GRAND O'LEVEL CHEMISTRY SEMINAR AT ST. JOSEPH'S S.S.S NAGGALAMA

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CHEMISTRY; PAPER 1; 545/1

SOLUTIONS

SECTION A

Food additives, Drugs and medicines, Nuclear processes, Soap

ITEM 1 (i)

(a) The ingredients used are **food additives** which are either: **Natural or Artificial/synthetic**,

(b) The food additives maintain or improve flavour, safety, freshness, texture and appearance of food.

(c)Excessive use of Artificial/synthetic food additives increases risk of high blood pressure and other communicable diseases, causing illness

Mitigation; Controlled amounts of artificial food additives should be used.

Both natural and artificial food additives have chemical compounds that are useful and some of which are harmful to the body but natural food additives have them in lower concentrations.
It is, therefore, advisable to use more of the natural ones than the synthetic additives.

ITEM 1 (ii)

(a) The product to use is **antibiotics,** which are **herbal**, or **modern**

(b) Inhibits growth of bacteria / kills bacteria

(c) Excessive use of the antibiotics causes **dizziness, headache, hearing loss, body organ damage hence health complications.**
Mitigated by: controlled use or following doctor's prescription

Evaluation: Both herbal and modern medicines are used to kill bacteria, but modern medicines are needed in smaller amounts and take a shorter time to cure the disease

ITEM 1 (iii)

(a) The product is **detergents**, which are either **soapy** or **soapless**

Mode of action: The detergents facilitate the emulsification and removal of grease /oil / dirt.

Alternatively

Detergents facilitate breakdown of fats into small parts.

A soap molecule contains two parts; namely; the water-soluble /polar carboxylate head / hydrophilic end and non-polar tail/fat soluble part / hydrophobic part.

-During washing, soap acts by lowering the surface tension between water and oil/grease/other water insoluble materials and also emulsifies them. The hydro-carbon tail becomes attached to dirt /oil /fat while the polar head dissolves in water. With constant agitation, the dirt is pulled off the cloth and gets dispersed in water as tiny droplets which are then poured away. The cloth is then rinsed several times and dried.

(b) Soapy detergents contain chemicals that can cause:

- Skin burns / blisters / skin irritation and hence pain or cancer mitigated by thoroughly washing the affected areas or by use of gloves during washing
- Eye redness and pain; hence loss of vision mitigated by thoroughly washing the affected areas
- Soapless detergents contain phosphates which cause algae bloom and hence polluting water that kills the aquatic organisms

Evaluation of the products

Similarities:

- Both soapy detergents and soapless detergents are salts of Organic acids of long carbon chain.
- Both soapy detergents and soapless detergents are effective cleansing agents in soft water / rain water.

Differences;

Soapy detergents	**Soapless detergents**
• Form scum with hard water	• Do not form scum with any form of water
• Gentle on skin during cleansing	• Not gentle on skin during washing
• Sodium salts of carboxylic acid of long chains and cannot be used in strongly acidic solutions	• Sodium salts of long chain benzene sulphonic acids and can be used in strongly acidic solutions
• Are biodegradable hence do not pollute the environment	• Are non-biodegradable hence pollute the environment

ITEM 1 (iv):

(a) The process is **nuclear reactions**, categorized into: **Nuclear fission** and **nuclear fusion**

(b) When uranium is bombarded with fast moving neutrons its atomic mass increases and the nucleus becomes unstable. Therefore it spontaneously splits into two lighter nuclei, three neutrons and energy. The three neutrons cause more successive disintegration, amplifying the energy given out. This can be used to boil water to steam which can eventually drive turbines and produce electricity.

Equation

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n + \text{energy}$$

However, the process has the following challenges

- The energy emitted can cause **mutations**, i.e. the emissions can cause sudden change in the arrangement of DNA/the genetic composition of the cells, hence **altering characteristics of organism.** This can be **mitigated** by wearing protective gears such as lead coats.
- The energy emitted can cause **cancer** resulting into **death, mitigated** by wearing protective gears such as lead coats or by posting warning information in the working area

(c) - **Both produce energy**, **but nuclear fission produces more energy than nuclear fusion**
- **Both are initiated by energy**, **but nuclear fusion requires a lot of energy to start** while nuclear fission requires little energy to start

TRENDS, POLYMERS, QUANTITY OF MATTER, PERIODIC TABLE, STRUCTURES AND BONDS

ITEM 2 (i):

a) He should realize that packaging materials may be;
Synthetic/artificial because they are man- made e.g. polyethene bags or **Natural** because they are God made e.g. cellulose in paper bags.

b) - Polyethene is tough
- It is insoluble in water
- Water proof
- Durable
Suitable for making packing bags for wet products.

Alternatively,
- Paper can easily be decomposed by fungi and bacteria (biodegradable),
- it is foldable
- absorbs moisture
- it is stiff
- strong
Suitable for making packing boxes for dry products.

