CHAPTER ONE: CARBON IN LIFE.

COMPETENCY: The learner appreciates the diversity of carbon compounds including alkanes, alkenes, alcohols and fatty acids.

A lot of compounds that are present in living things have been found to contain carbon. These are known as organic compounds. All living things such as trees, insects, birds and their derivatives such as ethanol, sucrose, vinegar and plastics contain carbon making it highly diverse.

Organic compounds are called so because they exist naturally and are important in building the back bone of life.

Carbon is a backbone of life because it forms the building block compounds such as proteins, carbohydrates etc. that make up life.

Activity: Demonstrating that derivatives of living things contain carbon.

What you need.

1. Sugar.

2. Concentrated sulphuric acid.

3. Glass beaker.

What to do.

1. Half fill the table sugar to a glass beaker on table.

2. Add concentrated sulphuric acid carefully to just cover the sugar and observe.

Caution.

1. Sulphuric acid is corrosive.

2. The reaction is exothermic.

Discussion.

Observation.

A black spongy mass of charcoal rose and filled the beaker, then steam was given off and the beaker became very hot.

Explanation.

Table sugar is chemically written as $C_{12}H_{22}O_{11}$, sulphuric acid has dehydrating properties and therefore absorbs water from substances. When it was added to table sugar, it removes all the water that was present and black mass remained. This is carbon.

Conclusion.

Living things and their derivatives contain carbon and are said to be organic in nature.

Organic chemistry is the study of chemistry of compounds of carbon except oxides of carbon and carbonates, hydrogen carbonates and carbides of metals. These are usually treated as inorganic chemistry.

Table showing common organic compounds and their importance.

Organic compound.	**Chemical name.**	**Living thing from which it is derived.**	**Daily life applications.**
Table sugar.	Sucrose	Sugar canes.	Used as a sweetener in food production.
Vinegar	Ethanoic acid	Apples, Grapes, Lemons, etc.	Used as a preservative in food processing.
Alcohol	Ethanol	Maize, cassava, sugar canes, etc.	Used as a solvent in many chemical reactions. Used as a sterilizer in medical field.
Vegetable oil	Glycerol linoleate.	Soya bean, sun flower,	Making cooking oil Making soap
Animal fats	Glycerol oleate.	Olive oil	Making fats. Making soap

Classification of organic compounds.

Because organic compounds are very many, they are put into families **called homologous series**. A Latin word which means same family.

Examples of homologous series include;

1. Alkanes

2. Alkenes

3. Alcohols

4. Carboxylic acids.

Members of the same homologous series share similar chemical properties and nearly similar physical properties. This is because they share the same functional group.

A functional group is the one that gives chemical properties or characterizes a homologous series

OR.

A functional group is an atom or group of atoms that imparts chemical properties to organic compounds of the same family.

A homologous series is a group of organic compounds with similar chemical properties and nearly the same physical properties.

Note

If an organic compound is made up of carbon and hydrogen only, it is called a hydrocarbon.

Examples of hydrocarbons

Alkane e.g. ethane

Alkene e.g. ethene

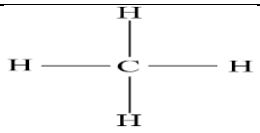
Hydrocarbons are said to be saturated if within the carbon skeleton there is only carbon to carbon single bonds or unsaturated if within the carbon skeleton, there is at least one carbon to carbon double bond

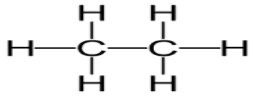
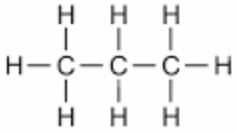
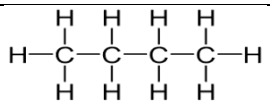
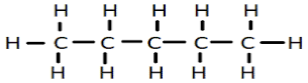
Alkanes are saturated hydrocarbons whereas alkenes are unsaturated hydrocarbons.

ALKANES.

Alkanes are saturated hydrocarbons with a general molecular formula C_nH_{2n+2} where $n \geq 1$

Examples of alkanes.

Number of carbon atoms	Name of alkane	Molecular formula	Structural formula
1	Methane	CH_4	

2	Ethane	C_2H_6	
3	Propane	C_3H_8	
4	Butane	C_4H_{10}	
5	Pentane	C_5H_{12}	

Physical properties of alkanes.

1. The lower members e.g. methane, ethane, propane and butane are gases; the next twelve are liquids; the rest are waxy solids e.g. paraffin wax.

2. Alkanes are insoluble in water and their densities gradually increase with increase in mass.

3. The boiling points of alkanes also increase with increase in mass.

4. They burn in excess air forming carbon dioxide and water

Note: Alkanes are generally unreactive.

THE MOST IMPORTANT ALKANES

1. Crude oil

It is also called petroleum formed from remains of dead organisms that fell to the ocean floor and were buried under thick sediments, high pressure slowly converted them to petroleum over millions of years.

