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⇐ SECOND EDITION ⇒

Engineering Chemistry II

(For Diploma I Yrs. II Part)

Second Semester

(Engineering All)

By

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4.	2079	Falgun Regular/Back
5.	New Course Model Set	
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1. a) What do you mean by hardness of water ? Describe the permutit method of hardness of water ?

- The hardness of water is due to the presence of soluble bicarbonates, chlorides and sulfates of calcium and magnesium.

Permutit process

- Permutit is a complex compound known as hydrated sodium aluminium silicate, $Na_2Al_2Si_2O_8 \times H_2O$.
  Sodium ion of this compound is exchanged by Ca^{++} and Mg^{++} ions of hard water and cause the precipitation of calcium and magnesium aluminium silicates in the form of zeolite. Soluble $NaCl$ and Na_2SO_4 are separated by distillation process.

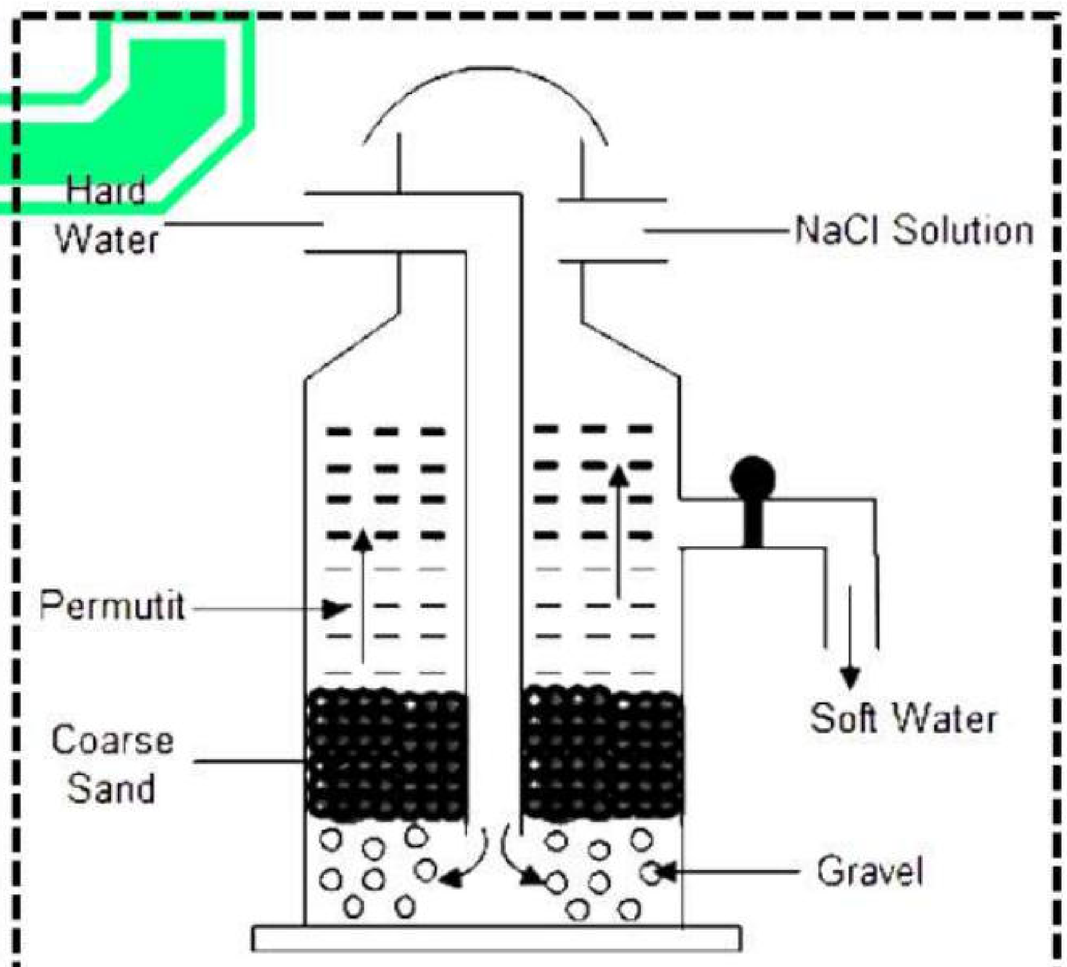

Fig:- **Permutit Process.**

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$$CaCl_2 + Na_2Z \longrightarrow CaZ \downarrow + 2NaCl$$
$$MgSO_4 + Na_2Z \longrightarrow MgZ \downarrow + Na_2SO_4$$

where, $Z = Al_2Si_2O_8 \times H_2O$.

After sometime, the whole of the $Na_2Al_2Si_2O_8$ gets changed into calcium and magnesium zeolites and the sodium ions are regenerated by adding 10% $NaCl$ solution to continue the reaction.

$$CaZ + 2NaCl \longrightarrow Na_2Z + CaCl_2$$

$$MgZ + 2NaCl \longrightarrow Na_2Z + MgCl_2$$

b) Describe the manufacture process of nitric acid with it' principle and well labeled diagram.

❖**Principle**

i) Ammonia is oxidized to nitric oxide in presence of air at 800°C over the catalyst platinum gauze or a rhodium-platinum alloy.

$$4NH_3 + 5O_2 \xrightarrow[\text{Pt/Rh}]{\Delta} 4NO + 6H_2O + \text{Heat}$$

ii) Nitric oxide formed is cooled and allowed to come into contact with air and it gets oxidized to nitrogen dioxide.

$$2NO + O_2 \longrightarrow 2NO_2$$

iii) Nitric acid is obtained when nitrogen dioxide is dissolved in water in presence of air.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

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Working Process

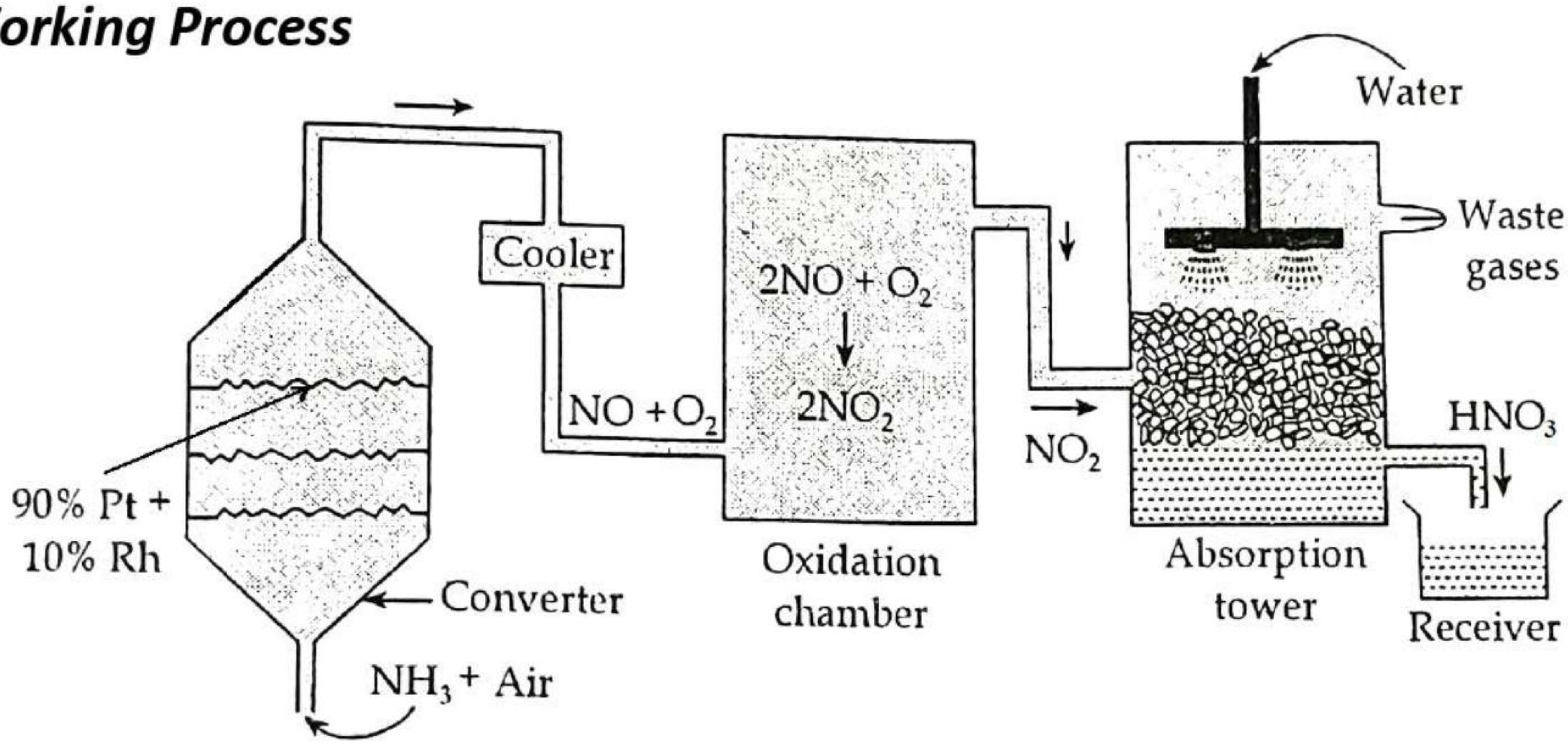

Figure :- **Ostwald's process for manufacture of nitric acid.**

The mixture of ammonia and air is passed to converter which contains platinum gauge at $800°C$ and here NH_3 is oxidized to nitric oxide. This nitric oxide is passed to oxidation chamber through cooler where it oxidizes to nitrogen dioxide. The nitrogen dioxides from oxidation tower are passed through absorption tower which is packed with acid-proof stone or quartz. The nitrogen dioxide comes into contact with water and air and gets dissolved to form nitric acid which is collected at the foot of the tower in the receiver.

2. a) Define allotrophs of carbon? Explain the structure of Diamond and Graphite.

- The two or more forms of the Carbon having same chemical properties but different physical properties are called *allotropes of carbon.*

