UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

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Candidate's Name ..... KIBUGO DENNIS .....

Signature ..... Kib .....

Subject ..... Paper code ...../.....

Random No. 0750-732031

Personal Number Watsapp.

1st ELEMENT OF CONSTRUCT;

THE LEARNER APPRECIATES CONTRIBUTION OF CHEMISTRY TO OUR ECONOMY.

Areas of emphasis;

1. Manufacture of Oxygen
2. Manufacture of Chlorine
3. Extraction of Metals ← Fe, Cu, Al
4. Manufacture of fertilizers
5. Manufacture of detergents
6. Manufacture of Sodium hydroxide
7. Manufacture of Sulphuric acid
8. Manufacture of Cement
9. Manufacture of ethanol
10. Manufacture of Biogas.

Each Process;

V – Vessel
Cp – Chemical process
Cd – Conversion to desired product
Ch – Coherence
Pr – Purification

Key points in assesment

⇒ Raw materials
⇒ Process of production.
⇒ Side effects of the process of production and mitigation
⇒ Social benefits

UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

LEARNER APPRECIATES CONTRIBUTION OF CHEMISTRY TO OUR ECONOMY.

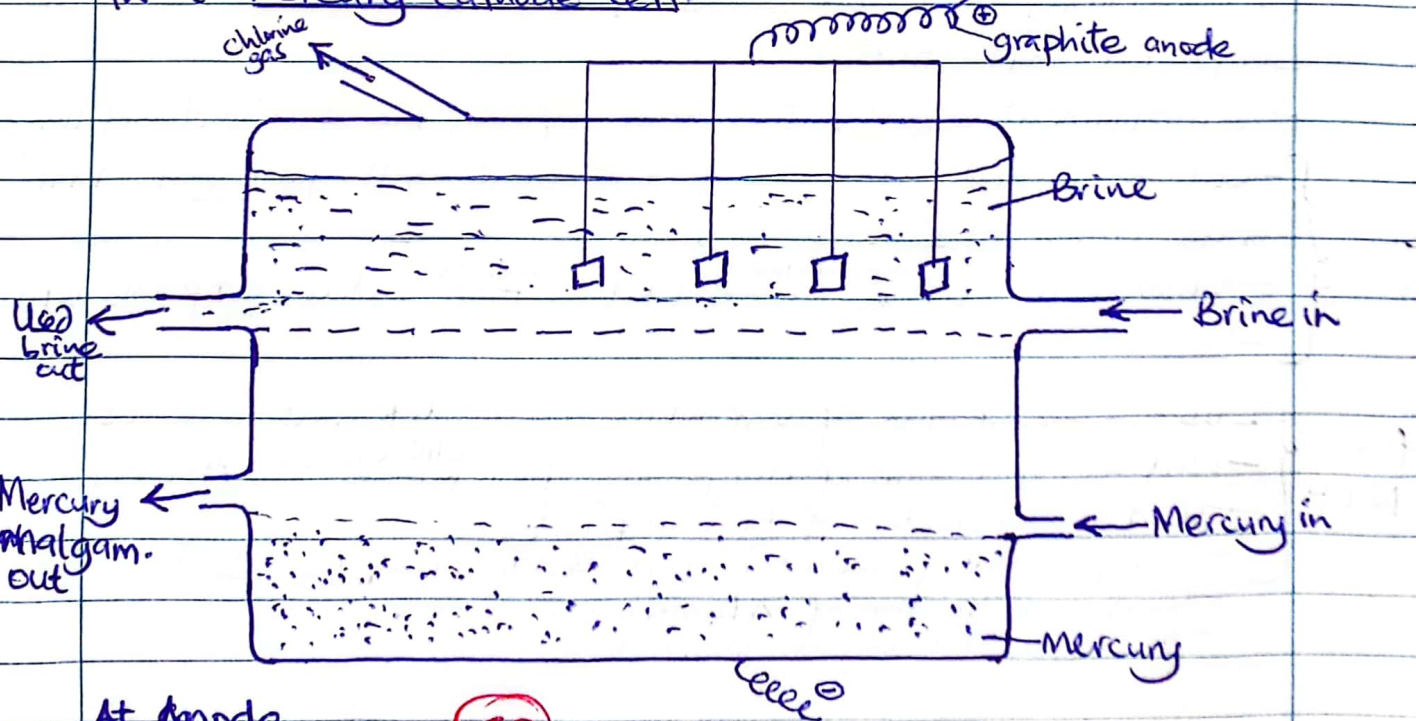
ASSESSABLE AREAS.