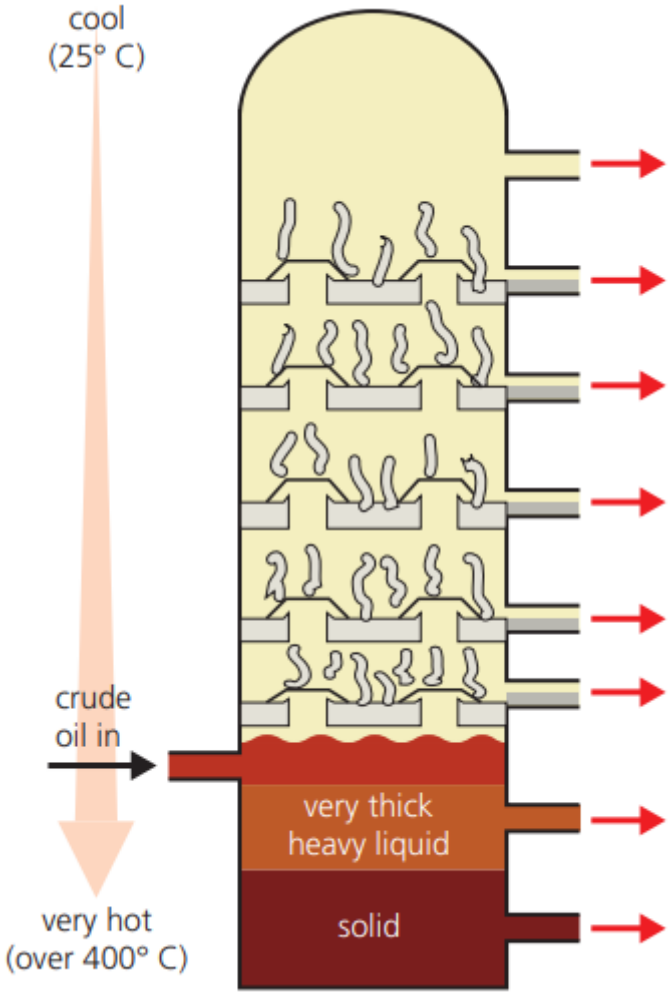
It is a mixture of hundreds of different organic compounds especially the saturated hydrocarbons (alkanes)

Areas in Uganda that contain deposits of crude oil.

1. Hoima
2. Kikuube
3. Buliisa

Crude oil refinery.

In a refinery, the fractional distillation is carried out in a tower that is kept very hot at the base, and cooler towards the top. Look at the drawing. Petroleum is pumped in at the base. The compounds start to boil off. Those with the smallest molecules boil off first, and rise to the top of the tower. Others rise only part of the way, depending on their boiling points, and then condense.



The table shows the fractions that are collected.

Name of fraction.	**Number of carbon atoms.**	**Use.**
LPGs (refinery gas)	C1 to C4	Gases for cooking and heating
Gasoline; petrol	C5 to C6	Fuel for cars
Naphtha	C6 to C10	Feedstock/ starting point for many chemicals and plastics

Paraffin/kerosene	C10 to C15	Fuel for aircraft, oil stoves and lamps
Diesel oil/gas oil	C15 to C20	Fuel for diesel engines
Fuel oil	C20 to C30	Fuel for power stations, ships and home heating system.
Lubricating fraction	C30 to C50	Oil for car engines and machinery used to make waxes and polishes.
Bitumen	C50 to above	For road surfacing and roots For making paints

As the molecules get larger, the fractions get less runny, or more viscous: from gas at the top of the tower to solid at the bottom. They also get less flammable. So the last two fractions in the table are not used as fuels.

The importance of crude oil refinery.

1. On its extraction, crude oil comes along with other impurities e.g. sulphur compounds and nitrogen compounds hence a need for purification.

2. To put alkane molecules of the same kind together for better utilization.

Cracking

Cracking is the breaking down of high alkanes to lower alkanes in the presence of high temperatures and a catalyst.

How important is cracking of alkanes

It changes alkanes of very big molecular masses to lower alkanes

It increases the efficiency of crude oil components by breaking down those with big molecular mass into small ones.

2. Natural gas.

How it is formed

It is formed when dead organisms covered under rocks are exposed to very high pressure for millions of years. Natural gas is mainly methane and always found together with petroleum. It contains other substances e.g.

Hydrogen

Nitrogen

Hydrogen sulphide

Butane

Ethane

Carbon dioxide.

Importance of natural gas

1. It is a source of fuel

3. Provides warmth when burnt at home

4. It fuels power stations that provide electricity to homes and businesses

5. It is an important ingredient for chemical producing industries such as paints and plastic industries

3. BIOGAS.

Biogas is a combustible gas carbon based fuel produced through the anaerobic break down of waste biomass.

How bio gas is produced.

Raw materials include cattle dung, farm refuse, and organic waste.

Feedstock collection:

Various organic matter to be used in bio gas production is collected. These may include animal manure, agriculture residues, food waste, etc.