Impact to the environment

- Polyethene is non- biodegradable, hence pollutes the soil environment, limiting free circulation of water and air in the soil
Mitigation; Reduce on its use, dispose it off properly, reuse or recycle.
- Paper easily catches fires, so can lead to fire outbreaks and damage
Mitigation; not using it near fire

ITEM 2 (ii):

(a) X is a **metal**, since it forms ions by loss of electrons, for example Calcium.

(b) Mass of oxygen in the oxide = 0.5 – 0.3 = 0.2g

Symbols of elements in the oxide	X	O
Composition by mass	0.3	0.2
Number of moles	$\frac{0.3}{24} = 0.0125$	$\frac{0.2}{16} = 0.0125$
Simplest ratio (mole ratio)	$\frac{0.0125}{0.0125}$	$\frac{0.0125}{0.0125}$
	1	1

Hence the formula of the oxide is **XO**

(c) - When in contact with drinking water, especially in large amounts can cause **cancer** leading to death, **mitigated** by purifying the water
- Their accumulation in soil can be absorbed by plants which are consumed by humans causing **cancer** and then **death**, **mitigated** by consuming plant materials with the right amount of mineral content
- When contaminated in air can be **inhaled**, hence **causing respiratory diseases**
Mitigated by purifying the air

ITEM 2 (iii)

(a) The product is a **covalent compound**, because **it is formed by sharing of electron between non-metal atoms**, examples include sulphur dioxide , ammonia, etc

(b) It has the following properties
- does not dissolves in water
- does not conduct electricity
- has a giant covalent structure
- exists as a molecule
- is not made up of ions

The product is used in;
- fire extinguishers to put out fire
- the manufacture of fizzy drink to improve on the taste and to preserve them

(c) **From the equation**,
12 g of charcoal produces 24*l* of the product at s.t.p

Then,
The 80.5 g of used will produce $\frac{80.5 \times 22.4}{12}$ *l* of the product
= 150.3 *l* of the product at s.t.p

The product has the following dangers:
Its **accumulation in the atmosphere**, causes an **increase in the temperature of the earth** that **causes discomfort to people and other animals**, **death of plants due to increased transpiration**.
This is mitigated **by planting trees** to absorb it.

Its accumulation in the atmosphere causes acid rains that cause crumbling of buildings and change in soil pH. Mitigated **by planting trees** to absorb it.

ITEM 2 (iv)

(a) Salt is **an ionic compound** because it is formed by complete transfer of electrons from a metal to a non-metal atom, e.g. sodium chloride
It has the following characteristics
- dissolves readily in water
- it is a crystalline solid at room temperature
- conduct electricity in molten and aqueous state
- has a high melting and boiling point
- its composed of particles called ions

Alternatively

Sand is a covalent compound because it is formed as a result of sharing electrons between non-metal atoms
It has the following properties
- does not dissolves in water
- does not conduct electricity
- has a giant covalent structure
- exists as a molecule
- is not made up of ions

Uses

Sand is used during construction, used as an electrical insulator

(b) - Over use of the salt can lead to **high blood pressure** that may result into **death**, **mitigated** by using it in regulated amounts
- lead to **kidney disorders** causing **illness**, **mitigated** by using it in regulated amounts

ITEM 2 (v):

(a) (i) X, Y and Z are metals, since they form ions by loss of electrons, for example calcium and potassium
A, Q and M are nonmetals, since they forms ions by gain of electrons, for example oxygen, sulphur
W is a metalloid because it has both metallic and non-metallic properties, for example silicon

(ii) There is a sharp increase in melting points from X to Y because of the decrease in atomic radius and increase in the number of electrons each metal atom contributes towards metallic bond formation resulting into stronger metallic bonds
Melting point increases slightly from Y to Z because of the slight increase in the strength of the metallic bond due to the decrease in the atomic radius
W has the highest melting point because it adopts a giant atomic structure with many strong covalent bonds that require a lot of heat energy to break.
A, Q and M are non-metals which exist as molecules with simple molecular structures and the melting point decreases with decrease in the strength of the Van derWaals forces due to decreasing molecular mass.

(b) **Uses**

Metals are used in electronic devices, in construction, manufacture of aeroplanes
Non-metals are used as electrical insulators, manufacture of drugs,fertilizers
Metalloids, used in production of alloys, as flame retardants, as semiconductors in the manufacture of dry cells and batteries

Environmental impacts
Metals

- when in contact with drinking water, especially in large amounts can cause cancer leading to death **mitigated** by purifying the water
- their accumulation in soil can be absorbed by plants which are consumed by humans causing cancer leading to death, **mitigated** by consuming plants with the right amount of mineral content
- when contaminated in air can be inhaled, hence causing respiratory diseases, **mitigated** by purifying the air

Nonmetals

When burnt in air produce acidic gases which pollute the atmosphere causing respiratory diseases, **mitigated** by burning them cautiously

Metalloids

During mining, smelting and industrial processes, they can **get in contact with water and soil**, polluting them and **causing harm to organisms**, **mitigated** by handling them carefully during the above named processes

SECTION B

PART I:

Contribution of chemistry to our economy

Copper, iron, aluminium, nitric acid, sulphuric acid, fertilizers, ethanol, detergents, sodium hydroxide, chlorine gas, bio gas, oxygen gas, cement

Item 1 (cement)

Raw materials; lime stone, sand and clay

Process of production;

The lime stone obtained from the quarry is mixed with sand and clay in the correct proportions and crushed into a fine powder.