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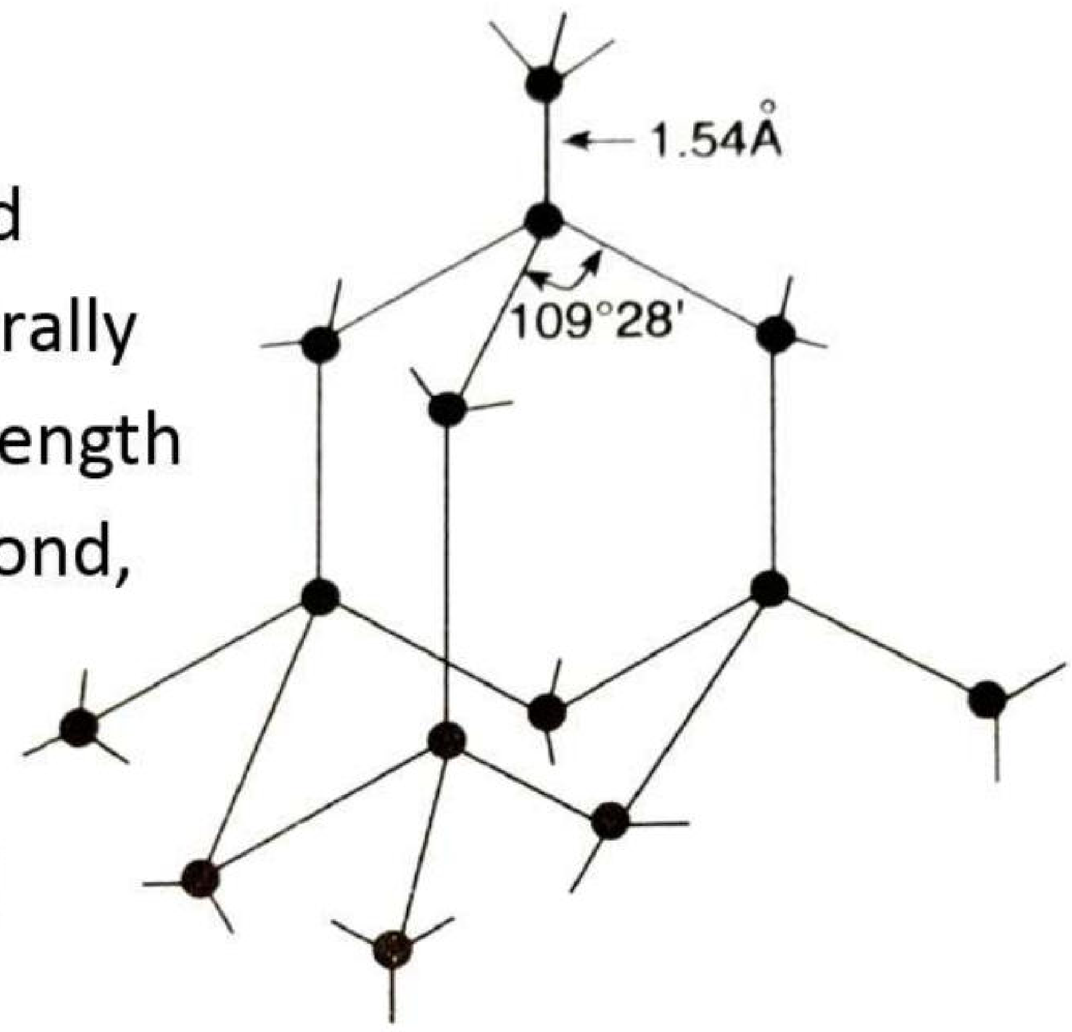
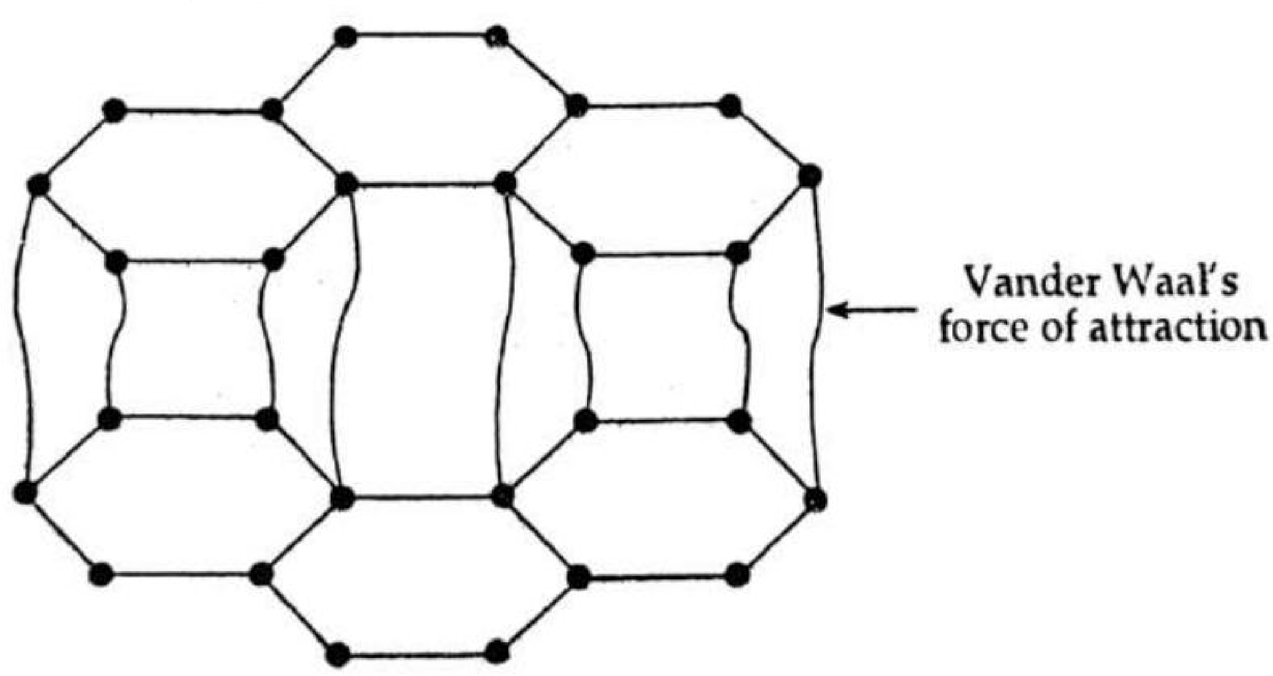
❖ Structure of Diamond



➢ It is a crystalline allotropes of carbon in which each carbon atom is combined with other four carbon atoms tetrahedrally having an angle of 109°, 28' and bond length of 1.54 Å. As there is strong covalent bond, it is considered as hardiest substance. It is considered to be the purest form of carbon and is believed to be formed when very high pressure develops on coal beds in the earth. As there are no electrons, it is bad- conductor of heat and electricity.

❖ Structure of Graphics

➢ In graphite each carbon atom is bonded with other three carbon atoms by a covalent bond forming an angle of 120° having bond length 1.42 Å. The slippery and soft nature of graphite is due to the presence of weak Vander Waal's force of attraction which is acting between the different layers of carbon hexagonally. As there is a presence of one electron free from each carbon atom and which are free to move. The structure of graphite is shown below.



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b) How does hydrochloric acid is prepared in the laboratory? Explain, the properties of hydrochloric acid.

- In the laboratory, hydrogen chloride gas is prepared by heating sodium chloride with concentrated sulphuric acid.

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl \text{ (On gentle heating)}$$
$$NaHSO_4 + NaCl \longrightarrow Na_2SO_4 + HCl \text{ (On Strong heating)}$$

Here, sodium chloride is taken a powdered form in a round bottomed flask fitted with a dropping funnel and delivery tube. Conc. H_2SO_4 is poured in sufficient quantity so that salt is covered. At first, HCl and sodium hydrogen sulphate are formed and at red heat normal sodium sulphate and more HCl is formed.

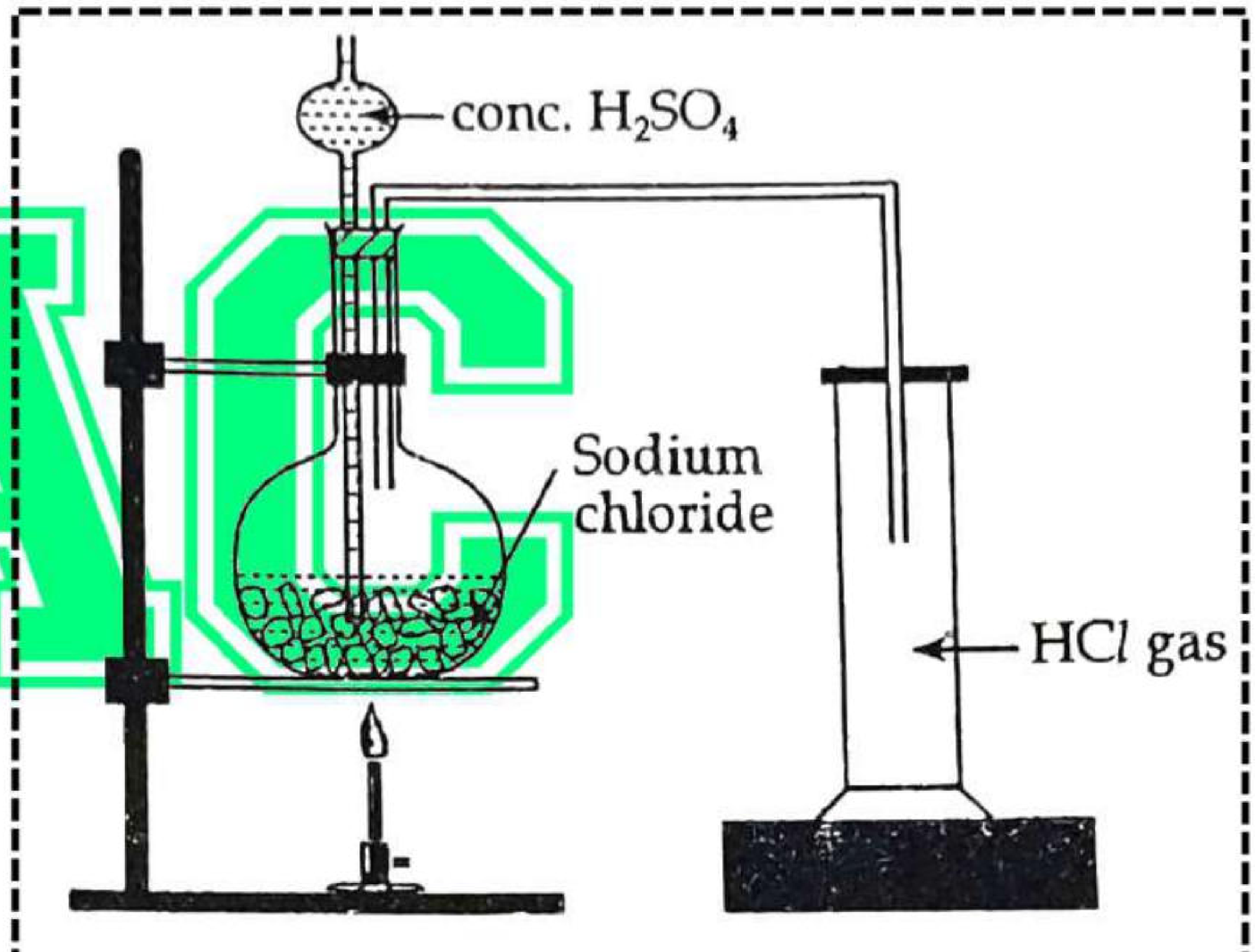

Fig :- **Laboratory preparation of HCl gas.**

Hydrogen chloride gas is highly soluble in water. So, to prepare HCl solution care must be taken to see that the water is not sucked back into the generating flask. To avoid that, an anti-suction device is made by connecting an inverted funnel to the delivery tube with rubber tubing to the stem of the funnel dipped just under the surface of water in a beaker.

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In this way after adjusting all apparatus HCl gas is passed into water which then forms aqueous hydrochloric acid.

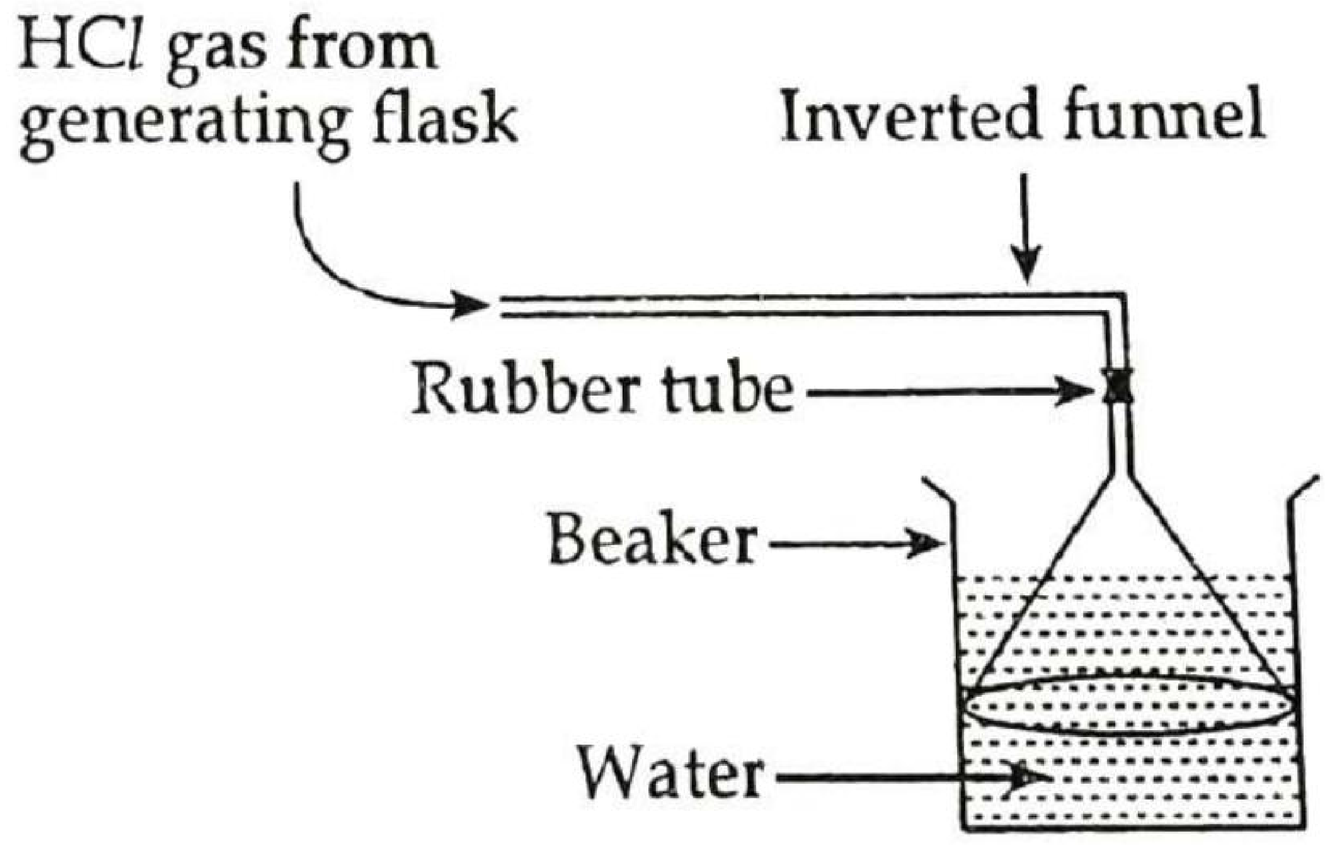

***Fig:-* preparation of hydrochloric acid solution.**

➢ The Properties of Hydrochloric acid :-

- **Physical Properties**

(i) It is a colourless pungent smelling gas.