Pre-treatment:

Feed stock is pre-treated to its digestibility. This involves chopping and mixing different types of feed stock to create an optimal blend.

Anaerobic respiration:

The pre-treated feedstock is then fed into an anaerobic digester; a sealed tank where micro-organisms breakdown the organic matter in absence of oxygen.

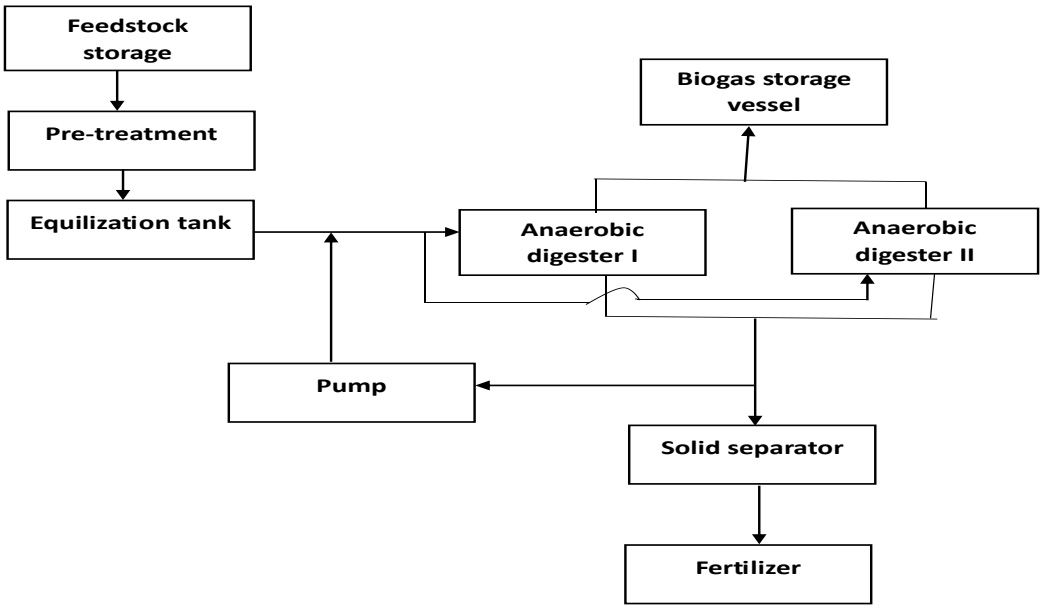
This process produces bio gas.

Digestate management:

After digestion process is complete, the left over material called the Digestate can be used as a fertilizer since it is nutrient rich.

Bio gas collection:

The bio gas produced during anaerobic respiration is collected from the digester and stored in storage tanks for various applications.



Uses of biogas.

1. Biogas is used for cooking

2. Biogas is used for lighting purposes

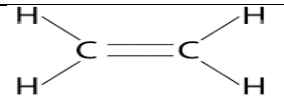
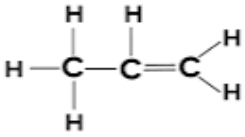
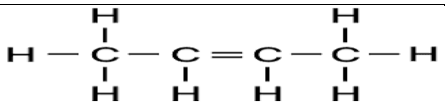
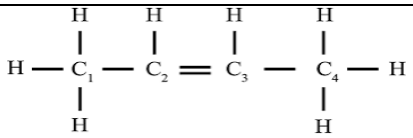
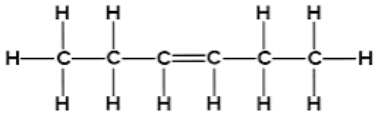
ALKENES.

Alkenes are members of a homologous series with a general formula C_nH_{2n}. The simplest alkene has n ≥2.

They are characterized with at least one carbon to carbon double bond and this is their functional group.

They are unsaturated and this makes them to undergo additional reactions.

Examples of alkanes.

Number of carbon atoms	Name of alkene	Molecular formula	Structural formula
2	Ethene	C_2H_4	
3	Propene	C_3H_6	
4	Butene	C_4H_8	
5	Pentene	C_5H_{10}	
6	Hexene	C_6H_{12}	

Physical properties of alkenes.

1. Lower members. E.g. ethene, propene and butene are gases, those with five carbon atoms to 14 are liquids whereas higher members with more than 15 carbon atoms are solids at room temperature.

2. Alkenes are usually immiscible with water.

3. The boiling point increases with increase in their molecular masses.

Chemical properties of alkenes.

Using ethene.

1. Combustion.

Alkenes burn in excess air to form carbon dioxide and water.

$C_2H_{4\,(g)} + 3O_{2\,(g)} \longrightarrow 2CO_{2\,(g)} + 2H_2O_{\,(l)}$

Note: In limited supply of air carbon monoxide is formed instead.

2a. **Reaction with bromine.**

When ethene is passed through bromine liquid (red), the red liquid becomes colourless.