The powder is then mixed with water and allowed to flow down a **rotating tank** (**or cylinder or cement kiln**) where it is strongly heated at about 1500^{o}C

Limestone decomposes into calcium oxide and carbon dioxide

$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$

Calcium oxide reacts with sand forming calcium silicate and also reacts with aluminium oxide forming calcium aluminate.

$2CaO(s) + SiO_2 \longrightarrow Ca_2SiO_3$

$3CaO(s) + Al_2O_3 \longrightarrow Ca_3Al_2O_6$

Calcium silicate and calcium aluminate form a mixture called clinker

Gypsum is added to clinker to moderate the setting of the cement and the lumps are then crushed by machine to obtain the fine cement powder

Clinker + $CaSO_4.2H_2O \longrightarrow$ Cement

Side effects of the process of production

- **Effluent discharge** from the cement plant can **contaminate water bodies**, affecting aquatic life and quality of water, **mitigated** by treatment of waste water through sedimentation and filtration before discharge / recycling the water with in the plant.
- **Carbon dioxide emissions** to the atmosphere can **cause global warming**, this is **mitigated** by recycling of carbon dioxide
- **Inhalation of air contaminated** with cement dust **causes respiratory diseases**, **mitigated** by wearing personal protective equipments

Social benefits

- **Source of employment opportunities**, hence **improved income** and therefore **better standards of living**
- **Increased government revenue** through taxes hence **improvement of infrastructure** such as roads, schools, health facilities leading **development of the society**.
- **Provision of market** for goods of the community members, hence **generating income**, leading to **better lives**
- **Production of cement for use** during **construction** by the community members, **hence acquiring better houses**

ITEM 2 (copper)
Raw materials used; Copper pyrites ($CuFeS_2$)

Process of production;

The ore (copper pyrites) is crushed into powder and mixed with water containing special oils called frothing agents.

Air is brown into the mixture and a froth forms. Earthly impurities in the ore are wetted with water and sink to the bottom of the **flotation tank** while the copper pyrites floats on the surface in the froth.

The froth is skimmed off, and an acid added to it to break it.
The ore is filtered off, dried and roasted to convert it to copper(I) sulphide, sulphur dioxide and iron (II) oxide

$$2CuFeS_2(s) + 4O_2(g) \longrightarrow Cu_2S(s) + 2FeO(s) + 3SO_2(g)$$

Sand is then added and the mixture heated in absence of air to convert iron(II) oxide to iron (II) silicate liquid.

$$FeO(s) + SiO_2 \longrightarrow FeSiO_3(l)$$

The ore is then heated in a controlled amount of air to produce impure copper and sulphur dioxide;

$$Cu_2S(s) + O_2(g) \longrightarrow 2Cu(s) + SO_2(g)$$

Or, $2Cu_2S(s) + 3O_2(g) \longrightarrow 2Cu_2O(s) + 2SO_2(g)$
Then; $Cu_2S(s) + 2Cu_2O(s) \longrightarrow 6Cu(s) + SO_2(g)$

The copper produced is then **purified by electrolysis of copper (II) sulphate** using this produced impure copper as the anode and a pure copper as the cathode
The impure copper anode dissolves in the electrolyte producing copper (II) ions which move to the cathode where they are discharged to form pure copper.

Anode: $Cu(s) \longrightarrow Cu^{2+}(aq) + 2e$
Cathode: $Cu^{2+}(aq) + 2e \longrightarrow Cu(s)$

Side effects of the process of extraction of copper
- **Release of sulphur dioxide** causes **air pollution resulting into acid rains that affect plant growth** and also causes **global warming**, **mitigated** by treatment of the gas or installing catalytic converters in the exhaust pipes
- **Exposure to copper fumes** or **dust** can cause **poisoning leading to cancer and even death**, **mitigated** by personal protective equipments

Social benefits
- **Source of employment opportunities**, hence **improved income** and therefore **better standards of living**
- **Increased government revenue** through taxes hence **improvement of infrastructure** such as roads, schools, health facilities leading **development of the society** improving standards of living
- **Provision of market** for goods of the community members, hence **generating income**, leading to **better lives**

ITEM 3 (iron)