(ii) It is extremely soluble in water giving strong acidic solution. It is highly ionized in aqueous solution.

(iii) HCl gas can be liquefied to a colourless liquid (b.pt. -83°C) and frozen to a white crystalline solid (m. pt.-114°C).

- **Chemical Properties**

(i) Combustibility: Hydrogen chloride is neither combustible nor supporter of combustion.

(ii) Acidic nature: HCl react with sodium hydroxide to give sodium salt and water.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

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3. a) Explain the dehydrating and oxidizing properties of sulphuric acid.

➢ Sulphuric acid as dehydrating agent :-

- Oxalic acid is react in the presence of con H_2SO_4 then, carbon dioxide and carbon monoxide is formed.

$$\underset{\text{Oxalic acid}}{\begin{matrix} COOH \\ | \\ COOH \end{matrix}} \xrightarrow{\text{Conc. } H_2SO_4} CO_2 + CO + H_2O$$

- Formic acid is react in the presence of con. H_2SO_4 then, carbon monoxide is formed.

$$\underset{\text{Formic acid}}{HCOOH} \xrightarrow{\text{Conc. } H_2SO_4} CO + H_2O$$

➢ Sulphuric acid as oxidizing agent :-

- Metals are oxidized to their oxides, which then form sulphates.

$$H_2SO_2 \longrightarrow H_2O + SO_2 + [O]$$
$$Cu + [O] \longrightarrow CuO$$
$$CuO + H_2SO_2 \longrightarrow CuSO_4 + H_2O$$

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2$$

Similarly,

Some metals like iron, zinc, etc react with dilute acid to liberate hydrogen, hence oxidized.

$$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$$
$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

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b) What do you mean by acid rain? Mention the types of chemical fertilizer with its features (Characteristics).

- The Large amount of oxides of nitrogen and sulphur are evolved into the atmosphere from the industries, automobiles, oil refiners etc. which dissolve in rain water to give different acids like H_2SO_4, H_2SO_3, HNO_3 etc are called **acid rain**.

- **The types of Chemical fertilizer are listed below:-**
  - **Nitrogen fertilizers**

    $(NH_4)_2SO_4$ Ammonium sulphate

    CAN Calcium ammonium nitrate

    NH_2CONH_2 Urea
  - **Phosphorus fertilizers**

    $Ca(H_2PO_4)_2 \cdot H_2O$ Super phosphate of lime
  - **Potash fertilizer**

    KNO_3 Potassium nitrate

    K_2SO_4 Potassium sulphate

- **Its features (characteristics) are listed below :-**
  - Fertilizer must be stable.
  - It must be freely soluble in water.
  - The fertilizer should have no harm to plants.
  - It should have good storage property.

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4.a) What are the characteristics of alkali metals? Explain the properties of sodium?

➢ **The characteristics of alkali metals are listed below :-**

- They are strongly reducing agents as they give electrons very easily.
- They are soft as compared with other metals.
- They have low melting points.
- They are very reactive so they are found in combined state.
- These metals act vigorously with water, oxygen and chlorine.
- They have very low ionization potential with bigger atomic size in their respective period.
- They possess +1 oxidation state.
- They are highly electropositive in their respective period.

➢ **The properties of sodium are listed below :-**

- Sodium is a silvery white soft solid and can be cut with a knife.
- It is less dense than water.
- The density of sodium is 0.97 g/cm³.
- It is good conductor of heat and electricity.
- Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \longrightarrow 2Na_2O + Si$$

- Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

- Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \longrightarrow 2NaCI$$

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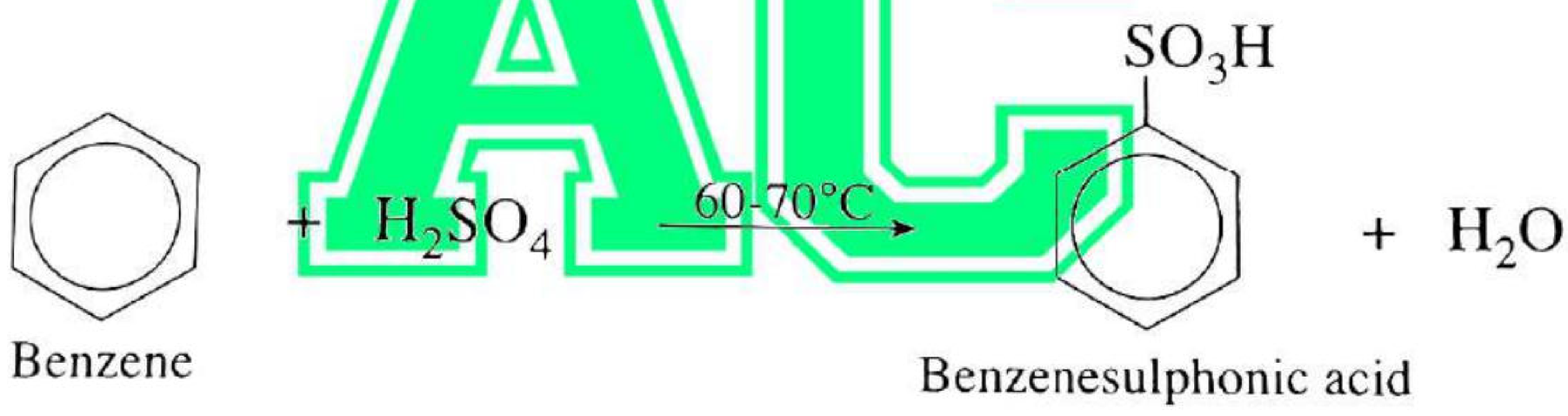
b) What are the characteristics of aromatic compounds? Explain the chemical properties of benzene?

➢ **The characteristics of aromatic compounds are :-**

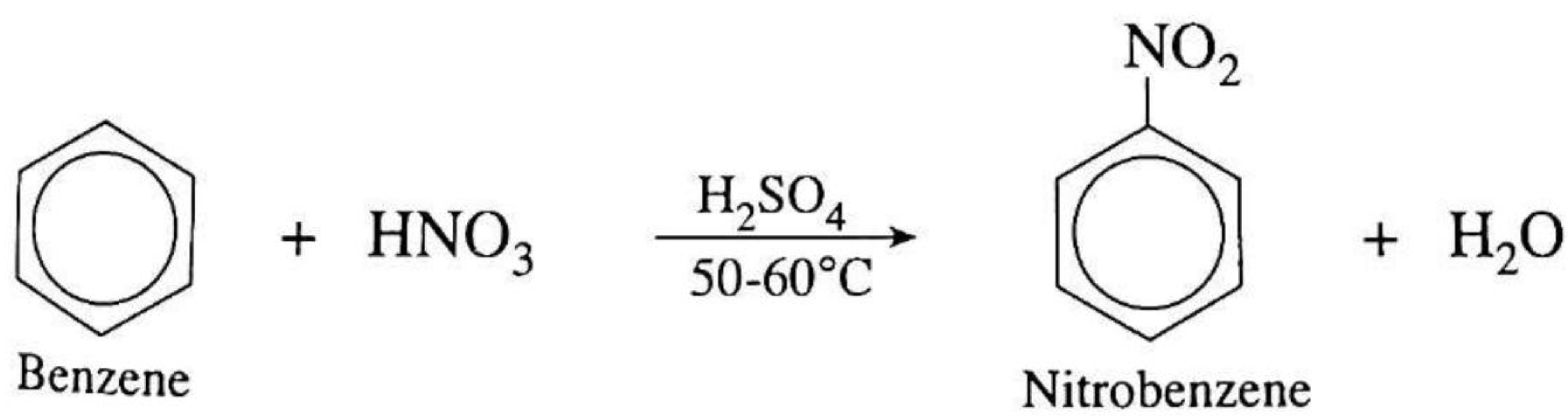
- Aromatic compounds are planar molecules.
- They produce induce ring current.
- They produce sooty flame on burning.
- The percentage of carbon is higher in aromatic compounds as compared to the aliphatic compounds.

➢ **The chemical properties of benzene are :-**

- **Sulphonation** :- Benzene on heating with fuming sulphuric acid (concentrated sulphuric acid containing some dissolved SO_3) undergoes sulphonation forming benzenesulphonic acid.



- **Nitration** :- It is carried out by heating benzene with a mixture of concentrated nitric acid and sulphuric acid (nitrating mixture) to 50-60°C.



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5. Write short notes on: (Any Five)

a) Aqua-regia

- A mixture containing one part of conc. HNO_3 and three part of conc. HCl is Called **aqua-regia (Kingly Water).** It is able to dissolve noble metal like gold, Platinum, etc because nascent chlorine is generated.

$$HNO_3 + 3HCl \longrightarrow NOCl + 2H_2O + 2[Cl]$$
$$Au + 3[Cl] \longrightarrow AuCl_3$$
$$Pt + 4[Cl] \longrightarrow PtCl_4$$

b) bleaching action

- The process of removal of colour from coloured matter is called bleaching. In the presence of moisture, chlorine bleaches vegetable colouring matters by oxidixing them into colourless matters.

$$Cl_2 + H_2O \longrightarrow 2HCl + [O]$$
$$\text{Vegetable colouring matter} + [O] \xrightarrow{\text{Oxidation}} \text{Oxidized colourless matter}$$

Bleaching by chlorine is permanent, i.e., bleached substances cannot restore their original colour on standing. This is because of the fact that chlorine bleaches, the substances by oxidizing them into colourless substances and no any reducing agent is present in the atomosphere.

c) Functional group

- Functional group is an atom or radical which determines the characteristics of homologous series as well as that of homologues. Each class of the compound possess a similar properties which is because of the presence of particular group of atoms like $-COOH$, $-CHO$, etc.

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$For\ E.g.$: all the aldehydes have $-\mathrm{CHO}$ as functional group.

d) Polyethene

- It is an addition polymer of ethylene monomers. It is obtained by two varieties viz. low density polythene (LPD) and High density polythene (HPD).

  Low density polythene can be produced by heating at about 250°C and applying 1500 atmospheric pressure in the presence of trace amount of oxygen.

$$\mathrm{nCH_2 = CH_2} \xrightarrow[250°\mathrm{C}]{1500\ \mathrm{atm}} (-\mathrm{CH_2} - \mathrm{CH_2} -)_\mathrm{n}$$

  High density polythene is produced at relatively lower temperature (50-75°C) and lower atmospheric pressure (6.7 atm.) in the presence of triethyl aluminium $[\mathrm{Al}(\mathrm{C_2H_5})_3]$ and titanium tetrachloride $[\mathrm{Ti}(\mathrm{Cl})_4]$ as the catalyst.

e) Alkaline earth metals

- The metals of group $\mathrm{II\,A}$ of the periodic table are called alkaline earth metals. All the alkaline earth metals have two electrons in the valance shell. They have strong tendency to lose the s electrons and thus show strong electropositive character.

  Oxides of calcium, barium, strontium are called 'Earth' in early days because they occur in earth crust and remain unchanged even after strong heating. Afterwards, it was found that the so called earth is soluble to some extent in water, and the solution is alkaline to litmus. Thereafter, it was named as alkaline earth and the metals as alkaline earth metals.

  Alkaline earth metals are:- Be, Mg, Ca, Sr, Ba, Ra.

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f) Homologous series.

- A series obtained by placing the member of organic compound of same functional group from lower to higher is called homologous series and this phenomenon is known as homology.

$E.g:-$

$CH_3 - OH$: Methanol

$CH_3 - CH_2 - OH$: Ethanol

$CH_3 - CH_2 - CH_2 - OH$: Propanol

$CH_3 - CH_2 - CH_2 - CH_2 - OH$: Butanol

$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - OH$: Pentanol

6. What happen when: (Any Five)

a) Ammonia gas is passed on concentrated hydrochloric acid?

- Ammonia gas is passed on conc. HCl Then, ammonium chloride is formed.

$$NH_{3(g)} + conc.HCl \longrightarrow NH_4Cl$$

b) Concentrated HCl and concentrated HNO, is mixed in 3:1 ratio.

- When Conc HCl and HNo_3 is mixed is the ratio 3:1 Then, Aqua-regia is formed.

$$3\,HCl + HNO_3 \longrightarrow NoCl + 2H_2O + 2[Cl]$$

Conc. Nascent chlorine.

