

Candidate's Name KIBUGO DENNIS
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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 $\leftarrow \begin{matrix} Fe \\ Cu \\ Al \end{matrix}$
- 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 processes
- Cd - Conversion to desired product
- Ch - Coherence
- Pr - Purification

Key points in assessment

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

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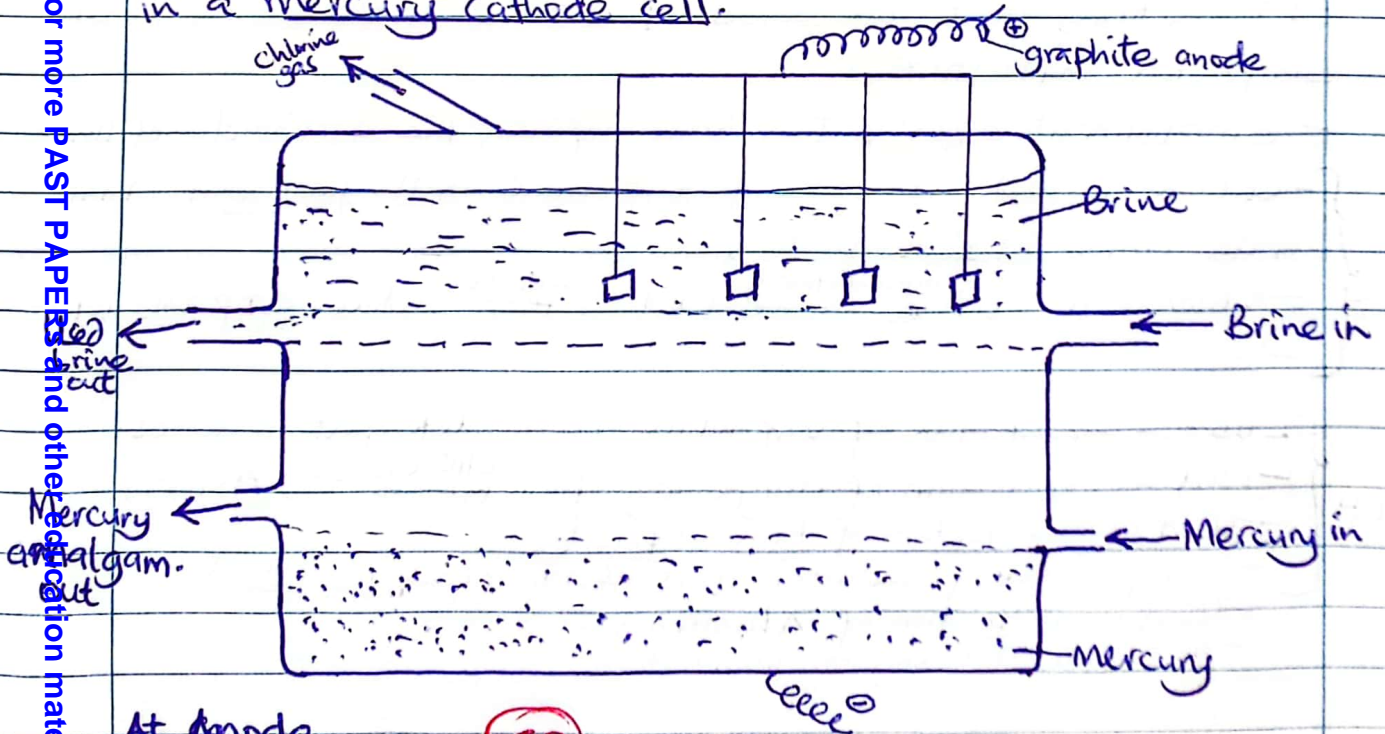
LEARNER APPRECIATES CONTRIBUTION OF CHEMISTRY.
TO OUR ECONOMY.

ASSESSABLE AREAS.

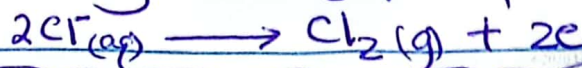
and 2. MANUFACTURE OF CHLORINE; - Using Mercury Cathode cell.
OR SODIUM HYDROXIDE SOLUTION.

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

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.



For NaOH; At Anode; $Na^+_{(aq)} + e^- \rightarrow Na(s)$ The sodium then mixes with mercury
 $Na(s) + Hg(l) \rightarrow Na/Hg(aq)$

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Sodium amalgam reacts with water forming sodium hydroxide and hydrogen
$$Na/Hg(l) + H_2O(l) \rightarrow NaOH(aq) + H_2(g) + Hg(l)$$

Side effects of the process and mitigation.