$C_2H_{4\,(g)} + Br_{2\,(l)} \longrightarrow C_2H_4\,Br_{2\,(l)}$

The product is called 1, 2-dibromoethane. This reaction is used to distinguish between alkanes and alkenes.

Alkanes have no effect on bromine liquid because they lack the carbon to carbon double bond where addition of bromine takes place from as compared to alkenes.

2b. **Addition of bromine water**

Bromine water is a reddish-brown liquid when any alkene vapour is bubbled through, it changes from being reddish brown to colourless.

$C_2H_4 \xrightarrow[aq]{Br_2/H_2O} C_2H_4BrOH$

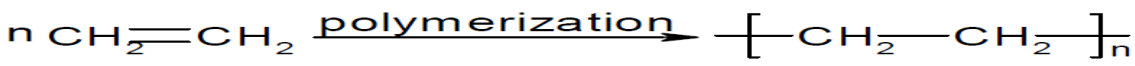
3. **Reaction with hydrogen at 150°C in presence of nickel catalyst**

Alkenes react with hydrogen to form alkanes e.g.

$C_2H_{4\,(g)} + H_{2\,(g)} \xrightarrow[150°C]{Ni} C_2H_{6\,(g)}$

4**. Addition polymerization**.

Very many ethene molecules react to form polyethene at high temperatures and pressure without loss of any small molecules. This reaction is called polymerization with polyethene being the polymer and ethene molecules being the monomers. Alkenes undergo a type of polymerization called addition polymerization.



Polymerization is a reaction in which many small molecules react to form a single complex molecule called **polymer**.

The molecules that react are called **monomers.**

The single complex molecule formed from the reaction is called the polymer.

Note: The other type of polymerization is condensation polymerization.

Polymers are of two types;

- Natural
- Artificial polymers

Natural polymers exist in nature and are manufactured mainly by plants.

Table showing examples of natural polymers, their properties and uses.

Natural polymer.	**Monomer units.**	**Properties.**	**Uses.**
Wool; natural protein fibers.	Amino acids.	It is durable. It is flexible. It is an excellent insulator. It is capable of absorbing moisture.	Making clothes. Making blankets. Making sandal cloths.
Cotton; contain cellulose fibers.	Glucose molecules.	It is capable of absorbing moisture. It is strong. It is bio-degradable and eco-friendly. It is durable. It is breathable.	It is used to make home textile like beddings and towels. It is used in textile industries to make clothes. It is used to make surgical products such as sponges.
Silk; natural protein fibers.	Amino acids.	It is strong. It has a smooth, soft texture. It is elastic. It is light weight and breathable. It is water proof It is a poor conductor of electricity.	It is used for formal wear such as dresses, suits and ties. It is used for curtains, drapes, beddings and wall hangings. It is used for sutures and wound closing because it is naturally anti-bacterial

		It is bio-degradable and eco-friendly.	It is used to make parachutes.
Natural rubber	Isoprene	It is highly elastic. It is highly resilient; can return to original form after being deformed. It has a good tensile strength. It is flexible at low temperatures. It is biodegradable and eco-friendly. It is durable.	Making car tyres. Making foot wear. Making tight fitting and expandable clothing. Manufacturing electric insulation. Making flooring material like carpets, play grounds, etc.
Wood; contain cellulose fibers	Glucose molecules.	High mechanical strength. High thermal insulation. High workability. Light weight when dry. Renewable when obtained from fast growing trees.	It is used to build homes, fences and floorboards. It is used to make furniture. It is used to make paper in paper industry.
Sisal; contain cellulose.	Glucose molecules.	It is strong. It is durable. It is elastic. It is smooth. It absorbs moisture.	Making ropes and twine. Making handcraft.

Artificial / synthetic polymers are man-made since their existence is influenced by man.

Table showing examples of artificial/synthetic polymers, their properties and uses.

Synthetic polymer.	Monomer unit(s)	Properties.	Uses
Polythene.	Ethene molecules.	Resistant to chemical attack. High electrical insulation. Highly flexible. Water proof.	Used in many types of packaging such as plastic bags, bottles, containers and films. Used to insulate wires and cables. Used to make many house hold materials such as toys, housewares, and kitchenware and garbage containers.
Nylon.	Hexane-1, 6-diamine and hexan-1, 4-dioic acid.	Very strong. Durable. Resistant to chemical attack Has a good electrical insulation. Highly elastic. Light weight Wrinkle resistant.	Used in ropes. Used in carpets. Used in seat belts. Used in parachutes.
Terylene.	Ethane-1,2-diol and benzene-1,4-dicarboxylic acid	Strong. Resistant to chemical attack. Highly elastic. Recyclable.	Used in clothing such as dresses, fleece jackets and sarees. Used to make plastic bottles, tyres cords, boat sails
Perspex.	Methyl-2-methylpropeneoate	Chemical resistant. Light weight. Durable	Making aquariums of all sizes.