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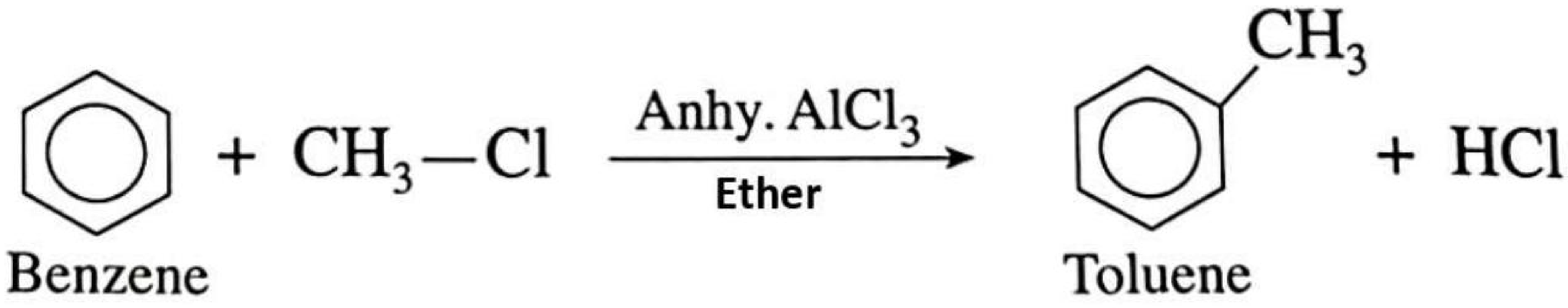
c) Benzene is treated with (methyl chloride) helpful chemical presence of Anhydrous $AlCl_3$ and ether.

- When benzene is treated with methyl chloride in the presence of anhydrous $AlCl_3$, methylbenzene (toluene) is formed.



d) Calcium metal is allowed to react with water molecule.

- Calcium metal is reat with water molecule to form $Ca(OH)_2$ & H_2 gas.

$$\underset{(metal)}{Ca(s)} + 2H_2O \longrightarrow \underset{(aq)}{Ca(OH)_2} + H_2\ (\uparrow)$$

e) Ammonia is passed over excess of chlorine.

- Ammonia is passed over excess of chlorine Then, NCl_3 and HCl is formed.

$$NH_3 + \underset{(excess)}{3Cl_2} \longrightarrow \underset{(Nitrogen\ trichloride)}{NCl_3} + 3HCl$$

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e) Iron rod is immersed into copper sulphate solution.

- When iron rod is immersed into copper sulphate solution following reaction takes place.

$$Fe(S) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

Note:- This reaction shows Iron is more reactive than copper because , it displaces copper from the copper sulphate solution.

–The End –

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1.a) Define hardness of water. How can you remove permanent hardness of water by permutit process? What are the natural sources of water?

➢See the solution of 2076 R/B of Q.no 1 (a) on page.no. 3

➢**The natural sources of water are :-**

- Rain Water
- River water
- Sea Water
- Spring Water etc.

b) Describe in detail the manufacture process of nitric acid by Ostwald's process with well labeled diagram.

➢See the solution of 2076 R/B of Q.no 1 (b) on page.no. 4

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2. a) Describe the manufacturing process of sulphuric acid by contact process (principle and diagram only).

- The principle involved in contact process for the manufacture of sulphuric acid which is commonly known as king of chemicals are listed below.

i) At first, sulphur is burnt in air to produce sulphur dioxide. Sulphur dioxide may also be prepared by roasting iron pyrites or sulphide ores.

$$S_8 + 8O_2 \longrightarrow 8SO_2$$

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

ii) Sulphur dioxide is then catalytically oxidized to sulphur trioxide by the oxygen of air at a temperature of 450°C in the presence of platinum asbestos or divanadium pentaoxide (V_2O_5) as catalyst under a pressure of only 2-3 atmosphere. The reaction is reversible and exothermic in nature.

$$2SO_2 + O_2 \underset{\substack{V_2O_5 \\ 450°C \\ 2\text{-}3\ atm}}{\rightleftharpoons} 2SO_3 + 196\ KJ$$

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iii) The sulphur trioxide thus produced is absorbed in conc. H_2SO_4 (about 94%) to form oleum' which is also called Pyrosulphuric acid.

$$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7$$

iv) Oleum is then diluted with the required amount of water to Get conc. H_2SO_4.

$$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$$

As conc. H_2SO_4 being dehydrating agent it absorbs the water from the paper which cause charring sound.

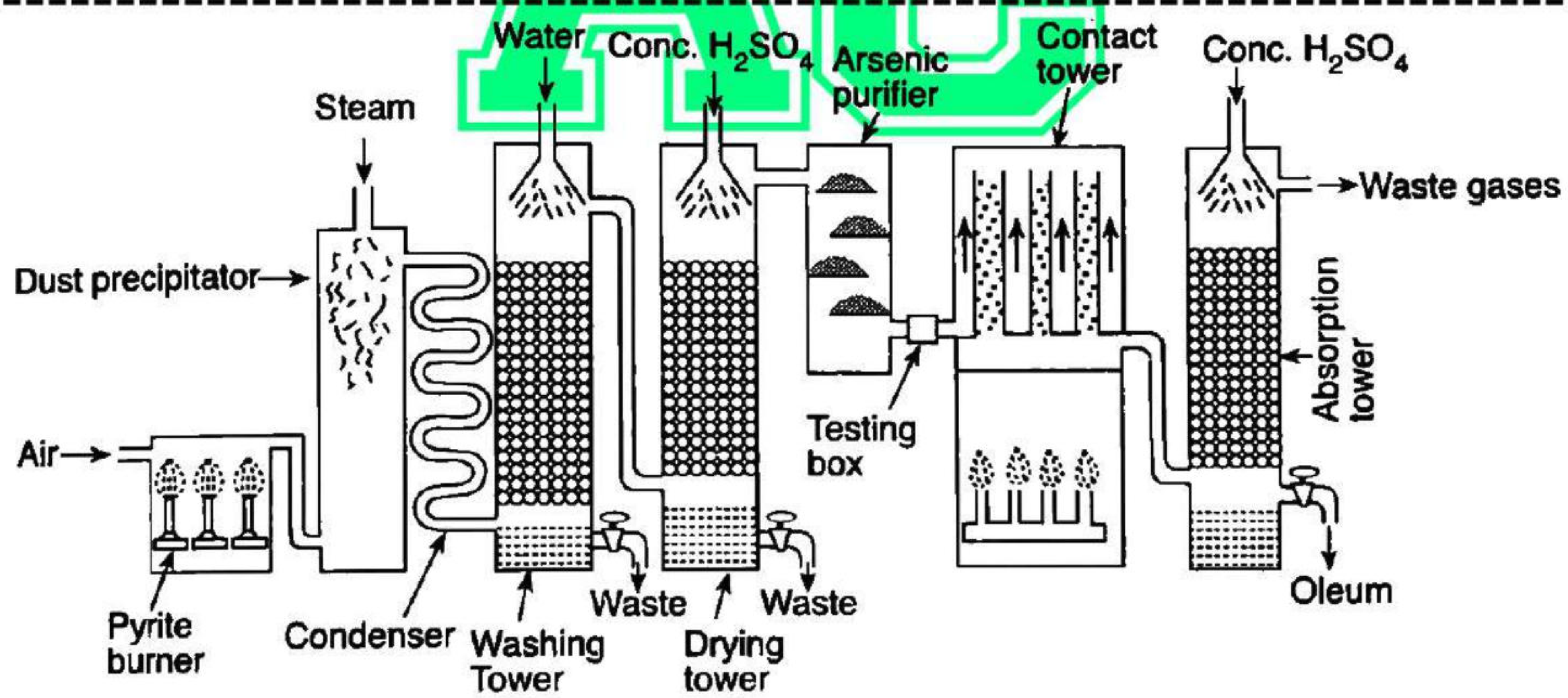

Fig:- **Manufacturing process of sulphuric acid by contact process**

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b) Define acid rain. Explain the chemical fertilizer in detail.

➢ See the solution of 2076 R/B of Q.no 3 (b) on page.no. 10

3.a) Explain the laboratory preparation of hydrochloric acid with required diagram.

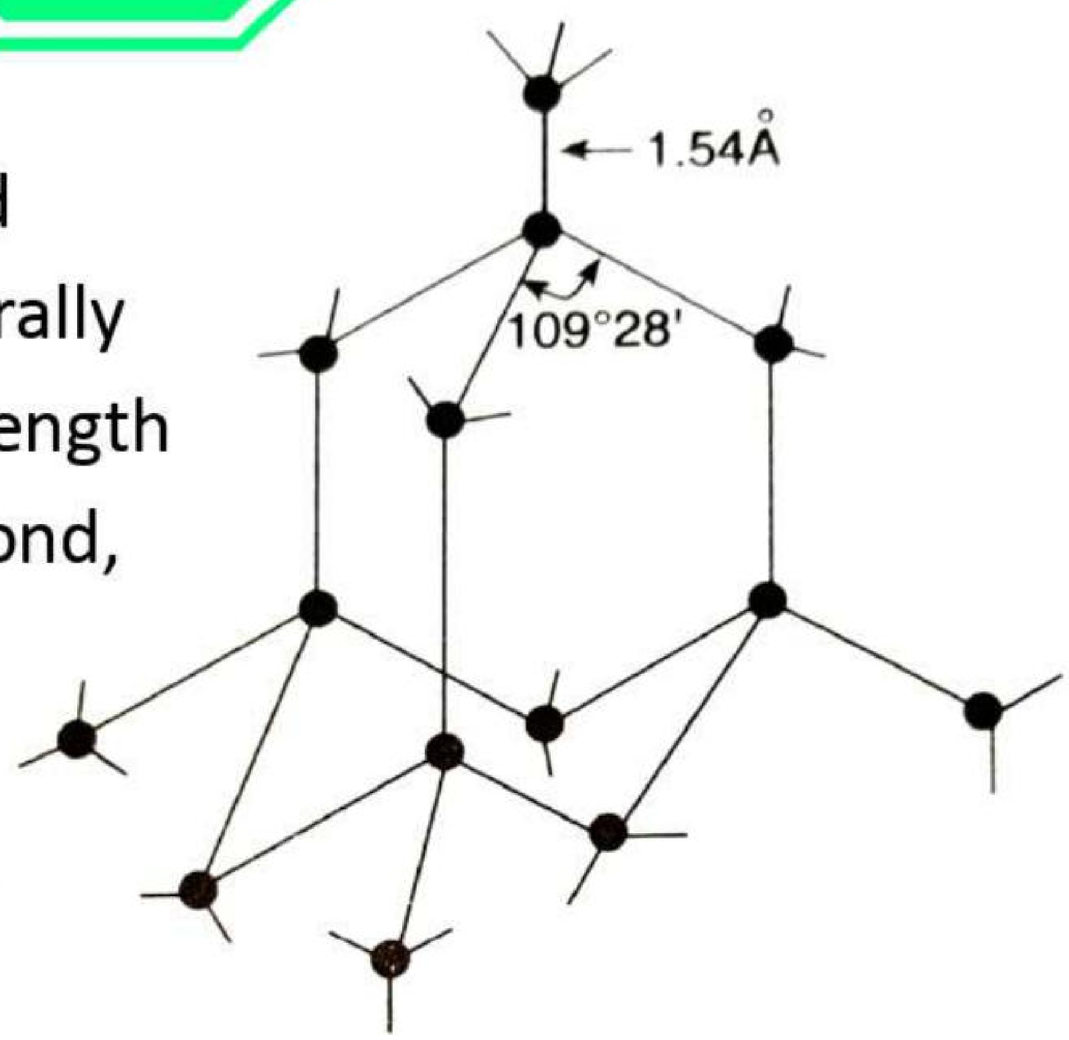
➢ See the solution of 2076 R/B of Q.no 2 (b) on page.no. 7

b) What are the allotrophs of carbon? Explain the structure of diamond.

➢ The are two allotrophs of carbon are Diamond, Graphite.

*The lastest discovered allotropic form of carbon is fullerence.

❖ **Structure of Diamond**



➢ It is a crystalline allotropes of carbon in which each carbon atom is combined with other four carbon atoms tetrahedrally having an angle of 109°, 28' and bond length of 1.54 Å. As there is strong covalent bond, it is considered as hardiest substance. It is considered to be the purest form of carbon and is believed to be formed when very high pressure develops on coal beds in the earth. As there are no electrons, it is bad- conductor of heat and electricity.

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4.a) What do you mean by bleaching action of chlorine? What are effect of oxides of carbon on environment and human?

- The process of removal of colour from coloured matter is called bleaching. In the presence of moisture, chlorine bleaches vegetable colouring matters by oxidixing them into colourless matters.

$$Cl_2 + H_2O \longrightarrow 2HCl + [O]$$

$$\text{Vegetable colouring matter} + [O] \xrightarrow{\text{Oxidation}} \text{Oxidized colourless matter}$$

- **Effect of oxides of carbon on :**
  - **Environment**

    Carbon Monoxide (CO) is oxide of carbon ,when it is emitted into the atmosphere it effects the amount of green house gases, that change in climate and global warming.
  - **Human**

    Carbon Monoxide (CO) is harmful for human because it binds to hemoglobin in the blood (Carboxyhemoglobin as complex), reducing the ability of blood to carry oxygen and cause suffocation may cause in dead of person.

$$CO + Hb \longrightarrow \mathbf{CO - Hb}$$

Carboxyhemoglobin

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b) Describe the manufacture process of ammonia by Haber's process.