Suffocation due to release of other gases like hydrogen in ^{confined} spaces
Proper Use of PPEs

Exposure to high concentrations of chlorine leading to death or itching 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

- 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 Chlorine

for NaOH

- used in manufacture of soap which is a detergent in homes.
- Used in manufacture of drugs eg pain ^{relievers} killers - 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,

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MANUFACTURE OF OXYGEN

Raw materials ; Air ^{or} (Atmospheric air)

Process of production

Atmospheric air is pumped into ^{tanks} plant and the process involves the following stages.

① Filtration

Atmospheric air is filtered using air filters to remove dust particles.

② Drying

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 (NO₂, SO₂, CO, etc)

④ Removal of Carbon dioxide

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

⑤ Compression

Air is repeatedly compressed at high pressure of 200atm and ^{allowed to} cooled at -200°C to form liquid air.

⑥ Fractional distillation

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 PPE's
- Cold burning of oxygen cylinders

Social benefits

- ~~for air~~ - For breathing by sea divers, astronauts
- Employment - salary - ^{improved} standards of living
- ^{Manufacture of steel} - Used in ~~acet~~ oxy-acetylene flames for cutting and welding of metals
- Govt revenue - ^{improved} in infrastructures.

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MANUFACTURE OF FERTILIZERS.

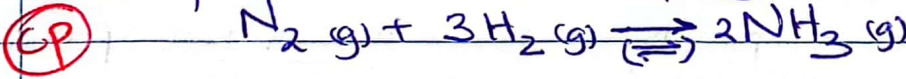
A. AMMONIUM FERTILIZERS

- ← Urea (H₂NCONH₂)
- ← Ammonium nitrate
- ← Ammonium sulphate
- ← Ammonium phosphate
- ← Calcium Ammonium Nitrate (CAN)

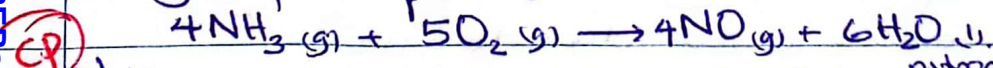
Raw materials; Nitrogen gas, Hydrogen gas.

Process of production:

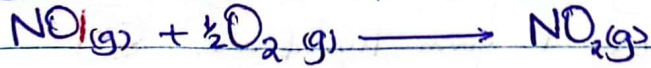
Nitrogen from fractional distillation of liquid air is reacted with hydrogen from natural gas in a ratio of 1:3 respectively to form ammonia by Haber process. The reaction requires low temperature (450-500), high pressure (200atm) and finely divided Iron Catalyst



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

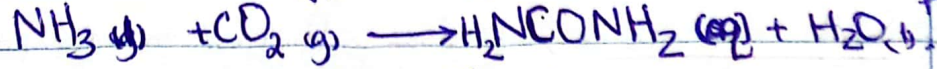


Nitrogen monoxide is further oxidised to nitrogen dioxide

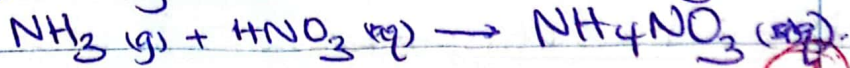


Nitrogen dioxide is dissolved in water in presence of oxygen, forming nitric acid. in a tank

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



Ammonium Nitrate; By reacting nitric acid with ammonia gas.



Ammonium sulphate;
$$NH_3(g) + H_2SO_4(l) \rightarrow (NH_4)_2SO_4(s)$$
 (Cd)

The fertilizers are further concentrated and converted to solid form.

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⇒ Side effects + Mitigation:

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

⇒ Social benefits:

- Source of employment as residents get salaries hence improved standards of living.
- High levels of nutrients supplied ^{leading} by ^{fer} 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

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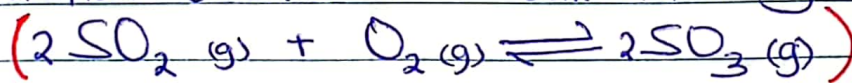
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MANUFACTURE OF SULPHURIC ACID

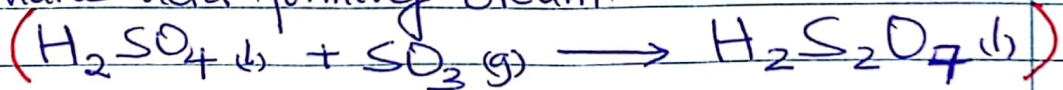
⇒ Raw materials ; - Sulphur dioxide gas.
- Oxygen gas.