		High electrical insulation. Transparent. Recyclable. Water proof. Impact resistant	Construction material alternative to glass. Used as a screen for flat televisions. Used to make submarine windows.
Polyphenylethene.	Styrene	Hard. Resistant to chemical attack. Light weight. Low thermal conductivity.	Used for food and non-food packaging. Used for medical products such as test tube and petri dishes. Used as a lighting fixture.
Polyvinylchloride	Chloroethene.	Resistant to chemical attack. Highly durable. High electrical insulation. Strong.	Building materials like pipes, window frames, wall covering, etc. Used in electrical cable insulation. PVC pipes are the most common plastic piping material and used in sewer, irrigation, water service lines and drain waste vents.

Thermal plastics (thermo softening plastics)

These are plastics that become soft and moldable on heating without undergoing any significant chemical changes and on cooling they harden. Examples include;

Polyethene

Nylon

P.V.C

Thermosetting plastics (thermosets)

These are plastics which decompose on heating and cannot be reshaped after the manufacture. Examples include;

Vulcanized artificial rubber

Bakelite

Advantages of synthetic polymers over natural polymers

Synthetic polymers are relatively cheaper than natural polymers

They are easy to manufacture

They are usually stronger than the corresponding natural material

Disadvantages of synthetic polymers

They are non-biodegradable

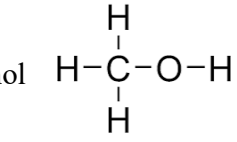
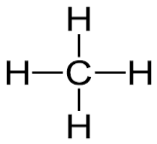
People working in industries are exposed to hazards

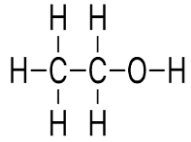
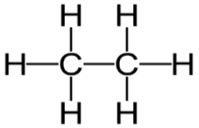
<u>Alcohols</u>

A family of organic compounds with general formula $C_nH2_{n1.OH}$.

Alcohols have a functional group called the hydroxyl group (OH).

They are named from alkanes by removing the ending "e" of alkanes and replace it with "ol". I.e. from alkane to alkanol.

Methanol  From Methane 

Ethanol  From ethane 

Physical properties of alcohols

Using ethanol.

1. It is colourless (with a burning taste)

2. It is miscible with water

3. It is a hygroscopic substance (substances when exposed absorb water from the atmosphere and this makes their volumes to increase)

Chemical properties of alcohols

<u>Using ethanol.</u>

1. Combustion

Ethanol burns in air with a blue flame to give carbon dioxide and water. This reaction is exothermic.

$C_2H_5OH_{(l)} + 3O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)}$

2. Dehydration of ethanol

When concentrated sulphuric acid is added to ethanol and a mixture is heated at 180°C, ethanol is dehydrated to ethene.

$C_2H_5OH_{(l)} \xrightarrow[180°C]{\text{conc } H_2SO_4} C_2H_{4(g)} + H_2O_{(l)}$

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

Manufacture of ethanol.

Ethanol is manufactured by a process called fermentation. It involves break down of sugar molecules by micro-organisms like yeast forming beer, wine, ethanol, yoghurt, etc.

Ethanol can be manufactured from any natural source of sugars for example:

1. Potatoes.
2. Bananas.
3. Sugar canes.
4. Cone maize.
5. Cassava.

Obtaining ethanol from cassava.

Raw materials

Cassava.

Yeast.

Malt (sprouted barley).

Process

Ethanol is produced by a process called fermentation of sugars in presence of yeast. During this process, yeast cells decompose sugars into alcohols

Cassava is crushed and heated in steam under pressure in a large metallic tank to extract starch.

This starch is treated with malt (partially sprouted barley) for an hour at 60°C. This malt supplies an enzyme diastase, which catalyzes the hydrolysis of starch to a sugar called maltose.

$C_6H_{10}O_{5\ (aq)} + H_2O_{\ (l)} \longrightarrow C_{12}H_{22}O_{11\ (aq)}$

Yeast is then added at room temperature in a fermentation tank. It supplies two enzymes i.e.

1. Maltase

2. Zymase

The first enzyme maltase catalyzes the hydrolysis of maltose to glucose.

$C_{12}H_{22}O_{11\ (aq)} + H_2O_{\ (l)} \longrightarrow C_6H_{12}O_{6\ (aq)}$

Zymase catalyzes the decomposition of glucose to ethanol.

$C_6H_{12}O_6\ (aq) \longrightarrow 2C_2H_6O\ (aq) + 2CO_2\ (g)$

The resultant solution is crude ethanol which is converted to pure ethanol by fractional distillation.

Acronym for manufacture of ethanol from starch.

Colours seemingly appeal my zillion pal.

Colours- crushing and heating starch containing material to extract it

Seemingly- starch treated with malt.

Appeal- addition of yeast.

My- maltase converts maltose to glucose.

Zillion- Zymase converts glucose to crude ethanol.

Pal- purification of crude ethanol by fractional distillation.