- Nitrogen does not combine hydrogen under ordinary conditions. But when a mixture of nitrogen and hydrogen in the ratio 1:3 by volume is heated to about 450°C under a pressure of 200-500 atmospheric pressure in the presence of finely divided iron as catalyst and some molybdenum as promoter, ammonia is obtained.

$$\underset{(g)}{N_2} + \underset{(g)}{3H_2} \rightleftharpoons \underset{(g)}{2NH_3} + 98.6\text{KJ mol}^{-1}$$

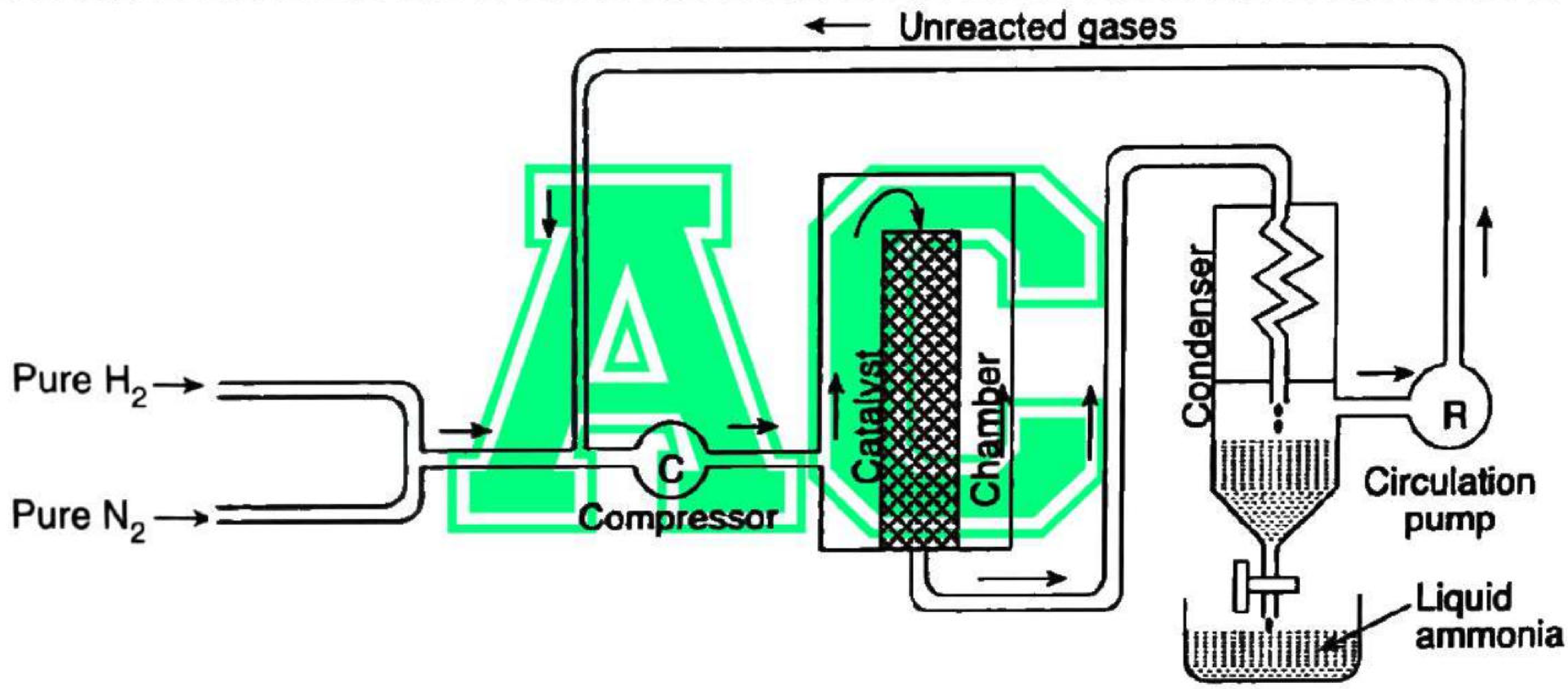

Fig :- Haber's process for the manufacture of ammonia.

5. a) Define alkaline earth metal. What are the chemical properties of alkaline earth metals? (Specially of calcium).

- The II A group element of the periodic table are called alkaline earth metal and they are named so because they occurs in the earth crust and remain unchanged even after strong heating.

  For example:- beryllium, calcium, magnesium, strontium, barium, and radium General characteristics of alkaline earth metals.

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➢The chemical properties of alkaline earth metals are:-

- **Action with air :-** The alkaline earth metals react slowly with air so that a tarnished layer of oxide is formed on the metals.

$$2Ca + O_2 \longrightarrow 2CaO$$

- **Action with water :-** These metals react with water to form hydroxides.

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$$

- **Action with hydrogen:-** All these metals react with hydrogen, except Be, directly to form hydrides.

$$Ca + H_2 \longrightarrow CaH_2$$

Calcium hydride

- **Action with halogens:-** When heated with dry halogen vapours, these metals form halides.

$$Ca + Cl_2 \longrightarrow CaCl_2$$

- **Action with acids:-** Alkaline earth metals react with mineral acids to yield hydrogen.

$$Ca + 2HCI \longrightarrow CaCl_2 + H_2 \uparrow$$

b) Define coinage metals? What are the properties of copper?

➢The elements of group IB (11) of the periodic table constitute three metallic elements, namely copper ($_{29}Cu$), silver ($_{47}Ag$) and gold ($_{79}Au$) . These metals are called coinage metals because of their use in making coins.

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- The properties of copper are:-

❖ **Physical Properties**

- It has a flesh pink colour.
- It is malleable and ductile.
- It exhibits high electrical and thermal conductivity.
- Copper readily alloys with many other metals.

❖ **Chemical Properties**

- **Action of chlorine:** Chlorine attacks copper forming cupric chloride.

$$Cu + Cl_2 \longrightarrow CuCl_2$$

- **Displacement reaction:** Copper displaces less electropositive metals like Ag, Pt, Au from their water soluble salts.

$$Cu + 2AgNO_3 \longrightarrow 2Ag\downarrow + Cu(NO_3)_2$$

- **Action of water:** Water at ordinary temperature has no action on copper but at high temperatures reaction takes place.

$$Cu + \underset{\text{(Steam)}}{H_2O} \longrightarrow CuO + H_2$$

6.a) What do you mean by functional group? Explain the properties of Methane.

- *Functional group* is an atom or radical which determines the characteristics of homologous series as well as that of homologues. Each class of the compound possess a similar properties which is because of the presence of particular group of atoms like $-COOH$, $-CHO$, etc.

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➢ The properties of methane are:-

- ***Nitration:-*** This involves the replacement of a hydrogen atom of an alkane with $-NO_2$ group. At room temperatures, alkanes do not react with nitric acid.

  The nitration of methane can be carried out in vapour phase by heating to very high temperature $(450 - 500°C)$.

$$CH_4 + HNO_3 \xrightarrow{450\text{-}500°C} \underset{\text{Nitromethane}}{CH_3NO_2} + H_2O$$

- ***Combustion of Methane :-*** Methane burns in air or oxygen to produce carbon dioxide and water vapour with liberation of heat energy.

$$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2O + \text{Energy}$$

- ***Pyrolysis :-*** The decomposition of compound by the action of heat in the absence of air is called pyrolysis. The pyrolysis of alkanes is known as cracking. For example,

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CHCH_3 + H_2$$

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CH_2 + CH_4$$

  Under pyrolysis, alkanes change into alkene (i.e., from single bond to double bond).

- ***Action of CH_4 with Steam :-*** When a mixture of methane gas and steam is passed over heated nickel at about $800°C$, a mixture of carbon monoxide and hydrogen (water gas) is obtained.

$$CH_4 + H_2O \xrightarrow[Ni]{800°C} CO + 3H_2$$

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b) Define Polymer? Explain the types and uses of rubber.

- A polymer is a large molecule of which is formed by repeated linking of the small molecules called "monomers".

$$\underset{\text{ethylene}}{n(CH_2 - CH_2)} \longrightarrow \underset{\text{polyethylene}}{(-CH_2 - CH_2 -)_n}$$

- **The Types of rubber are:-**

i) Natural rubber

The elastic material which is obtained from the nature i.e., latex sap of trees is called natural rubber. Natural rubber can be vulcanized and finished into various types of rubber products to use. The rubber molecules present in these latex tubes are made up of 5 carbon and 9 hydrogen atoms.

ii) Synthetic rubber

It is artificial rubber. It is artificial elastomer (a polymer) is called synthetic rubber. An elastomer can be defined as a material having the property of elasticity. There are various types of polymers used for making synthetic rubber types. Due to this, different types of synthetic rubber have different properties that are tailored for specific needs of rubber products industries.

- Used of rubber :- It is used in medical devices, surgical gloves, aircraft and car tires , tubes, pacifiers, clothes, toys, etc.

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7. a) What happen when:

(i) Steam is passed over red hot iron.

- When steam is passed over red hot iron then water is decomposed to given hydrogen gas as:

$$3Fe + 4H_2O \longrightarrow F_3O_4 + 4H_2 \uparrow$$

Steam Ferrosoferric oxide

(ii) Sodium is heated with ammonia.

- Sodium react with ammonia to form sodamide.

$$2Na + 2NH_3 \xrightarrow{\Delta} 2NaNH_2 + H_2$$

b) Write short notes on :

a) Homologous Series

- See the solution of 2076 R/B of Q.no 5 (f) on page.no. 15

b) Polyethene

- See the solution of 2076 R/B of Q.no 5 (d) on page.no. 14

c) Alloys

- An alloy is a homogenous mixture of two or more metals or metals with non-metals. An alloy is prepared to get a product possessing desirable properties which the constituent elements do not possess. Alloy possesses metallic properties.

Example; *Brass* is an alloy of copper and zinc
Bronze is an alloy of copper and tin
Steel is an alloy of iron and carbon.

-The End-

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(2078) Question Paper Solution.

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1. a) What do you mean by hardness of water? How can you remove the temporary hardness of water?

- The hardness of water is due to the presence of soluble bicarbonates, chlorides and sulfates of calcium and magnesium.
- It can be removed by following process:-

i) By the application of heat

The hardness of water is eliminated by heating the water sample due to which the soluble bicarbonates of calcium and magnesium change into respective insoluble calcium and magnesium carbonate.

$$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3\downarrow + CO_2 + H_2O$$

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + CO_2 + H_2O$$

ii) By reacting with calcium hydroxide

In this process the hard water is treated with lime water due to which soluble bicarbonates change into insoluble carbonate.

$$Ca(OH)_2 + Ca(HCO_3)_2 \longrightarrow CaCO_3 \downarrow + H_2O$$

$$Ca(OH)_2 + Mg(HCO_3)_2 \longrightarrow MgCO_3 \downarrow + H_2O$$

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b) How nitric acid is manufactured by Ostwald's process? Explain with diagram?

- See the solution of 2076 R/B of Q.no 1 (b) on page.no. 4

2. a) How is ammonia manufactured by Haber's process? Explain what happen when excess ammonia reacts with chlorine.

- See the solution of 2077 R/B of Q.no 4 (b) on page.no. 23

- When excess ammonia react with chorine then Nitrogen gas and ammonium chloride.

$$2NH_{3(g)} + 3Cl_{2(g)} \longrightarrow N_{2(g)} + 6HCl_{(g)}$$

$$6(NH_{3(g)} + HCl_{(g)} \longrightarrow NH_4Cl_{(g)})$$

$$8NH_{3(g)} + 3Cl_{2(g)} \longrightarrow N_{2(g)} + 6NH_4Cl_{(g)}$$

b) Define acid rain. Explain oxides of carbon as pollutants.

- The Large amount of oxides of nitrogen and sulphur are evolved into the atmosphere from the industries, automobiles, oil refiners etc. which dissolve in rain water to give different acids like H_2SO_4, H_2SO_3, HNO_3 etc are called **acid rain**.

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Carbon Dioxide as a Pollutant

- Carbon dioxide is one of the main pollutants with regards to air pollution. It is a primary pollutant, which means it is emitted into the environment directly by human and natural sources. It is a greenhouse gas, which is the main reason responsible for rising temperatures and global warming.

Carbon monoxide as a Pollutant

- Carbon monoxide is another primary pollutant which is extremely dangerous to the environment and also to human directly. It is colorless, odorless and tasteless gas which is very toxic and it is a potentially lethal gas a location has a constant high level of CO, its environment starts to suffer. They accumulate unhealthy levels of Ozone and Particulate Matter (PM). This, in turn, will cause further air pollution.

3. a) Explain contact process of manufacture of Sulphuric acid with labelled diagram.

- See the solution of 2077 R/B of Q.no 2 (a) on page.no. 19

b) How can you prepare hydrochloric acid in laboratory? Explain with figure.

- See the solution of 2077 R/B of Q.no 2 (a) on page.no. 7

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4. a) What do you mean by vital force theory? Why is it failed now?