1 and 2. **MANUFACTURE OF CHLORINE;** – Using Mercury Cathode cell. OR SODIUM HYDROXIDE SOLUTION.

⇒ **Raw materials;** Concentrated sodium chloride solution (Brine), Mercury.

⇒ **Process of production;**

Chlorine is manufactured by electrolysis of concentrated sodium chloride solution (Brine) using graphite as anode and mercury as cathode in a mercury cathode cell.



At Anode

Chloride and hydroxide ions migrate to the anode and chloride ions are preferentially discharged to form chlorine gas.

$$2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e$$

For NaOH; At Anode; $Na^+_{(aq)} + e \longrightarrow Na_{(s)}$ The sodium then mixes with mercury

Candidate's Name .....
Signature ..... Random No.
Subject ..... Paper code ..Water..... Personal Number

Sodium amalgam reacts with ~~with~~ forming sodium hydroxide solution.

$$NaHg_{(s)} + H_2O_{(l)} \longrightarrow NaOH_{(aq)} + \tfrac{1}{2}H_{2(g)} + Hg_{(l)}$$

⇒ Side effects of the process and mitigation.

- Suffocation due to release of other gases like hydrogen in confined spaces
  Proper Use of P.P.Es
- Exposure to high concentrations of chlorine leading to death or itchings of eyes, noses
  Proper use of PPEs
- Exposure to excessive noise from mechanical equipment/cylinders
  Proper use of Personal protective Equipment
- Exposure to mercury which is highly toxic and may cause damage to nervous system, reproductive system on long time-exposure.
  Proper Use of PPEs

⇒ Social benefits

- Manufacturing plants are source of revenue to the Govt hence improved infrastructures.
- Employment opportunities hence improving the standards of living

for Chlorine
- chlorine in water is a disinfectant hence kills pathogens that would cause diseases to man.
- Chlorine is used in manufacture of as a weed killers. weeds that reduce crop production.
-

for NaOH
- used in manufacture of soap which is a detergent in homes.
- Used in manufacture of drugs eg pain killers relievers - eg Aspirin
- Used in manufacture of baking powder
- In paper making industry, it is used to clean the wood ~~paper~~
- Used in extraction of Aluminium.
- In textile industry to make dyes,

(4)

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Candidate's Name .....

Signature ..... Random No.

Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF OXYGEN

⇒ Raw materials ; Air (Atmospheric air)

⇒ Process of production

(V) Atmospheric air is pumped into tanks and the process involves the following stages.

① Filtration

Atmospheric air is filtered using air filters to remove dust particles

② Drying:

(Ch) Air is cooled until the water vapour condenses. It is passed through a bed of silica gel. This is to remove water vapour.

③ Removal of pollutants

The remaining air components are passed through beds of charcoal to remove air pollutants (NO_2, SO_2, CO, etc)

④ Removal of Carbon dioxide

(CP) It is then passed through concentrated potassium hydroxide solution to remove Carbon dioxide gas.

⑤ Compression: Air is repeatitively compressed at high pressure of 200 atm and allowed to cool at −200°C to form liquid air. (Cd)

⑥ Fractional distillation (Pr): The liquid air is pumped into fractionating column where nitrogen at with lowest boiling point (−196°C) comes off and later on further warming. Oxygen is collected at −183°C

⇒ Side effects ;- Noise pollution from Compressors — Proper use of appropriate PPEs
- Cold burning of oxygen cylinders —

⇒ Social benefits; — ~~For~~ ~~Oxi~~ — For breathing by sea divers, astronauts
→ Employment — salary — improved standards of living — Manufacture of steel.
→ Govt revenue — Improved infrastructures. — Used in ~~Acet~~ oxy-acetylene flames for cutting and welding of metals

Candidate's Name .....

Signature ..... Random No.

Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF FERTILIZERS.

A. AMMONIUM FERTILIZERS
- Urea (H_2NCONH_2)
- Ammonium nitrate
- Ammonium sulphate
- Ammonium phosphate
- Calcium Ammonium Nitrate (CAN)

⇒ **Raw materials;** Nitrogen gas, Hydrogen gas.