Uses of ethanol

1. Ethanol is used as a solvent for perfumes, varnishes, paints and drugs precipitation

2. It is used in the manufacture of organic compounds such as ethanoic acid

3. Used in alcoholic drinks such as beer, wines and spirits

4. Ethanol is used as fuel

The importance of industries that manufacture ethanol to communities where they are established.

1. Manufacturing plants are a source of taxes hence government obtaining revenue and improve infrastructures like schools, roads, hospitals giving community members access to better services at a low cost.

2. Manufacturing plants are a source of job opportunities to people of the community enabling them earn income and improve their standards of living.

Impacts of the process of production of ethanol.

Impact.

1. Air pollution:

Emissions like sulphur dioxide, oxides of nitrogen from purification of crude ethanol by distillation using fossil fuels lower air quality leading to air pollution.

Mitigation:

Treating the emissions before release into the atmosphere.

Using alternative eco-friendly sources of energy like wind, hydroelectric power, etc.

Impact:

Water pollution:

Untreated waste water from ethanol producing plants contaminates water sources affecting aquatic life and human health.

Mitigation:

Treating waste water from the industries before release into natural water sources.

Impact:

Global warming:

This is due to release of carbon dioxide gas which is a greenhouse from the fermentation process into the atmosphere leading to global warming.

Mitigation:

Planting fast growing trees.

Dangers of abuse of alcohol.

Too much consumption of alcohol can lead to:

1. Liver damage.

2. Weakened immune system.

3. Memory loss.

4. Academic under performance.

Carboxylic acids.

Carboxylic acids are organic acids whose names are derived from alkanes by replacing one or two hydrogen atoms of the alkanes with a carboxylic group (-COOH).

The functional group in these compounds is the carboxyl group which has the structural formula.

They have a general formula $\mathbf{C_nH_{2n}O_2}$.

Number of carbon atoms	Name of organic compound.	Molecular formula	Structural form

1	Methanoic acid	$C_1H_2O_2$	
2	Ethanoic acid	$C_2H_4O_2$	
3	Propanoic acid	$C_3H_6O_2$	
4	Butanoic acid	$C_4H_8O_2$	
5	Pentanoic acid	$C_5H_{10}O_2$	
6	Hexanoic acid	$C_6H_{12}O_2$	
7	Heptanoic acid	$C_7H_{14}O_2$	

Characteristics of carboxylic acids.

Physical properties.

1. The first four members that is methanoic acid, ethanoic acid, propanoic acid and butanoic acid are liquids at room temperature. The rest are solids.

2. Carboxylic acids have higher melting and boiling points compared to alcohols of similar size. The boiling points of carboxylic acids increase with increase in molecular mass.

3. Carboxylic acids of low molecular mass are miscible with water, solubility decreases when molecular mass increases.

Chemical properties.

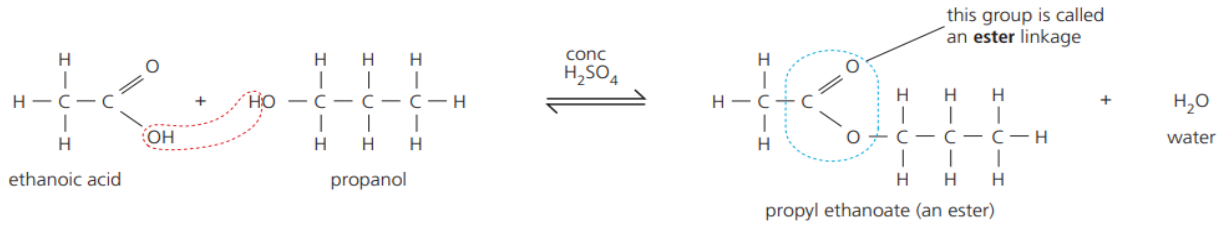
Using ethanoic acid.

1. A solution of ethanoic acid turns blue litmus paper to red.

2. Ethanoic acid also reacts with alcohols, to give compounds called esters.

ESTERS.

Reaction showing how ethanoic acid reacts with propanol to form an ester.



or $CH_3COOH\ (l) + C_3H_7OH\ (l) \rightleftharpoons CH_3COOC_3H_7\ (l) + H_2O\ (l)$ (conc. H_2SO_4)

Esters have a formula, RCOOR', where R and R' are alkyl groups. Fats and oils are esters occurring naturally in plants and animals. Fats and oils are formed from long-chain carboxylic acids, fats are solids at room temperature.

Vegetable oil is obtained from sun flower, ground nuts, cotton seeds and Simsim

Animal oil is obtained from whales

Animal fats are obtained from pork and milk

Vegetable fat is obtained from coconut

Uses of esters

Used for making soap

Used as a solvent for drugs and antibodies

Used for artificial flavorings

High esters such as wax can be used for making candles

Soap

Soap is a sodium or potassium salt of a long chain carboxylic acid.

<u>Laboratory preparation of soap.</u>

The reaction between vegetable oil or animal fats and sodium hydroxide solution to form soap is called **Saponification.**

What you need.