Raw materials: Iron ore e.g. Haematite, Coke, Lime stone and air
Process of production;
Iron is extracted from its ores using a **blast furnace**
Haematite, coke and limestone are mixed together and introduced into the **blast furnace** from the top up where hot air is forced
As the hot air rises up the furnace it reacts with the coke to form carbon dioxide.
i.e. $C(s) + O_2(g) \longrightarrow CO_2(g)$

As the carbon dioxide formed rises up the furnace it is reduced by the unburnt coke to carbon monoxide

i.e. $CO_2(g) + C(s) \longrightarrow 2CO(g)$

The carbon monoxide then reduces the haematite to molten iron;

$2Fe_2O_3(s) + 3CO(g) \longrightarrow 4Fe(s) + 3CO_2(g)$

The molten iron then sinks to the bottom of the furnace where it is topped off

The lime stone decomposes into calcium oxide which reacts with the sand, a major impurity in haematite to form slag which drops to the bottom of the furnace and floats on top of the molten iron.

$CaCO_3(s) \longrightarrow CaO(s) + CO(g)$

$CaO(s) + SiO_2(g) \longrightarrow CaSiO_3(l)$

The iron obtained is impure and can be **purified by converting it onto wrought iron, by oxidizing the impurities**

Side effects of the process of extraction

- **Emission of poisonous gases** leading to **air pollution that may cause suffocation** hence illness or death, **mitigated** by treatment of these gases before emission to the atmosphere
- The **un reacted carbon dioxide can escape** into the atmosphere causing **global warming**, **mitigated** by recycling the carbon dioxide
- **Emission of heat** from the furnace causing **rise of temperature of the surrounding environment, which affects the people**, **mitigated** by installing heat absorbers around the furnace

Social benefits of process of extraction of iron

- Source of employment opportunities in the factory, hence improved income and therefore better standards of living
- Increased government revenue through taxes hence improvement of infrastructure such as roads, schools, health facilities leading development of the society and better lives
- **Provision of market** for local goods of the community members, hence **generating income**, leading to **better lives**

ITEM 4 (fertilizers)

The local investor will produce ammonium sulphate or ammonium nitrate fertilizer and the production will be as follows

For ammonium sulphate,

Raw materials; Nitrogen from the air, Hydrogen from water gas, sulphur and air

Process of production;

First is the production of ammonia

Nitrogen and hydrogen gases are purified, dried and mixed in a volume ratio of 1:3 respectively in a **reactor vessel**.

The mixture is passed over finely divided iron catalyst, at a low temperature of 400 -500^oC under high pressure of 200 atm, hence forming ammonia, through the Haber process.

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Then, sulphuric acid is manufactured by the contact process

Sulphur is burnt in air to produce sulphur dioxide

$S(s) + O_2(g) \longrightarrow SO_2(g)$

Sulphur dioxide, is purified and dried to prevent poisoning of the catalyst. It is then heated with dry pure oxygen gas at a low temperature of 400 – 500^oC under high pressure of about 1 – 3 atm in the presence of vanadium (v) oxide forming sulphur tri oxide.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

Sulphur trioxide is then dissolved in a little concentrated sulphuric acid to produce a fuming liquid called oleum.

$SO_3(g) + H_2SO_4(l) \longrightarrow H_2S_2O_7(l)$

The oleum is diluted with a known amount of water to give 98% concentrated sulphuric acid.

$H_2S_2O_7(l) + H_2O(l) \longrightarrow 2H_2SO_4(aq)$

Ammonium sulphate is then formed by reacting ammonia gas with concentrated sulphuric acid

$2NH_3(g) + H_2SO_4(l) \longrightarrow (NH_4)_2SO_4(s)$

The fertilizer is then **concentrated by crystallization**

For ammonium nitrate fertilizer nitric acid will be manufactured as follows

Ammonia gas from the Haber process is burnt in dry pure oxygen of the air, in the presence of platinum catalyst, to form nitrogen monoxide gas with in a **reaction vessel**

$4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(l)$

Nitrogen monoxide formed is then reacted with oxygen to form nitrogen dioxide gas;

$2NO(g) + O_2(g) \longrightarrow 2NO_2(g)$

Nitrogen dioxide gas is then mixed with oxygen and the mixture absorbed in water to form nitric acid

$4NO_2(g) + O_2(g) + 2H_2O(l) \longrightarrow 4HNO_3(aq)$

The nitric acid formed is then reacted with ammonia to form ammonium nitrate fertilizer which is concentrated by crystallization

$NH_3(g) + HNO_3(aq) \longrightarrow NH_4NO_3(s)$

Side effects of the process of production of fertilizers

Emission of ammonia, nitrogen oxides and sulphur oxides **can pollute the air, causing respiratory problems** and **environmental issues**, **mitigated** by installing catalytic converters to convert them to less toxic substances.