⇒ **Process of production;**

Nitrogen from fractional distillation of liquid air is reacted with hydrogen from natural gas in a ratio of 1:3 respectively to form ammonia by Haber process. The reaction requires low temperature (450-500°C), high pressure (200atm) and finely divided Iron Catalyst.

(CP) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

Ammonia produced is heated in air (oxygen) in presence of platinum catalyst forming nitrogen monoxide and water. All these in a tank. (V)

(CP) $4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(l)}$

Nitrogen monoxide is further oxidised to nitrogen dioxide

$NO_{(g)} + \frac{1}{2}O_{2(g)} \longrightarrow NO_{2(g)}$

Nitrogen dioxide is dissolved in water in presence of oxygen, in a tank, forming nitric acid.

Urea; Obtained by reacting liquid ammonia gas with carbon dioxide at high pressure (Cd)

$NH_{3(g)} + CO_{2(g)} \longrightarrow H_2NCONH_{2(aq)} + H_2O_{(l)}$

Ammonium Nitrate; By reacting nitric acid with ammonia gas.

$NH_{3(g)} + HNO_{3(aq)} \longrightarrow NH_4NO_{3(aq)}$ (Cd)

~~Ammonium sulphate; $NH_{3(g)} + H_2SO_{4(l)} \longrightarrow (NH_4)_2SO_{4(aq)}$~~

The fertilizers are further (H) concentrated and converted to solid form.

6

UCE

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Signature .....

Subject ..... Paper code ...../.....

Random No.						
Personal Number						

⇒ **Side effects + Mitigation:**

- Runoff into water bodies promoting increased algae growth thus oxygen supply is cut off leading to suffocation of aquatic animals
- Some when dissolved in water form acidic solution that alter soil pH hence low crop production.

⇒ **Social benefits.**

- Source of employment as residents get salaries hence improved standards of living.
- High levels of nutrients supplied by ~~fe~~ leading to improved crop production hence better standards of living to farmers
- Some when dissolved in water form acidic solutions that alter soil pH, hence low crop pro

UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

Candidate's Name .....

Signature ..... Random No.

Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF SULPHURIC ACID

⇒ **Raw materials ;** - Sulphur dioxide gas.
- Oxygen gas.

⇒ **Process of production;**

Dry Sulphur dioxide free from impurities is heated with dry pure Oxygen gas at low temperature (of about 450-500°C), high pressure (of about 1-3 atmospheres) in presence of vanadium(V) oxide Catalyst to form sulphur trioxide. The reaction occurs in a Combustion (V) cylinder.

$$(2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)})$$

(cp) Sulphur trioxide is ~~reacted~~ dissolved in ~~with~~ little concentrated Sulphuric acid forming oleum.

$$(H_2SO_{4(l)} + SO_{3(g)} \longrightarrow H_2S_2O_{7(l)})$$

(cd) Oleum is added to moderated ~~amounts~~ volumes of ~~use~~ distilled water forming 98% Concentrated Sulphuric acid.

$$(H_2S_2O_{7(l)} + H_2O_{(l)} \longrightarrow 2H_2SO_{4(l)})$$

⇒ **Side effects and mitigation**

- Toxic misty fumes from oleum which ~~is~~ when inhelled may cause breathing problems and many side effects.
- Acid spills on the floor / surfaces leading to accidents

⇒ **Social benefits**

- Employment ≡ salaries ≡ improved standards of living
- ~~Used~~ Manufacture of fertilizer ≡ Increased farm yields ≡ Improved standards of
- Used in car batteries as electrolyte - - - -

UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

Candidate's Name .....

Signature .....

Subject ..... Paper code ...../.....

Random No.						
Personal Number						

MANUFACTURE OF CEMENT.

⇒ **Raw materials;** Limestone, clay, gypsum.

⇒ **Process of production;**

A mixture of Limestone and clay is crushed and milled into a fine powder.

The fine powder is then mixed with water and allowed to flow down a rotating drum (cylinder) in which it is strongly heated to about 1500°C. (V)

Limestone decomposes to calcium oxide and carbon dioxide

$$CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$$

(CP) Calcium oxide reacts with aluminium oxide and silicon dioxide in clay form lumps of calcium aluminate and calcium silicate

(Pr) The lumps are crushed to form (Cd) cement as a fine powder

Gypsum is added during the grinding process to moderate the reaction between cement and water (setting of cement)

Cement is packed in bags ready for use.