1. 10cm^3 of 5M sodium hydroxide.

2. 2cm^3 of castor oil.

3. Glass beaker.

4. Glass rod.

5. Saturated sodium chloride solution.

What to do.

1. Mix 10cm^3 of 5M sodium hydroxide solution with 2cm^3 castor oil or lard, or other oil or fat in a beaker.

2. Warm to boiling and stir with a glass rod while it boils gently for 5-10 minutes. The soap remains in solution.

3. Add saturated sodium chloride solution, boil gently and stir for further 2 minutes and allow to cool. Soap is insoluble in sodium chloride.

4. Filter off the solid soap.

Discussion.

Observation.

Soap solid forms on filter paper.

Word equation.

Fat + Alkali $\longrightarrow$ Soap + glycerin (propane-1, 2, 3-triol).

Industrial manufacture.

Soap is manufactured by a process called saponification that is alkaline, hydrolysis of an ester.

Raw materials.

1. Vegetable oil or fat. (Coconut oil, palm oil, mutton fat).

2. Concentrated sodium hydroxide solution or potassium hydroxide solution.

3. Saturated solution of sodium chloride.

Process of production.

1. Oils and fats are heated by steam with sodium or potassium hydroxide solution.

$RCOOR' + NaOH \longrightarrow RCOONa + R'OH$

2. Saturated sodium chloride solution is added to separate the soap as an upper layer. This is called salting out of soap. Potassium hydroxide forms soft soap.

3. Soap is separated from glycerin by distillation.

4. Soap obtained is further purified, additives such as moisturizers, thickeners, fragrances are added.

5. Soap is made into desired shape ready for market.

The cleansing action of soap

Soap works by lowering the surface tension of water hence increasing the wetting abilities of water.

Soap has two parts; the hydrophilic or lipophobic polar end which is water loving and the hydrophobic or lipophilic tail which water hating.

When soap is added to a cloth in water the polar end containing COO^-Na^+ group dissolves in water and the non-polar dissolves grease or all deposit in a cloth. Agitation causes emulsification of grease oil and then the dirty tiny droplets are carried away by clean water. If water is hard, soap first reacts with dissolved calcium and magnesium ions to form insoluble salts called scum.

$Ca^{2+}(aq) + 2St(aq) \longrightarrow CaSt_2(s)$

$Mg^{2+}_{(aq)} + 2St_{(aq)} \longrightarrow MgSt_{2\,(s)}$

Soapless (synthetic detergents)

Soapless detergents are cleansing agents made from components of crude oil called long chain alkyl benzene and other raw materials that are not derivatives of crude oil.

They are alternatives of soapy detergents and more effective cleansing agents.

This is because they don't form scum in presence of magnesium and calcium ions.

Soapless detergents form soluble salts in hard water hence don't affect action of soap in removing stains.

Soapless detergents can be manufactured in solid form (for example washing powders) or in liquid form (for example washing-up liquids and shampoos).

Common detergents include; Omo, Nomi, Fab, Sunlight and Axion.

Dangers of using detergents.

1. Soapy detergents.

Danger:

Soapy detergents contain chemicals that can cause:

a. skin burns/blisters/irritations and hence pain or cancer.

b. eye redness and pain hence loss of vision.

Mitigation:

Thoroughly wash affected areas like skin or eyes with clean water or irrigating the affected area like eyes and skin.

2. Soapless detergents:

These contain phosphates which cause algal bloom hence water pollution.

Comparison of the soapy and soapless detergents.

a. Similarities.

Both soapy detergents and soapless detergents are salts of organic acids of long chains.

Both soapy and soapless detergents are effective cleansing agents in soft water / rain water.

b. Differences.

Soapy detergents.	**Soapless detergents.**
Forms scum with hard water.	Does not form scum with any form of water.

Gentle on skin during washing.	Not gentle on skin during washing.
Sodium or potassium salts of long chain carboxylic acids and cannot be used in strongly acidic medium.	Sodium or potassium salts of benzene sulphonic acids and can be used in strongly acidic solutions.
Biodegradable.	Non-biodegradable.

EXAM BASED ITEMS.

Item 1.

A small village in rural Uganda faces a pressing waste management issue. Excessive organic waste from agriculture, livestock and households is improperly disposed in open pits leading to negative impacts to the environment and health issues. The chairperson of the village knows that these materials can be converted into a gaseous fuel with highest percentage being methane which can be used for cooking at home but lacks enough knowledge of how this can be done and has contacted you for advice.

Task: As a chemistry learner;

a. Explain the category of fuels the chair person wants his people to know about.

b. What are the properties of the substances to which the components of the fuel fall?

c. Suggest any other importance of the fuel other than cooking.

d. Write down the impact to the environment due to using the fuel and mitigation.

Item 2.

Gomba district faces a challenge of excess cassava production, leading to post significant harvest losses. To address the issue, the area Member of Parliament suggests that excess cassava can be used for ethanol production and the government has cleared a local investor to set-up an ethanol production unit in the area.