Social benefits

- **Source of employment opportunities**, hence **improved income** and therefore **better standards of living**
- **Increased government revenue** through taxes hence **improvement of infrastructure** such as roads, schools, health facilities leading **development of the society**.
- **Development of small scale businesses**, hence generating income, leading to **better lives**
- **Availability of fertilizers**, hence **better plant growth** in the community **leading increased crop yields**.

ITEM 5 (chlorine and sodium hydroxide)

NOTE: This item requires manufacture of chlorine, but the solution also gives room for manufacture of sodium hydroxide

Raw materials used; Brine (concentrated sodium chloride solution)

Process of production;

Sodium hydroxide and chlorine are manufactured by electrolysis of brine

Brine which mainly contains sodium ions, chloride ions, is placed in a **diaphragm cell** that consists of a graphite anode and a steel cathode.

Brine ionizes according to the equation;

$NaCl(aq) \longrightarrow Na^+(aq) + Cl^-(aq)$

The sodium ions migrate to the cathode where they are preferentially discharged to form sodium which reacts with water to form **sodium hydroxide** solution that can be **purified by evaporation to dryness** to form solid sodium hydroxide,

$Na^+(aq) + e \longrightarrow Na(s)$
$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

Chloride ions migrate to the anode where they are preferentially discharged to form chlorine gas which is then packed in strong cylinders.

i.e. $2Cl^-(aq) \longrightarrow Cl_2(g) + 2e$

Side effects of the process of production;

- **Contact with sodium hydroxide** causes **severe burns to the eyes, skin, digestive system resulting into permanent damage of the body organs and even death**, **mitigated** by wearing personal protective gears
- **Repeated inhalation of sodium hydroxide vapor** causes **lung damage**, **mitigated** by wearing protective gears
- **Inhalation of chlorine** can **cause death** as it is a poisonous gas, **mitigated** by wearing protective gears
- **Escape of chlorine into the surrounding atmosphere** can **pollute the resulting into acid rain which leads to crumbling of buildings**, **lowering soil pH** and **corrosion of roofs made of iron**, **mitigated** by regular maintenance of the plant.

Social benefits

- **Source of employment opportunities**, hence **improved income** and therefore **better standards of living**
- **Increased government revenue** from taxes hence **improvement of infrastructure** such as roads, schools, health facilities leading **development of the society**.
- **Provision of market** for goods of the community members, hence **generating income**, leading to **better lives**

ITEM 6 (oxygen)

Raw material; liquid air / air.

Process of production;

Air is passed through **air filters** to remove dust and smoke particles. It is then passed through concentrated sodium hydroxide solution to remove carbon dioxide,
$2NaOH(aq) + CO_2(g) \longrightarrow Na_2CO_3(aq) + H_2O(l)$.

Air free from carbon dioxide is now passed through Silicon(IV) oxide to absorb water vapour. Carbon dioxide and water vapour are removed from air before it is liquefied because they would solidify and block the apparatus.
The air is then compressed at 200 atmospheres and allowed to cool by making it escape into a large space through a jet.
The process of cooling is repeated several times to obtain liquid air at about –200^{o}C. The liquid air is **fractionally distilled** using a **fractionating column / tower**.

Nitrogen boils off first because it has a lower boiling point (–196ºC) leaving behind oxygen with a higher boiling point (-183ºC). . Pure oxygen is then stored under pressure in steel cylinders.

Side effects of the process of production

- Explosion of oxygen cylinders due to high pressure **causing injuries and fire outbreaks** also **resulting into damage to equipment**, **mitigated** by;

* regular maintenance and monitoring of cylinders.
* keeping cylinders in cool areas to avoid exposure to heat.

- Exposure to liquid oxygen can **cause severe skin and eye irritations and burns, loss of vision and cancer**, m**itigated by**:

* Posting hazard and warning information in the working area.
* Communicating all information on the health and safety hazards of oxygen to potentially exposed workers; for example; submerging the affected body parts in warm water.

Social benefits

- **Source of employment opportunities**, hence **improved income** and therefore **better standards of living**
- **Increased government revenue** from taxes hence **improvement of infrastructure** such as roads, schools, health facilities leading **development of the society**.
- **Development of small scale businesses**, hence **generating income**, leading to **better life**

Item 7 (soapy detergents)

Raw materials; vegetable oil, concentrated sodium hydroxide, concentrated sodium chloride

Process of production;

Vegetable is mixed with concentrated sodium hydroxide solution (or potassium hydroxide solution) in a **non aluminium tank** and the mixture boiled while stirring until no further change occurs, and allowed to cool.

Concentrated sodium chloride solution is added into the mixture to precipitate (salt out) soap from the solution. Solid soap is skimmed off, washed and dried.