- The theory proposed by Swedish chemist Berzelius in 1815 A.D. in which it is stated organic compounds are produced only under the influence of some mysterious force existing in living organisms. This mysterious force is called vital force and this theory is called vital force theory. In 1828, Wohler, a German chemist made an accidental discovery of urea, a well-known organic compound presents in the urine of mammals. He discovered by decomposing ammonium chloride and potassium cyanate.

$$NH_4Cl + KCNO \xrightarrow{\Delta} NH_4CNO + KCl$$

$$NH_4CNO \xrightarrow{\text{Rearrangement}} \underset{\text{Urea}}{NH_2CONH_2}$$

Again Kolbe in 1845 A.D. found that organic compound can be prepared in lab when he prepared acetic acid. These events drop the last nail in the coffin of vital force theory.

b) What is meant by nitrogen fixation? Describe the nitrogen cycle with flow sheet diagram.

- The Conversion of free atmospheric nitrogen into biologically acceptable form or nitrogenous compounds is known as ***nitrogen fixation***.
- **The nitrogen cycle is explained below.**

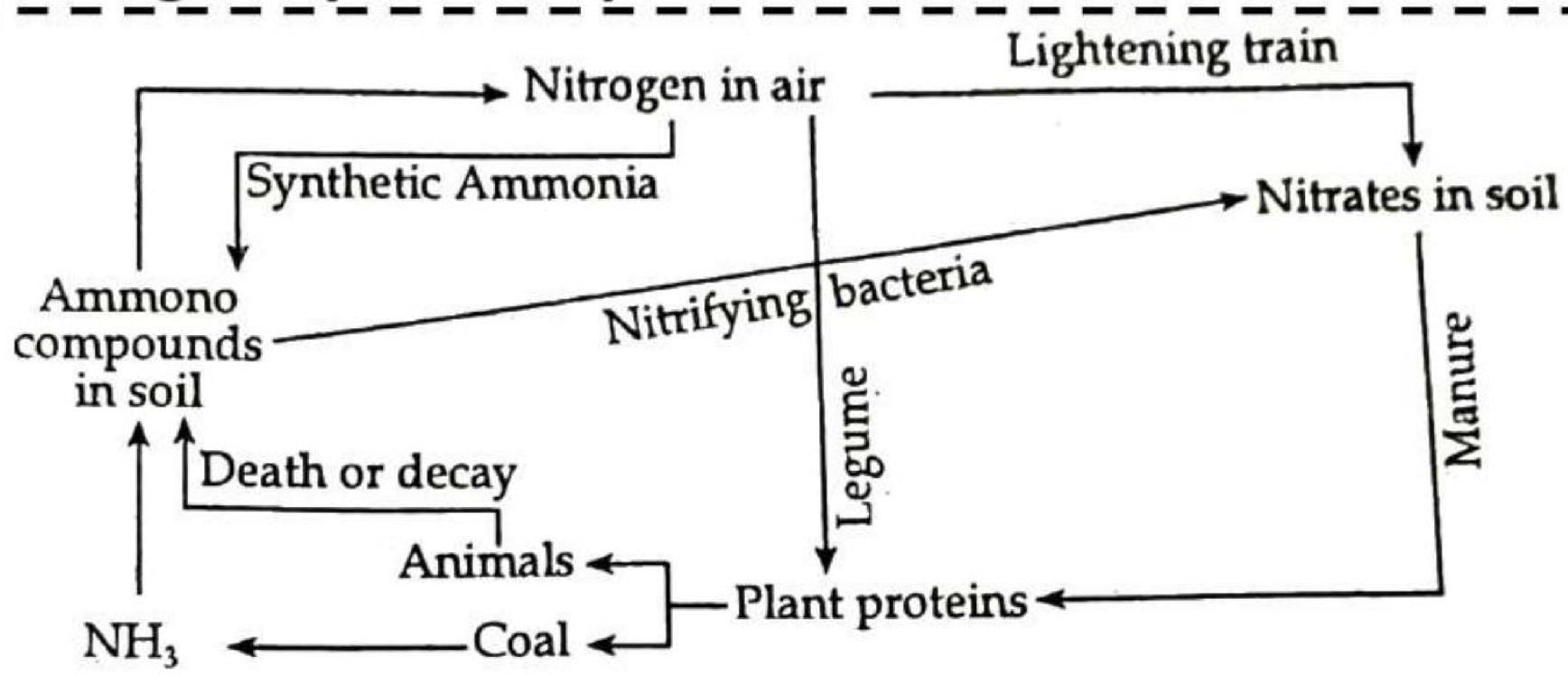

Figure: Flow chart of Nitrogen cycle.

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The series of complex reactions by which nitrogen is slowly but continually recycled in the atmosphere is called ***nitrogen cycle.***

Atmosphere is the reservoir of free nitrogen. The conversion of atmospheric nitrogen into useful nitrogenous compounds is known as fixation of nitrogen which occurs by:

i) Lightening discharge

When the nitrogen and oxygen molecules collide in the atmosphere in the presence of lightning bolt, molecule NO is formed which reacts. with O_2 and water to form HNO_3.

$$N_2 + O_2 \longrightarrow 2NO + \text{heat}$$

$$2NO + O_2 \longrightarrow 2NO_2$$

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

HNO_3 or HNO_2 dissolves in rain water and come down to the earth's surface where reacts with the soil component to form nitrates. The nitrates are assimilated by plants to form proteins.

ii) By symbiotic bacteria

The class of plants called legumes has nodules in their root within which there live some bacteria that absorb nitrogen molecules directly from the air and convert them into NH_3.

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5. a) What do you mean by alkali metals? Explain the properties of sodium.

- The series of six chemical elements (lithium, sodium, potassium, rubidium, caesium and francium) in group I of the periodic table are called ***alkali metals.***
  They are called alkali metals because they produce OH^- (hydroxide ions) when dissolved in water.

- **The properties of sodium are listed below :-**
  - Sodium is a silvery white soft solid and can be cut with a knife.
  - It is less dense than water.
  - The density of sodium is 0.97 g/cm³.
  - It is good conductor of heat and electricity.
  - Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \longrightarrow 2Na_2O + Si$$

  - Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

  - Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \longrightarrow 2NaCI$$

b) Define allotropes. What are the properties of calcium as alkaline earth metal?

- The two or more forms of the same element having same chemical properties but different physical properties are called ***allotropes*** and phenomenon is known as allotropy.

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➢ The properties of calcium as alkaline earth metals are:-

- **Action with air :-** The alkaline earth metals react slowly with air so that a tarnished layer of oxide is formed on the metals.

$$2Ca + O_2 \longrightarrow 2CaO$$

- **Action with water :-** These metals react with water to form hydroxides.

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$$

- **Action with hydrogen:-** All these metals react with hydrogen, except Be, directly to form hydrides.

$$Ca + H_2 \longrightarrow \underset{\text{Calcium hydride}}{CaH_2}$$

- **Action with halogens:-** When heated with dry halogen vapours, these metals form halides.

$$Ca + Cl_2 \longrightarrow CaCl_2$$

- **Action with acids:-** Alkaline earth metals react with mineral acids to yield hydrogen.

$$Ca + 2HCl \longrightarrow CaCl_2 + H_2 \uparrow$$

6. a) Explain the properties of methane in brief:

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➢ The properties of methane are:-

- ***Nitration:-*** This involves the replacement of a hydrogen atom of an alkane with $-NO_2$ group. At room temperatures, alkanes do not react with nitric acid.

  The nitration of methane can be carried out in vapour phase by heating to very high temperature $(450 - 500°C)$.

$$CH_4 + HNO_3 \xrightarrow{450\text{-}500°C} \underset{\text{Nitromethane}}{CH_3NO_2} + H_2O$$

- ***Combustion of Methane :-*** Methane burns in air or oxygen to produce carbon dioxide and water vapour with liberation of heat energy.

$$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2O + \text{Energy}$$

- ***Pyrolysis :-*** The decomposition of compound by the action of heat in the absence of air is called pyrolysis. The pyrolysis of alkanes is known as cracking. For example,

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CHCH_3 + H_2$$

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CH_2 + CH_4$$

  Under pyrolysis, alkanes change into alkene (i.e., from single bond to double bond).

- ***Action of CH_4 with Steam :-*** When a mixture of methane gas and steam is passed over heated nickel at about $800°C$, a mixture of carbon monoxide and hydrogen (water gas) is obtained.

$$CH_4 + H_2O \xrightarrow[Ni]{800°C} CO + 3H_2$$

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b) Write short notes: (Any Two)

i) Homologous series

- A series obtained by placing the member of organic compound of same functional group from lower to higher is called homologous series and this phenomenon is known as homology.

$E.g:-$

$CH_3 - OH$: Methanol

$CH_3 - CH_2 - OH$: Ethanol

$CH_3 - CH_2 - CH_2 - OH$: Propanol

$CH_3 - CH_2 - CH_2 - CH_2 - OH$: Butanol

$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - OH$: Pentanol

ii) Functional group

- Functional group is an atom or radical which determines the characteristics of homologous series as well as that of homologues. Each class of the compound possess a similar properties which is because of the presence of particular group of atoms like $-COOH$, $-CHO$, etc.

For E.g.:- all the aldehydes have $-CHO$ as functional group.

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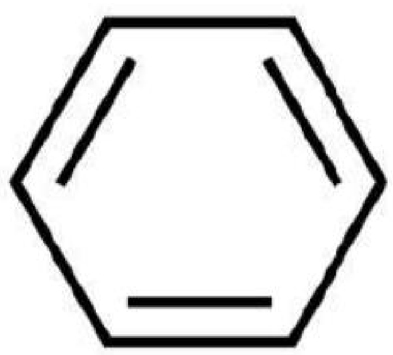
iii) Polymer

- The word "Polymer" word where 'Poly' means many and 'meros' means parts. Hence a polymer is defined as a no. of repeating chemical units which are held together by covalent bonds. The small unit of polymer is monomer. Thus it can simply define as the combination of various monomers with high molecular weight.

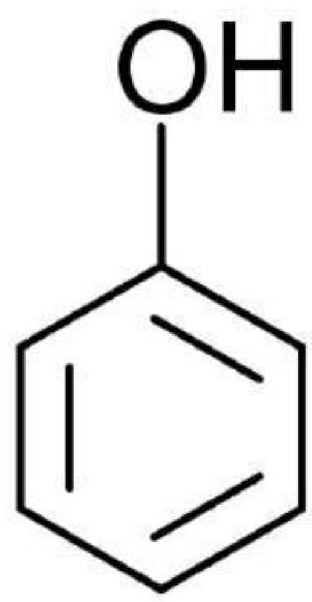
iv) Aromatic compounds

- The compounds which give as sweet smell are known as Aromatic compounds. The Aromatic compounds are cyclic. They are obtained from coals, petroleum, etc. They follow Huckel's rule with alternate single and double bond. They have sweet odour. They are almost unsaturated and contain at least one benzene ring.

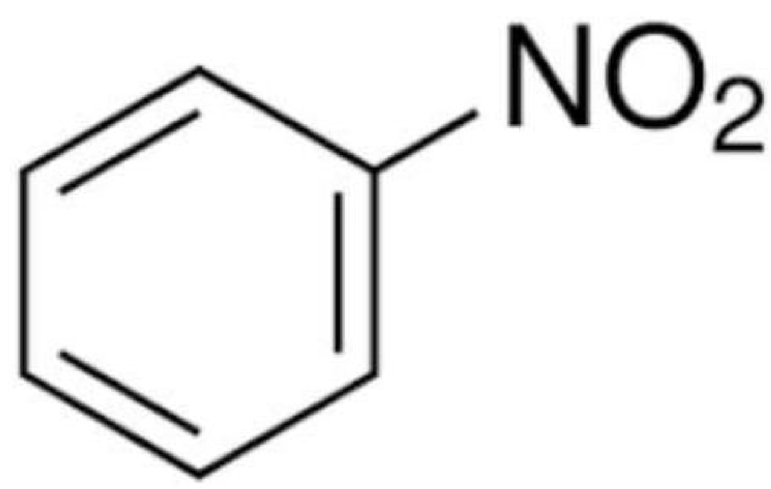
For eg:–



Benzene



Phenol



Nitrobenzene

-The End-

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(2079 *New Course*) Question Paper Solution.

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1. Define hard water. How can you remove hardness of water by permutit process?

- Water containing dissolved salt ions like SO_4^{--}, Cl^-, HCO_3^- of calcium (Ca^{++}) or magnesium (Mg^{++}) which doesn't produce enough lather easily with soap is called hard water.

Permuit process

- Permutit is a complex compound known as hydrated sodium aluminium silicate, $Na_2Al_2Si_2O_8 \times H_2O$. Sodium ion of this compound is exchanged by Ca^{++} and Mg^{++} ions of hard water and cause the precipitation of calcium and magnesium aluminium silicates in the form of zeolite. Soluble $NaCl$ and Na_2SO_4 are separated by distillation process.