⇒ **Side effects and mitigation**

- Dust, noise during crushing
- Poisonous fumes during crushing
- Falling objects
- Hot surface burns
- Slips and falls during lifting, overloading

} use of Appropriate PPE's

⇒ **Social benefits.**

- Employment opportunity to residents to improve their standard of living.
- Revenue to government of Uganda to ~~increase~~ improve on infrastructure

UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

Candidate's Name .....

Signature ..... Random No.

Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF ETHANOL

Raw materials; - Starch containing material eg Maize, Cassava, sweet potato, millet, sorghum. or glucose

- Malt, Yeast.

Process of production.

The starch containing material is crushed and roasted (heated) to extract starch. Malt is then added to starch in a container (v) and it is then covered. Malt contains an enzyme, diastase (cp) that catalyses hydrolysis of starch to maltose.

Yeast is then added to maltose after about 3 days at room temperature. Maltase in yeast catalyses the hydrolysis of of maltose to glucose

(cd) Zymase enzyme in yeast catalyses the decomposition of glucose to crude ethanol and carbon dioxide.

Crude ethanol is converted to pure ethanol by fractional distillation (Pr)

Side effects and mitigation

- Ethanol spills on surface leading to falls and accidents. — Appropriate PPEs
- Hot surface burns during distillation

(Add more points)

Social benefits.

- Employment opportunity, salary hence improved standards of living.
- Ethanol is used as a fuel in motor engines ---
- As a solvent for some paints ---
- Manufacture of drugs ---
- Manufacture of perfumes ---

} build the point from there.

(10)

Candidate's Name .....
Signature ..... Random No.
Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF DETERGENTS

(A) NON-SOAPY / SOAPLESS DETERGENTS.

From an alcohol;

⇒ Raw materials; Duodecan-1-ol, Concentrated sulphuric acid, Sodium hydroxide solution.

Process of production;

Duodecan-1-ol is reacted with cold concentrated sulphuric acid in a plastic (V) container forming duodecyl hydrogen sulphate which is reacted with sodium hydroxide solution to form a detergent. This mixture can be added to minimum volumes of water to form liquid/gel detergent. Some additives such as whitening agents, biological enzymes, fragrance, fillers, stabilizers may be added during the process.

Side effects and mitigation.

- Acid spills on surfaces
- Burns from acids when in contact with skin.
-

Social benefits.

- Production of cleansing agents that one can use to clean surfaces to improve on hygiene hence improved health living.
- Employment ⇒ Salaries ≡ improved standards of living.

(B) SOAPY DETERGENTS

→ Take them through Saponification.

Candidate's Name .....
Signature ..... Random No.
Subject ..... Paper code ...../..... Personal Number

MANUFACTURE OF BIO-GAS.

Raw materials; Organic waste, Water.

Process of production

Animal or plant (organic) wastes are put in a container and mixed with some little water.

The container is covered to prevent aerial oxidation

The container and contents are maintained at a temperature between 25–30°C.

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

Side effects and mitigation

- Fire outbreaks during leakages on pipes — By sealing off all pipes
- Poisonous fumes in case of any leakages on pipes — Maintain taps closed
  — Proper use of PPE's

Social benefits

- Biogas is used for cooking and lighting since it is a renewable gas.....
- Bio-slurry is used as an organic fertilizer and animal feeds to increase farmer's farm production hence better standards of living

EXTRACTION OF IRON

⇒ **Raw materials**; Ore (Haematite), Limestone, Coke.

⇒ **Process of production;**

The raw materials, ie haematite, limestone and coke are fed into a blast furnace. (V)

Bottom part of furnace — **Stage 1; Oxidation of Coke.**

Hot air from the bottom reacts (oxidises) with Coke forming Carbon dioxide gas

$(C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)})$

Middle part of furnace — **Stage 2; Reduction of Carbon dioxide**

Carbon dioxide reacts with excess Coke forming Carbon monoxide

$(C_{(s)} + CO_{2(g)} \longrightarrow 2CO_{(g)})$ (Cp)

Stage 3; Reduction of Iron(III) oxide (Haematite)

(Cd) Carbon monoxide reduces haematite to molten iron and carbon dioxide

$(3CO_{(g)} + Fe_2O_{3(s)} \longrightarrow 2Fe_{(l)} + 3CO_{2(g)})$

Role of Limestone

Calcium Carbonate decomposes to Calcium oxide and Carbon dioxide. The Calcium oxide reacts with Silicon dioxide and aluminium oxide impurities forming Calcium silicate and Calcium aluminate that are tapped off.