Side effects of the process of production

- **Discharge of wastewater containing surfactants solvents, phosphates and other chemicals into water bodies** can cause **contamination** or **pollution**, **harming aquatic life and affecting water quality**, **mitigated** by treatment of the wastes
- **Accidental spills or leaks of raw materials and finished products** can lead to **contamination** or **pollution**, affecting soil fertility and hence plant growth, **mitigated** by use of proper storage and handling procedures for raw materials and chemicals.

Social benefits

- Source of revenue to the government through taxes, hence, improved infrastructures for example; health facilities, roads etc hence improvement in the other sectors such as health and transport resulting into living a better life.
- Source of **employment** resulting into **improved income** hence, **better standards of living**.
- **Provision of market** for goods of the community members, hence **generating income**, leading to **better lives**

Item 8 (soapless detergents)

Raw materials: concentrated sulphuric acid, long chain of alkyl benzene, sodium hydroxide

Process of production

A long chain of alkyl benzene is heated with concentrated sulphuric acid in a **reactor vessel** to form alkyl benzene sulphonate, which is then cooled and then reacted with sodium hydroxide solution to form alkyl benzene sodium sulphonate which is then **purified by evaporation**, **evaporated** and cooled to obtain the soapless detergent.

Side effects

When the non-biodegradable soapless detergents **leak to water, they pollute it causing death of aquatic organisms, mitigated by**, not pouring water containing soapless detergents near water bodies.

Social benefits, same as above

ITEM 9(ethanol)

Raw material: bananas, sorghum, water

Process of production

The bananas are covered after harvesting for about a week to ripen. The carbohydrates are converted into maltose by means of enzymes diastase

The ripe bananas are put in a **wooden trough** and then squeezed between spear grass to extract the juice from them while adding water.

The mixture is filtered to obtain juice

Sorghum which has been roasted is added to the filtered juice and the mixture is stored.

The mixture is then covered in a warm place to cut off oxygen supply to allow fermentation to occur.

Yeast from sorghum provides maltase enzyme which catalyses hydrolysis of maltose to glucose

Zymase enzyme from yeast catalyses the decomposition of glucose to ethanol which is crude

The crude ethanol is **purified by fractional distillation** to obtain pure ethanol.

Side effects

Bursting of distilling tanks, causing **wounds and even death to the workers**, **mitigated** by regular inspection and maintenance of the distilling tank

Social benefits

- Source of **employment** resulting into **improved income** hence, **better standards of living**.
- **Provision of market** for goods of the community members, hence **generating income**, leading to **better lives**
- **Provision of ethanol to the community members** or **use as a sanitizer and disinfector** hence **living a better health**

PART II
Natural resources

ITEM 1 (Oil)

Category of the natural resource: Oil is a **non renewable natural resource** because it cannot be replenished / replaced by natural processes in man's life time orit gets used up.

Composition: alkanes, alkynes, paraffin, petrol and diesel.

Impact of the human activities on the natural resource

- **combustion of oil, releases** carbon dioxide **which can results into acid rain that interferes with the soil pH**, hence affecting plant growth, also leads to **global warming**
  Mitigated by increased afforestation such that the trees absorb carbon dioxide
- **Oil spills by humans** can **reach water bodies cutting off oxygen supply causing suffocation of aquatic animals**.
  Mitigated by proper waste management routines

Importance of the natural resource

When purified it produces various chemicals like motor fuels, lubricants, paints, detergents, drugs, etc.

ITEM 2 (rocks and minerals)

Category of the natural resource

Rocks and minerals are **non-renewable natural resources** because they cannot be replenished / replaced by natural processes in man's life time. **Or** they get used up.

They are categorized as: **Igneous rocks, Sedimentary rocks** and **Metamorphic rocks**

- **Igneous rocks**, comprising of minerals like **Quartz**, **Feldspar**, and **Olivine**
- **Sedimentary rocks**, composed of minerals like **Calcite**, **Quartz**, **Clay materials**, **Gypsum**
- **Metamorphic rocks**, composed of minerals like **Garnet**, **Mica(biotite** and **muscovite)**,**Quartz** and **Feldspar** (**Marble** or **Gneiss**)

Impact of the human activities on the natural resource

- **Stone quarrying produces dust particles** which **erode into water bodies, hence reducing on its quality**
  Mitigation extracting carefully and use of personal protective equipments
- **Stone quarrying and mineral extraction removes top soil and ditches** which **degrades the soil environment**, **hence affecting growth of plants, hence destruction of vegetation cover**
- **Mineral extraction** results into **breaking of rocks into smaller stones and gravels** which **depreciates the rocks**
  Mitigation, careful extraction

Importance of the natural resource

- Rocks are broken into hard core, gravel or panels used as materials for construction of roads, bridges, houses
- They are usefully in formation of soil by a process of weathering

ITEM 3: (water)

Category: Water is a renewable natural resource because it can be replaced/replenished by natural processes in man's life time.

Composition: Dissolved oxygen, mineral salts, aquatic plants and big animals as well as microorganisms and pollutants from man's activities.