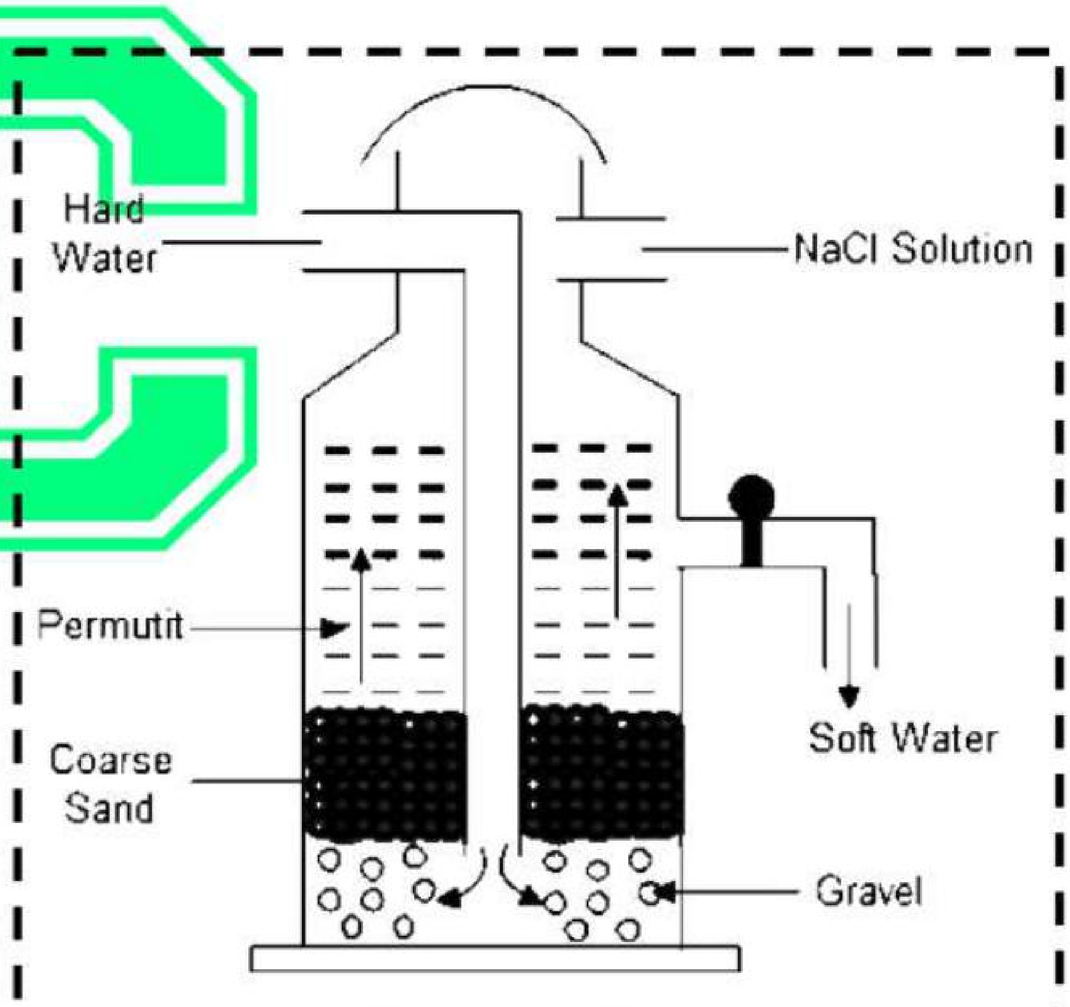

Fig:- **Permutit Process.**

$$CaCl_2 + Na_2Z \longrightarrow CaZ\downarrow + 2NaCl$$
$$MgSO_4 + Na_2Z \longrightarrow MgZ\downarrow + Na_2SO_4$$

where, $Z = Al_2Si_2O_8 \times H_2O$.

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After sometime, the whole of the $Na_2Al_2Si_2O_8$ gets changed into calcium and magnesium zeolites and the sodium ions are regenerated by adding 10% $NaCl$ solution to continue the reaction.

$$CaZ + 2NaCl \longrightarrow Na_2Z + CaCl_2$$

$$MgZ + 2NaCl \longrightarrow Na_2Z + MgCl_2$$

2. How can you manufacture ammonia by Haber's process? Explain.

- Nitrogen does not combine hydrogen under ordinary conditions. But when a mixture of nitrogen and hydrogen in the ratio 1:3 by volume is heated to about 450°C under a pressure of 200-500 atmospheric pressure in the presence of finely divided iron as catalyst and some molybdenum as promoter, ammonia is obtained.

$$\underset{(g)}{N_2} + \underset{(g)}{3H_2} \rightleftharpoons \underset{(g)}{2NH_3} + 98.6\text{KJ mol}^{-1}$$

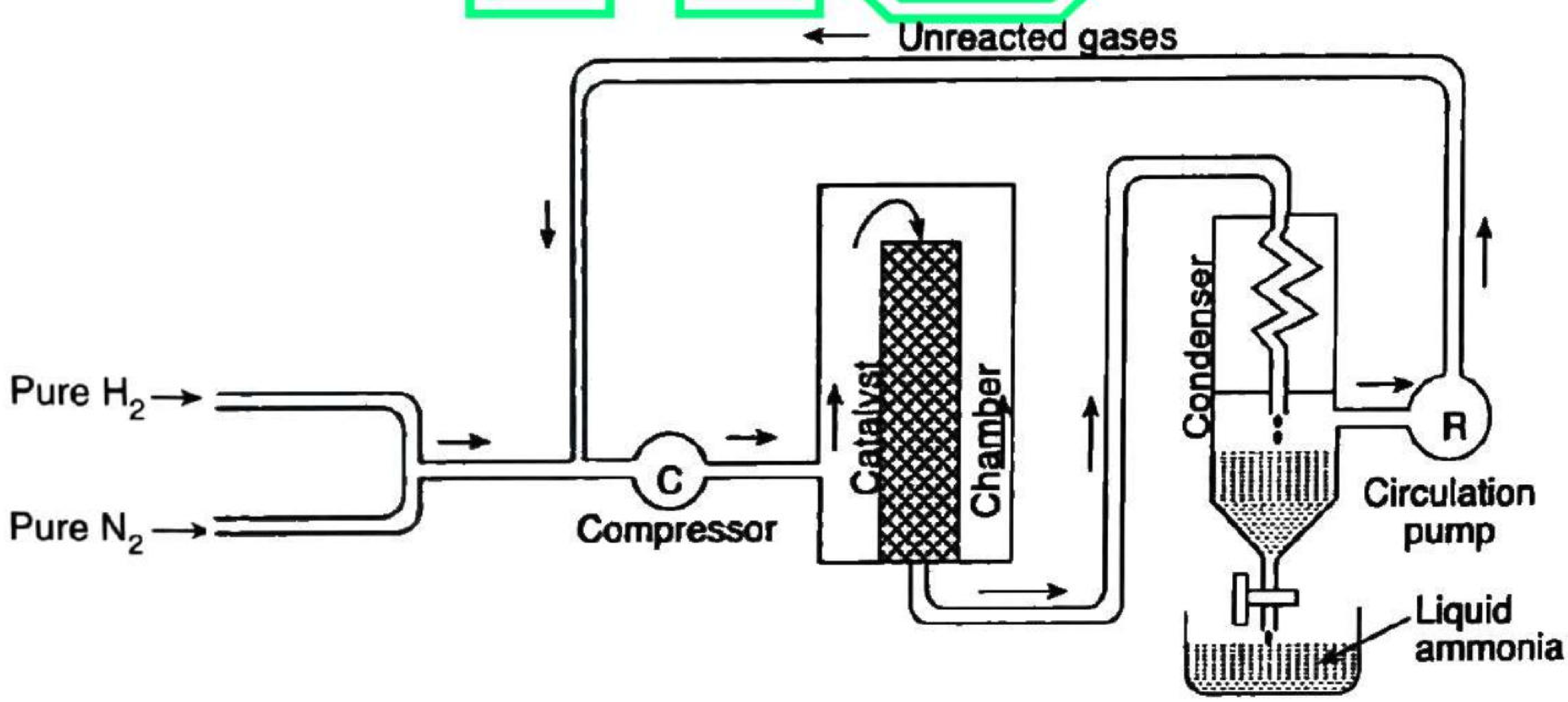

Fig :- Haber's process for the manufacture of ammonia.

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3. Explain Ostwald's process of manufacture of nitric acid (principle and diagram only).

❖ Principle

i) Ammonia is oxidized to nitric oxide in presence of air at 800°C over the catalyst platinum gauze or a rhodium-platinum alloy.

$$4NH_3 + 5O_2 \xrightarrow[\text{Pt/Rh}]{\Delta} 4NO + 6H_2O + \text{Heat}$$

ii) Nitric oxide formed is cooled and allowed to come into contact with air and it gets oxidized to nitrogen dioxide.

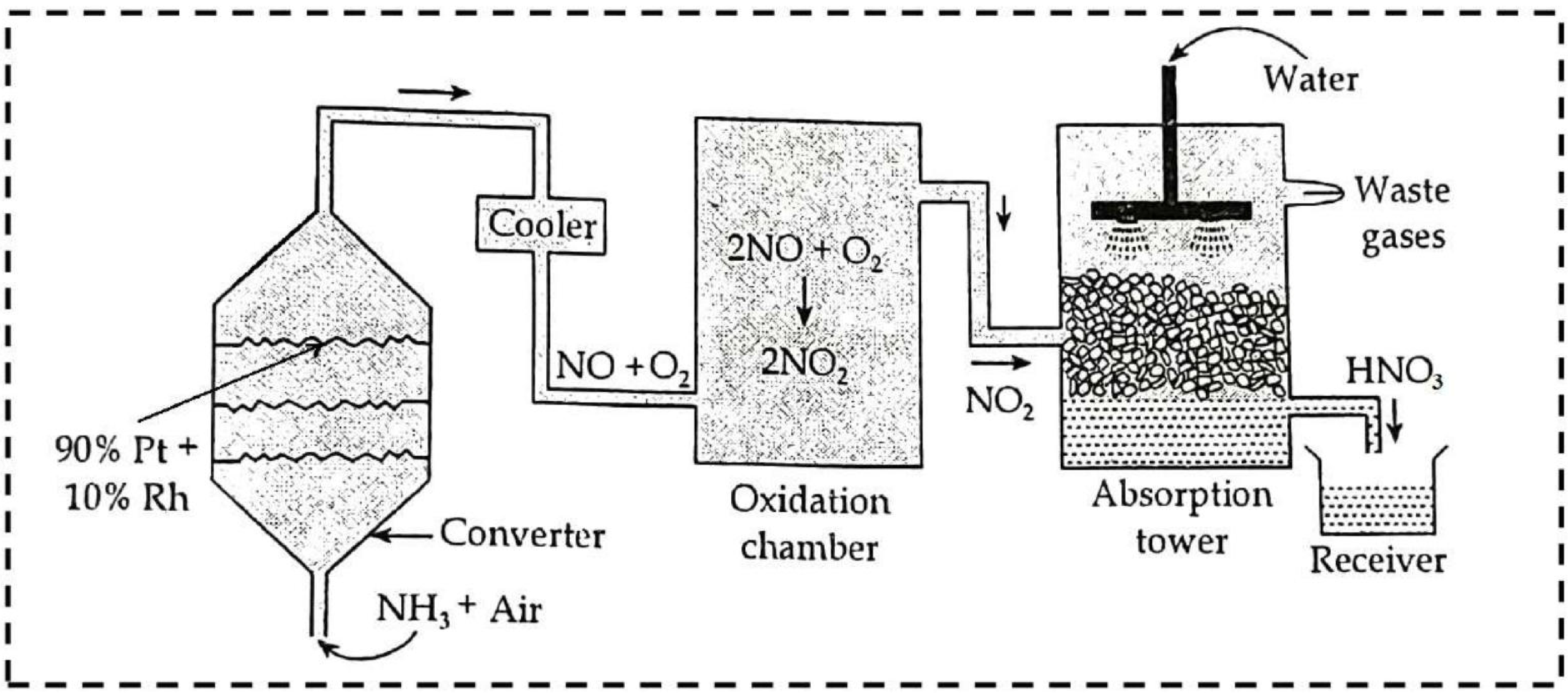
$$2NO + O_2 \longrightarrow 2NO_2$$

iii) Nitric acid is obtained when nitrogen dioxide is dissolved in water in presence of air.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

Nitric acid

Diagram of Ostwald's Process



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4. What do you mean by chemical fertilizer? Explain its types and characteristics of fertilizers.

- A chemical fertilizer is a substance applied to soils or directly onto plants to provide nutrients optimal for their growth and development. The essential nutrients contained in these fertilizers are nitrogen, phosphorous, and potassium.