(Pr) **Purification;** Pure Iron (Wrought iron) is obtained by passing air through molten iron to remove non-metal impurities.

⇒ **Side effects + Mitigation**

- Poisonous fumes → Proper use of PPE
- ~~Excessive~~ noise from the plant → PPE
- Too much heat from furnance to workers
- Chemical spills on molten slag

⇒ **Social benefits**

UGANDA NATIONAL EXAMINATIONS BOARD
OCTOBER - NOVEMBER, 2020

Candidate's Name ..... KIBUGO DENNIS Page 3

Signature ..... Kib

Subject ..... Paper code ...../.....

Random No.

Personal Number

EXTRACTION OF COPPER.

⇒ Raw materials; Ore (copper pyrites)
Silicon dioxide

⇒ Production process;

① Concentrating the ore by froth flotation.
The ore is crushed and mixed with water containing a frothing agent such as palm oil in a container. Air is blown in the mixture to aggitate as ore particles go to the surface with oil while impurities sink down with water. The froth is skimmed off and dilute sulphuric acid is added to break the froth. The froth is filtered off and dried

② Roasting.
The dried ore is roasted in air in a blast furnace (V) to form Copper(I) sulphide, Iron(II) oxide and sulphur dioxide (Ap)

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

(cp)

③ Smelting
Silicon dioxide is added
The above resultant mixture is heated in absence of air all in a furnace to remove Iron(II) oxide

④ Reduction;
The copper(I) sulphide is heated (cd) in controlled amount of air to form impure copper.

Purification; (Pr) Impure copper is purified by electrolysis using impure copper as anode and pure copper as cathode using acidified Copper(II) sulphate solution electrolyte

⇒ Side effects and Mitigation
- Toxic fumes from production process can lead to suffocation and death — Proper control of waste gases, use of PPEs
- Sulphur dioxide produced as a by-product reacts with water forming acidic rains that affect walls of houses

⇒ Social benefit
- Employment opportunity — salary — Improved standards of

Candidate's Name .....

Signature ..... Random No.

Subject ..... Paper code ...../..... Personal Number

EXTRACTION OF ALUMINIUM.

⇒ Raw materials; Ore (Bauxite), sodium hydroxide

⇒ Process of production;

Concentrating the ore

Bauxite is ground to powder and heated to convert any Iron(II) oxide impurity present to Iron(III) oxide and also to remove water of crystallisation.

The powder is then boiled with hot concentrated sodium hydroxide solution that dissolves the amphoteric aluminium oxide and acidic silicon dioxide (V. in a conifer) in the ore forming sodium aluminate and sodium silicate respectively (CP)

$$Al_2O_{3(s)} + 2NaOH_{(aq)} \longrightarrow 2NaAlO_{2(aq)} + H_2O_{(l)}$$

$$SiO_{2(s)} + 2NaOH_{(aq)} \longrightarrow Na_2SiO_{3(aq)} + H_2O_{(l)}$$

- The undissolved basic iron(III) oxide and titanium(IV) oxide are filtered off
- Carbon dioxide is bubbled through the filtrate to precipitate aluminium hydroxide leaving silicate ions in the solution.
- Aluminium hydroxide is washed, dried and heated strongly to produce aluminium oxide. (Cd)

Electrolysis of aluminium oxide

Aluminium oxide is dissolved in molten cryolite to lower its melting point to 800°C. Electrolysis of molten aluminium oxide occurs using graphite electrodes in an Iron bath lined with graphite (Pr)

At Cathode; $Al^{3+}_{(l)} + 3e \longrightarrow Al_{(l)}$ At Anode $2O^{2-}_{(l)} \longrightarrow O_{2(g)} + 4e$

⇒ Side effects and mitigation

- Pollution from poisonous fumes — Proper use of PPEs
- Burns caused by contact with hot surfaces of chemical spills — Proper use of PPE

⇒ Social benefits.

- Employment opportunities to residents hence improved standards of living
- Source of revenue to government hence improved infrastructures