Impact

Release of hot water as an effluent from industries into the water bodies, **increase the temperature of the water** bodies killing aquatic organisms. **Mitigated by** cooling the water before discharge and use of hot water reservoirs

Excessive use of fertilizers during crop farming, which infiltrate into water bodies, hence **polluting water**, **resulting into eutrophication** of nearby water bodies

Mitigated by use of organic fertilizers e.g. manure from both animal and plant waste which are biodegradable and reduce on use of synthetic fertilizers

Importance

Water bodies are very useful in rain formation which is useful for proper plant growth

ITEM 4 (air)
Category: Air is a renewable natural resource because it can be replaced/replenished in man's life time.

Composition: Nitrogen gas, oxygen gas, carbon dioxide gas, rare gases, water vapour and dust.

Impact
Burning of fossil fuels, increases amount of carbon dioxide gas thus **trapping a lot of heat in the atmosphere thereby causing global warming** and **consequently desertification**.
Mitigated by increased afforestation to absorb carbon dioxide from the atmosphere as quickly as it is formed

Importance
Air contains oxygen which is used for respiration and carbon dioxide which is used for photosynthesis

ITEM 5 (trees)
Category: Trees and natural vegetation are renewable natural resources because they can be replaced/replenished by natural processes in man's life time.

Composition Trees and natural vegetation are made up of cellulose which is a carbohydrate (made up of important elements like carbon, hydrogen and oxygen), and other minerals such as magnesium, nitrogen, etc.

Impacts
Charcoal burning involves **cutting down of trees which leads to deforestation** and **loss of habitat for wild animals**. **Mitigation:** use of charcoal briquettes made from waste organic materials, afforestation

Massive cutting down of tress leads to **increased amount of carbon dioxide** in the atmosphere resulting into **increasing temperatures of the earth**
Mitigation: Planting more trees

Importance
Trees provide herbal medicine, provide food, and purify air by adding oxygen and removing carbon dioxide

PRACTICALS

Practical item 4

(a)

Aim of the experiment	To determine the heat change of the reaction between metal X and hydrochloric acid
Hypothesis	The reaction between metal X and hydrochloric acid liberates heat energy
Variables	Dependent variable – temperatures Independent variable – time Controlled variable – volume of hydrochloric acid
Risk and mitigation	- Breaking of the thermometer hence causing injuries to the body. **Mitigated by** putting the thermometer in its casing immediately after use - Acid pouring on the skin hence causing burns. **Mitigated by** wearing a laboratory coat, gloves and closed shoes
Procedure	(a) Using a measuring cylinder, 30 cm^3 of hydrochloric acid are measured and transferred into a plastic beaker. (b) The initial temperature of the solution is read using a thermometer and recorded (c) 0.5g of metal X is weighed using a digital scale and added at once to the acid in the plastic beaker and the stop watch is simultaneously stated. (d) The mixture is stirred using a thermometer and the temperature of the solution mixture is read and recorded every after 30 seconds for 3 minutes (e) The results are entered in the table.

(b) Volume of BA1 used = 30.0cm^3

Time(s)	0.0	30.0	60.0	90.0	120.0	150.0	180.0
Temperature of mixture of BA1 and metal X(^oC)	25.0	40.0	51.0	57.0	60.0	59.0	58.0

(c) From the graph;