Community members want to know the processes involved in the production, the benefits of the industry to them and how negative impacts to the environment will be curbed.

The area MP has organized radio talk shows to create awareness.

Task: As a chemistry student, prepare a radio talk script show that can be used to create awareness.

Item 3.

Namukasa operates a laundry shop in kisenyi where the main water source is borehole water, the number of customers he receives are decreasing because her washing skills are not satisfying due to some stains that remain in the cloth and this is due to the detergent she chooses for washing. Namukasa is frustrated and has come to you for advice.

Task: Using the knowledge of chemistry;

a. Point out the problem Namukasa makes when choosing the product.

b. Help her know how the product works.

c. Advise Namukasa on the challenges associated with over dependence on the product.

Item 4.

The government of Uganda through the ministry of energy and mineral development wants to promote industrialization due to its secured benefits. Due to this, the government has cleared a local invest to set-up an industry that manufactures a soapy detergent on vast land of Mubende district**.** The locals are interested in knowing the processes involved in the production, social benefit of the industry and how the environmental impacts will be mitigated.

Task: As a chemistry student, prepare a newspaper article to be published in a local popular newspaper addressing the concerns of the community members.

Item 5.

In an experiment to find out the effectiveness of detergents Q and R on removing stains, Juma and Resty carried out experiments by washing equally stained clothes with the same amount of detergents using borehole water; Juma using detergent Q while Resty using detergent R.

After washing, Juma's cloth had some stains on it whereas Resty's was purely clean.

Task: As a chemistry learner;

a. Identify the categories of products used by Juma and Resty.

b. Give an accountability of the results of Juma and Resty in relation to how the products work.

c. Guide Juma and Resty on challenges associated with long term effects of using the products.

Item 6.

JMK fashions is a new boutique located in Wandegeya Kampala. The founder is interested in stocking products that maintain body warmth due to the season being rainy and their demand is high.

The manager knows that to make the right choice, she should be careful of the material from which products are made of.

However, the manager lacks enough knowledge about materials and has come to you for advice.

Task: As a chemistry learner,

a. Explain the category of materials from which the products can be made of.

b. Suggest the suitability of the materials.

c. Guide the manager on dangers that the material has to the environment and mitigation.

Item 7.

A new textile company has been established in Jinja. The company is to deal in production of swimming costumes. The manager wants to produce swimming costumes that can out compete on market but he is unaware of what to use as the raw material and he has come to you for advice.

Task: As a chemistry learner:

a. Explain the classes of materials the company manager can use.

b. What properties make the material the better choice over others on market?

c. Suggest any other use of the material other than in textile.

d. Write the impact to the environment the material has and mitigation.

Item 8.

Jimmy came across a chart showing some of the organic compounds whose molecular formulae are C_2H_4 (X) and C_2H_6 (Y). He became interested in chemistry of the two compounds, whether they can be useful in daily life and if their application in daily life can harm the environment in any way.

Task: As a chemistry student:

a. Identify the class of organic compounds to which X belongs giving reason to your answer and example.

b. Draw the structural formulae of compound and write a chemical test that can be carried out to distinguish between X and Y (include equation for the reaction where possible).

c. Suggest any daily life application of compound X.

d. How can application of compound Y endanger the environment and what is the mitigation.

Item 9.

Too much production of sugar canes is affecting people of Kamuli district where the prices dropped drastically hence low income to the farmers. On a radio talk show, the area Member of Parliament (MP) suggests that excess sugar canes can be converted to a useful product which is organic in nature with molecular formula $C_2H_6O_1$.

One of your classmates listened to the talk show and wanted to know more about the chemistry of the organic compound and came to you for help.

Task: As a learner of chemistry;

a. Identify the homologous series to which the useful product belongs, giving a reason for your answer and example.

b. Draw the structural formula of the useful product and write an equation for the reaction if to it in a test-tube is added to concentrated sulphuric acid and temperature maintained at 180^{o}c.

c. Suggest one way in which the product can be used in daily life without impacting human health.

d. What are the dangers associated with misuse of the product and mitigation.

Item 10.

During harvest of honey, Opio was stung by a bee on the hand which caused him feel inflammation. Doctors told him that the bee injected in him an organic compound with molecular formula $C_1H_2O_2$ and gave him some tablets which he promised will help him. Opio became interested in the chemistry of the compound and came to you for help.

Task: As a learner of chemistry;

a. Explain the homologous series to which the organic compound belongs.

b i. Guide Opio on the structural formula of the organic compound.

ii. State the properties of the organic compound in relation to its structural formula.

c. Identify any daily life application of the organic compound.

d. The organic compound undergoes combustion, what is the impact to the environment of this reaction and mitigation?

ACTIVITY OF INTEGRATION.

A debate has been scheduled with a motion that states carbon is the most diverse element in relation to life. You have been selected as one of the participants on proposers' side.

Task: As a chemistry learner, prepare a presentation you will use during this discussion.