- The solid bi-product is used as a fertilizer since it contains high nitrogen content.

Disadvantages.

- Some of the gases contained in bio-gas are air pollutants.
- Sulphur dioxide leads to formation of acid-rain which results in damage to plants and aquatic organisms.
- Hydrogen sulphide and ammonia contained in bio-gas cause irritation of eyes.

POLYMERS

A polymer is a complex compound of large molecular mass formed by a combination of small molecules. The small molecules from which a polymer is made are called monomers.

The process by which several small molecules combine to form complex molecule of a large molecular mass is called polymerization.

Types of polymers.

Polymers are majorly grouped into 2;

(a) **Natural polymers.**

These are polymers which are not human made. They are mainly produced by plants and animals, although some micro- organisms also produce natural polymers. Examples of natural polymers include wool, silk, natural rubber, proteins, glycogen, lipids, starch, and cellulose.

(b) **Synthetic polymers.**

These are man-made polymers e.g Polyethene, Nylon, Terylene etc. all synthetic polymers are plastic in nature, hence are called ***plastics.*** They are classified into;

(i) **Thermoplastics or thermo softening plastics.**

These are plastics that become softer when heated and hard when cooled. Thermoplastic materials can be cooled and heated repeatedly without any change in chemical composition or mechanical properties.

When thermoplastics are heated to their melting point, they melt to a liquid, which can be put into moulds forming new products. Examples include Polyethene, Polystyrene,PVC, Nylon etc

(ii) **Thermosetting plastics**

These are plastics which decompose on heating. Their chemical and physical properties change upon heating. They cannot be remoulded once they are heated. Examples include Bakelite and Melamine; Bakelite for making electric plugs; Melamine for making trays, plates etc.

Dangers of synthetic polymers

- Polythene cause animal choking,
- They pollute the soil and water.
- They cause blockage of channels, rivers and lakes
- They produce dangerous gases when burnt

What can be done to ensure proper disposal of synthetic polymers?

- Reducing usage of the polymers.
- Re-using the polymers.
- Recycling the polymers

SOAP

Soaps are water-soluble sodium or potassium salts of fatty acids. Soaps are made from fats and oils or their fatty acids. Heating them chemically with a strong alkali produces soap, water and gylcerine.

Apart from cleansing abilities, soaps are also used as an antiseptics and ingestible anti-dotes for mineral acids and heavy metal poisoning.

Special metallic soaps, made from soap and heavier metals, are used as additives in polishes, inks, paints and lubricating oils.

Preparation of soap

Fats and oils from plants and animals contain long chain carboxylic acids. The common carboxylic acid used is stearic acid. It has 18 carbon atoms.

Stearic acid is heated with sodium hydroxide an alkali to form sodium stearate (soap). The process of preparing soap is called ***saponification.***

Preparing soap in the laboratory

Materials needed

Sodium chloride	Coconut oil
Sodium hydroxide	Weighing scale machine
Beakers (500ml &250ml)	Measuring cylinder
Stirrer	Sieve
Heat source	Distilled water

Test-tube

Steps taken

Measure 25cm^3 of coconut oil and transfer it into a 500ml beaker.

Clean the measuring cylinder with distilled water and use it to measure 30cm^3 of sodium hydroxide solution. Add sodium hydroxide solution to the oil.

Boil the mixture for 10-15 minutes while stirring & add small amount of distilled water.

Measure 15g of sodium chloride, add it to the mixture and stir well.

Remove the mixture from the heat source and allow it to cool.

Filter off the solid and wash it with distilled water.

Place the solid in clean dry beaker.

Put a small solid in a test tube, then add arm water till quarter full and shake.

Questions.

(a) Explain what happens when sodium hydroxide is added to coconut oil and the mixture is boiled?

Frothing takes place

(b) What happens to the mixture when sodium chloride is added?

Precipitation takes place

(c) What happens if the mixture is allowed to cool***?***

The precipitated soap solidifies.

(d) How can you improve the quality of your soap prepared?

By adding dyes, perfumes etc.

Cleansing action of soap

Soap consists of two parts ie hydrophilic head and hydrophobic tail. The hydrophilic head dissolves in water and hydrophobic tail dissolves in dirt

During washing, the surface tension between the water and the dirt is lowered. Agitation causes emulsification of dirt and its carried away by the clean water.

If water is hard, the soap first reacts with calcium or magnesium ions which are precipitated as scum that is the scum is magnesium stearate or calcium stearate.

Soapless detergents

Soapless detergents are prepared by boiling vegetable oil (olive oil) or crude oil with concentrated sulphuric acid. The oil is unsaturated as it contains double bonds.

The sulphuric acid adds the double bond to form alkyl hydrogen sulphate. The alkyl hydrogen sulphate formed is then neutralized by adding sodium hydroxide solution.

A precipitate forms and on evaporation, a white solid soapless detergent is formed. The sodium alkyl hydrogen sulphate is the soapless detergent.

Common examples of soapless detergents include Omo, Magic, Aerial, Sunlight, Nomi etc.

Note; Soapless detergents are more effective than soap in hard water since they don't form a scum. This is because the calcium and magnesium salts of the hydrocarbon sulphonic acids of which the detergents are composed of, are soluble in water, so there is no precipitate (scum) formed.

Advantages of soap over detergents

- ❖ Detergents are more soluble in water than soap
- ❖ Detergents don't form scum with hard water unlike soap.

Advantages of soap over detergents

- ❖ Soap is biodegradable
- ❖ Soap is cheaper than detergents.

Effects of detergents on the environment

- Detergents reduce the natural water quality
- They change the PH of the soil and water
- It increases the concentration of salts in water sources.
- They cause eutrophication, since they contain phosphates that promote the growth of water weeds. When it comes to decay and decomposition of these plants, the water is derived of its oxygen which endangers the lives of organisms living in water like the fish.

The problems can be minimized by

- Avoiding washing with detergents near water sources
- Using eco-friendly detergents
- Limiting the use of detergents.