Maximum temperature attained by the mixture = 64^oC

Temperature change of the mixture = 64 – 25

= 39^oC

Heat change of reaction = $mc\Delta t$

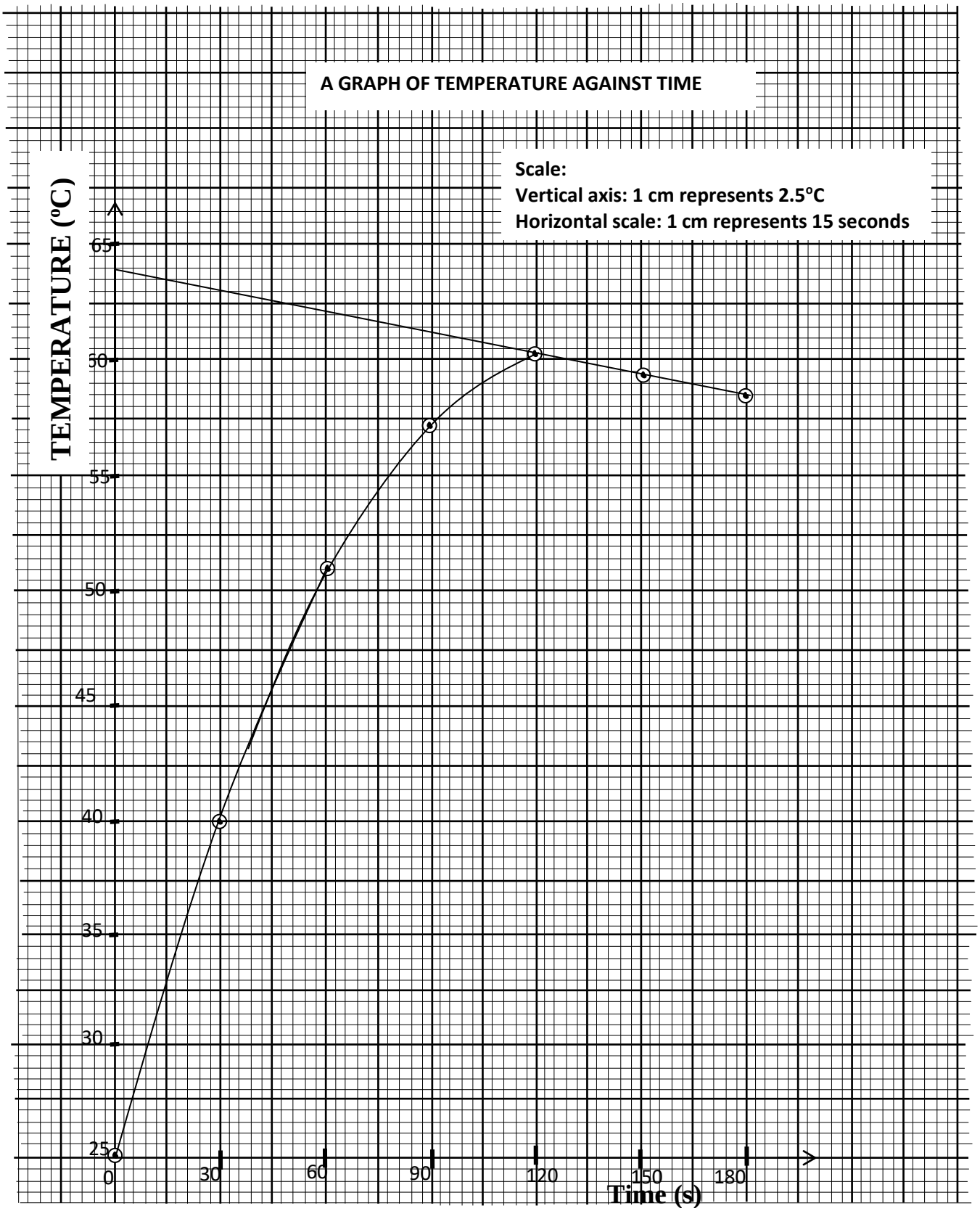
$= 30 \times 4.2 \times 39$

$= -4{,}914J$

Or; $-4.914KJ$

Conclusion;

The reaction between metal X and hydrochloric acid liberates = 4.914KJ of heat energy.


A GRAPH OF TEMPERATURE AGAINST TIME
Scale:
Vertical axis: 1 cm represents 2.5°C
Horizontal scale: 1 cm represents 15 seconds
TEMPERATURE (°C)
65
60
55
50
45
40
35
30
25
0
30
60
90
120
150
180
Time (s)

Practical item 5

(a) (i)

Aim of the experiment	To discover which type of water is more effective in cleaning and minimizing soap wastage
Hypothesis	Water sample BA3 or BA2 is more effective in cleaning and minimizing soap wastage
Variables	Dependent variable – volume of soap solution used Independent variable – type of water sample Controlled variable – volume of water sample used
Risk and mitigation	Soap solution pouring on the skin causing irritations and burns **Mitigated by** wearing gloves.
Procedure	(a) 25.0cm^3 of water sample BA2 is pipetted into a clean conical flask. (b) Soap solution is poured into a burette and initial burette reading recorded. (c) BA2 in the conical flask is then titrated with BA1 until a permanent lather is formed. (d) The final burette reading is recorded. (e) The titration is repeated two more times to obtain consistent results. (f) The results are then entered in a suitable table (g) The procedures (a) to (f) are repeated with water sample BA3.

(ii) Results for BA2

Experiment number	1	2	3
Final burette reading (cm^3)	25.10	25.00	25.00
Initial burette reading (cm^3)	0.00	0.00	0.00
Volume of BA2 used (cm^3)	25.10	25.00	25.00

Results for BA3

Experiment number	1	2	3
Final burette reading (cm^3)	10.20	10.00	10.00
Initial burette reading (cm^3)	0.00	0.00	0.00
Volume of BA3 used (cm^3)	10.20	10.00	10.00

(b) Average volume of soap required to form permanent lather with;

(i) Water sample BA2 $= \frac{25.10+25.00+25.00}{3}$

$= \underline{25.03\ cm^3}$

(ii) Water sample BA3 $= \frac{10.20+10.00+10.00}{3}$

$= \underline{10.07\ cm^3}$

Water sample; BA3 required less soap solution to form permanent lather than water sample BA2. Hence, BA3 is the effective water sample the laundry service provider should use.

E N D