⇒ Process of production;

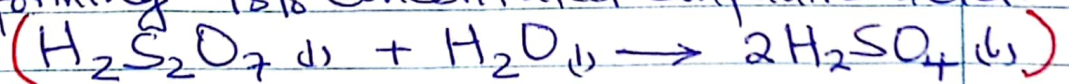
Dry Sulphur dioxide free from impurities is heated with dry pure Oxygen gas at ^{low} temperature (of about 450-500°C), high pressure (of about 1-3 atmospheres) in presence of vanadium(V) oxide Catalyst to form Sulphur trioxide. The reaction occurs in a Combustion cylinder.



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



(Cd) Oleum is added to moderated ~~amounts~~ ^{volumes} of distilled water forming 98% concentrated Sulphuric acid.



⇒ Side effects and mitigation

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

⇒ Social benefits

- Employment \equiv salaries \equiv improved standards of living.
- ~~Use~~ Manufacture of fertilizer \equiv increased farm yields \equiv improved standards
- used in car batteries as electrolyte - - -

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MANUFACTURE OF CEMENT.

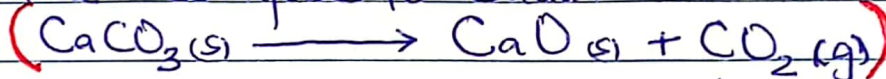
Raw materials; Limestone, clay, gypsum.

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.

Limestone decomposes to calcium oxide and carbon dioxide



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

The lumps are crushed to form 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

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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 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.

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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

- Poisonous fumes in case of any leakages on pipes

- Proper use of PPE's

- By sealing off all pipes.
- Maintain taps closed.

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.

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EXTRACTION OF IRON

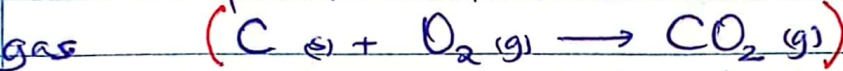
Raw materials: Ore (Haematite), Limestone, Coke.

Process of production:

The raw materials, i.e. haematite, limestone and coke are fed into a blast furnace.

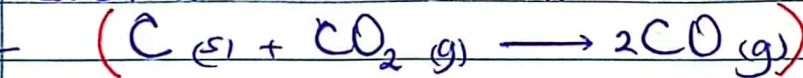
Stage 1: Oxidation of Coke.

Hot air from the bottom reacts with coke forming carbon dioxide gas. (oxidises)



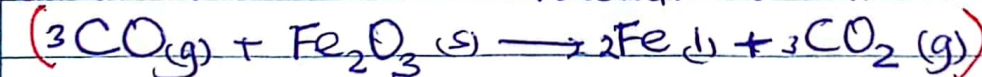
Stage 2: Reduction of Carbon dioxide

Carbon dioxide reacts with excess coke forming carbon monoxide



Stage 3: Reduction of Iron(III) oxide (haematite)

Carbon monoxide reduces haematite to molten iron and carbon dioxide



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.

Purification: Pure iron (wrought iron) is obtained by passing air through molten iron to remove non-metal impurities.

Side effects + Mitigation

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

Social benefits

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EXTRACTION OF ALUMINIUM.

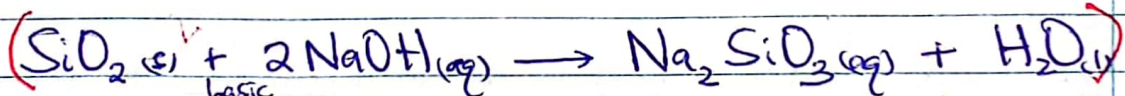
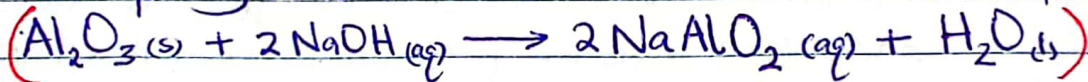
Raw materials; Ore (Bauxite), Sodium hydroxide

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 in the ore forming sodium aluminate and sodium silicate respectively.



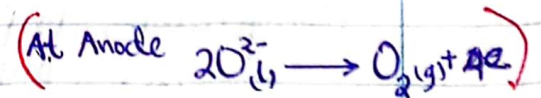
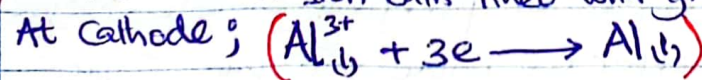
The undissolved ^{basic} Iron(III) oxide and titanium(IV) oxide are filtered off

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.

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.



Side effects and mitigation

- Pollution from poisonous fumes
- Burns caused by contact with hot surfaces of
- chemical spills

Proper use of PPEs
Proper use of PPE

Social benefits.

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