- **The types of Chemical fertilizer are listed below:-**
  - **Nitrogen fertilizers**

    $(NH_4)_2SO_4$ Ammonium sulphate

    CAN Calcium ammonium nitrate

    NH_2CONH_2 Urea

  - **Phosphorus fertilizers**

    $Ca(H_2PO_4)_2 \cdot H_2O$ Super phosphate of lime

  - **Potash fertilizer**

    KNO_3 Potassium nitrate

    K_2SO_4 Potassium sulphate

- **Its features (characteristics) are listed below :-**
  - Fertilizer must be stable.
  - It must be freely soluble in water.
  - The fertilizer should have no harm to plants.
  - It should have good storage property.

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5. How can you prepare chlorine gas by applying heat in the laboratory? What happen when chlorine reacts with hydrogen and ammonia?

- Chlorine is prepared in the laboratory by chemical oxidation of the respective halide or hydrogen chloride acid by using strong oxidizing agents like MnO_2.

$$MnO_2 + 2HCl \longrightarrow MnCl_2 + H_2O + [O]$$
$$2HCl + O \longrightarrow Cl_2 + H_2O$$

$$\underset{(s)}{MnO_2} + \underset{(aq)}{4HCl} \longrightarrow \underset{(aq)}{MnCl_2} + \underset{(l)}{2H_2O} + \underset{(g)}{Cl_2}$$

During the preparation a round bottom flask containing MnO_2 is fitted with a thistle funnel and a delivery tube which is further connected with a gas jar. Now the conc. HCl is poured into the round bottom flask and then it is heated due to which Cl_2 gas is formed. This formed Cl_2 is collected in a gas jar by upward displacement of air.

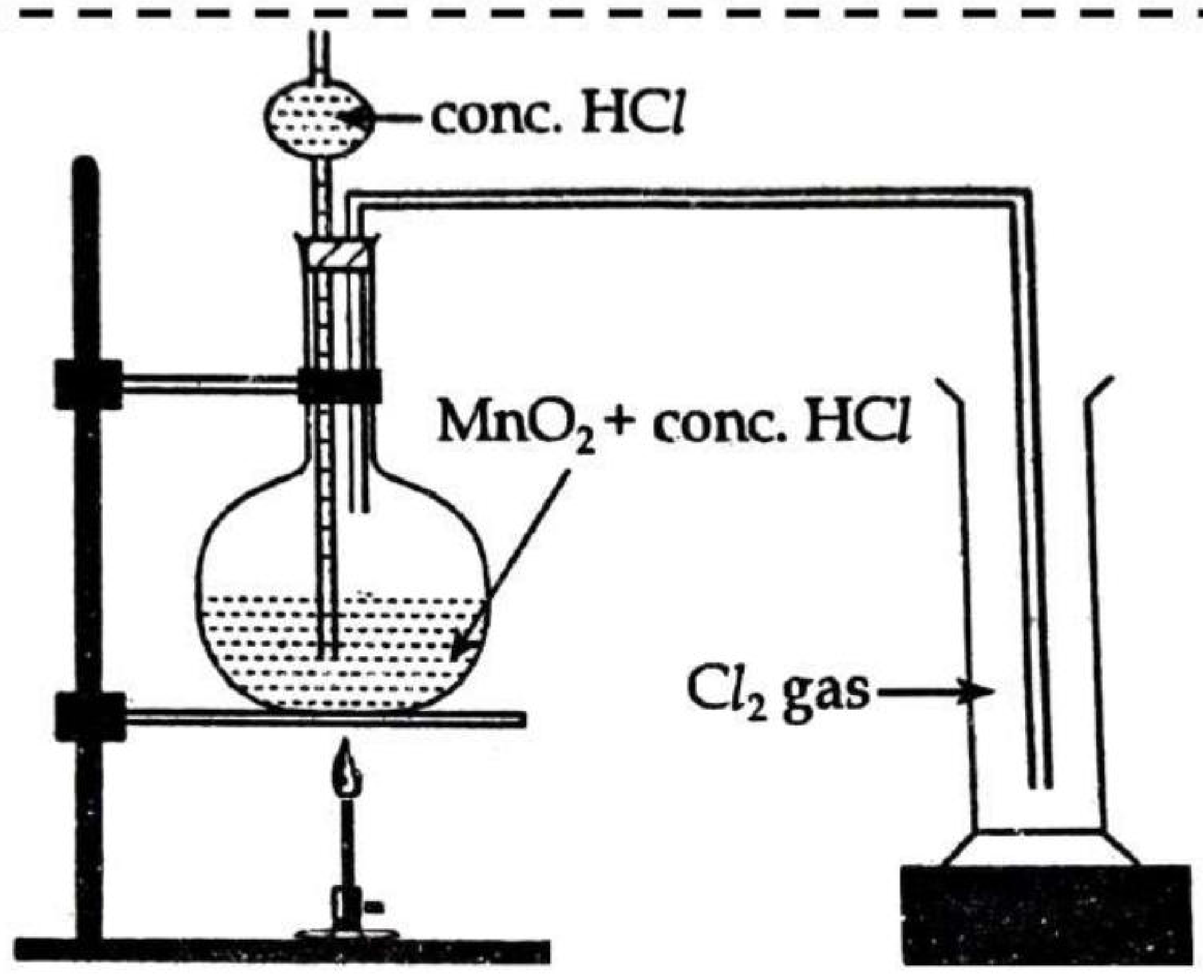

Figure: Laboratory preparation of Chlorine gas.

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- When Chlorine and hydrogen combine slowly in the dark, but unite explosively in strong light to form hydrogen chloride.

$$H_2 + Cl_2 \longrightarrow 2HCl$$

❖Reactions of chlorine and ammonia in two cases :-

i) Chlorine with excess of ammonia nitrogen is obtained.

$$\begin{array}{rcl} 2NH_3 + 3Cl_2 & \longrightarrow & N_2 + 6HCl \\ HCl + NH_3 & \longrightarrow & NH_4Cl] \times 6 \\ \hline 8NH_3 + 3Cl_2 & \longrightarrow & 6NH_4Cl + N_2 \\ \text{(Excess)} & & \end{array}$$

ii) Ammonia with excess of chlorine an explosive substance, nitrogen trichloride, is obtained.

$$NH_3 + \underset{\text{(Excess)}}{3Cl_2} \longrightarrow \underset{\text{Nitrogen trichloride}}{NCl_3} + 3HCl$$

6. How can you prepare HCl gas in the laboratory? What happen when HCl reacts with ammonia and $AgNO_3$.

- In the laboratory, hydrogen chloride gas is prepared by heating sodium chloride with concentrated sulphuric acid.

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl \text{ (On gentle heating)}$$
$$NaHSO_4 + NaCl \longrightarrow Na_2SO_4 + HCl \text{ (On Strong heating)}$$

Here, sodium chloride is taken a powdered form in a round bottomed flask fitted with a dropping funnel and delivery tube. Conc. H_2SO_4 is poured in sufficient quantity so that salt is covered.

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At first, HCl and sodium hydrogen sulphate are formed and at red heat normal sodium sulphate and more HCl is formed.

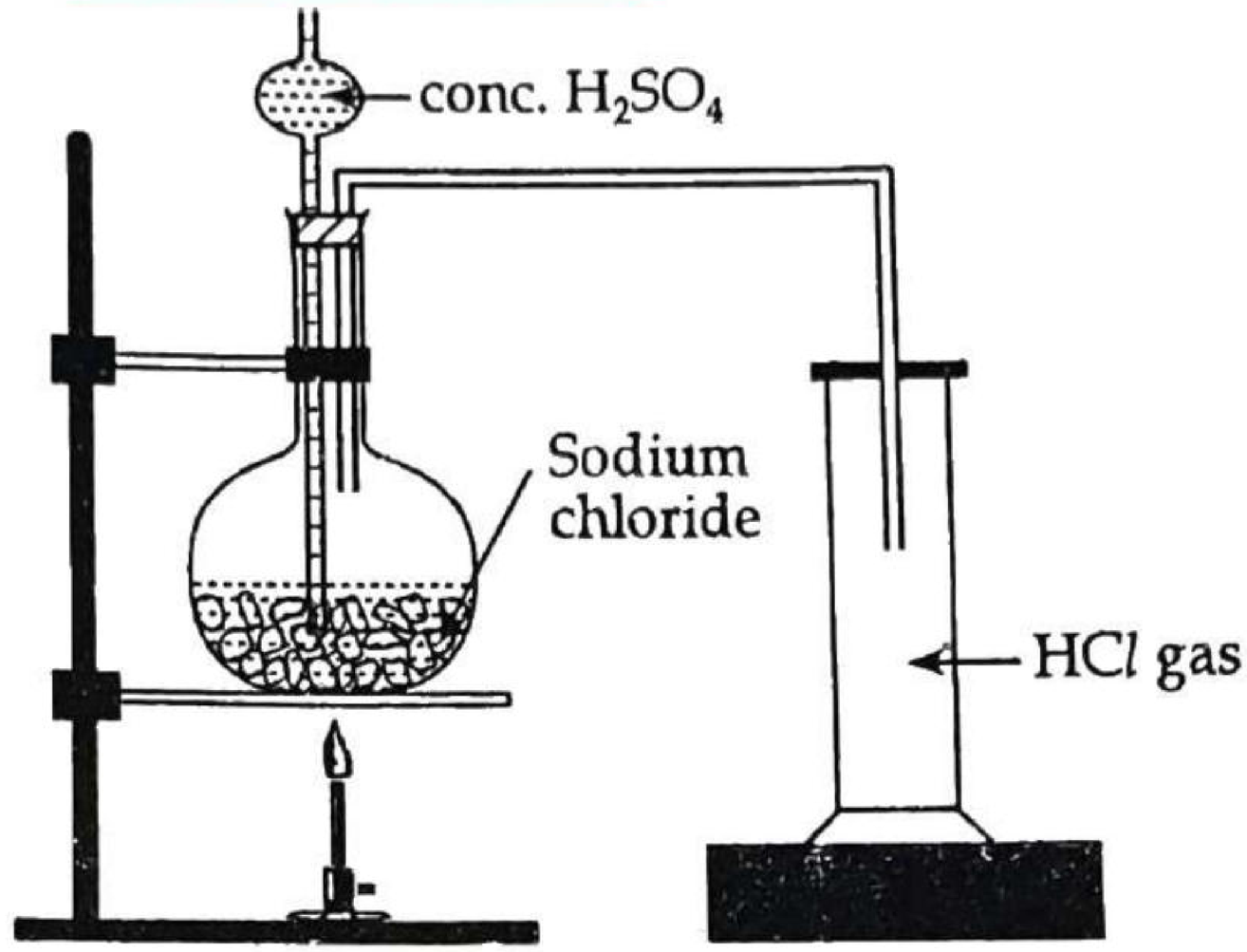

Fig :- **Laboratory preparation of HCl gas.**

- Hydrochloric acid gives white precipitate with silver nitrate, which is soluble in ammonia solution.

$$HCl + AgNO_3 \longrightarrow \underset{\text{(White precipitate)}}{AgCl\downarrow} + HNO_3$$

$$AgCl + 2NH_4OH \longrightarrow \underset{\substack{\text{Diamminesilver(I) chloride} \\ \text{(Soluble complex)}}}{[Ag(NH_3)_2]Cl} + 2H_2O$$

7. What are the oxidizing and dehydrating properties of H_2SO_4?

- **Sulphuric acid as oxidizing agent :-**

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- Metals are oxidized to their oxides, which then form sulphates.

$$H_2SO_2 \longrightarrow H_2O + SO_2 + [O]$$
$$Cu + [O] \longrightarrow CuO$$

$$CuO + H_2SO_2 \longrightarrow CuSO_4 + H_2O$$

$$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + 2H_2O + SO_2$$

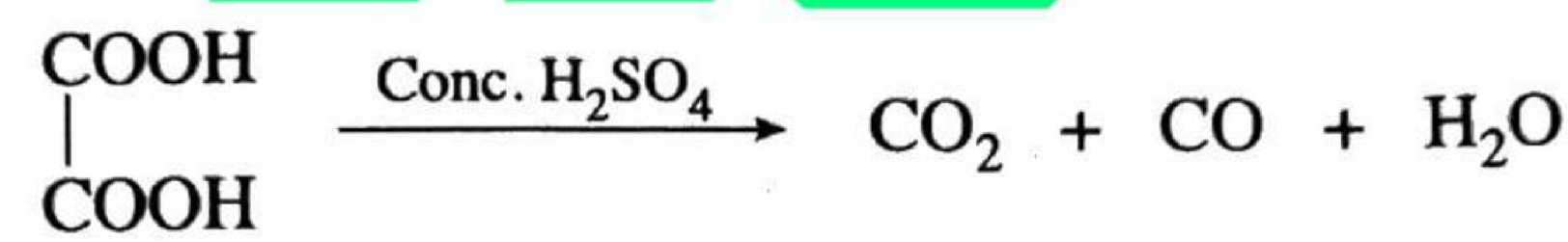
Similarly,

Some metals like iron, zinc, etc react with dilute acid to liberate hydrogen, hence oxidized.

$$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$$
$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

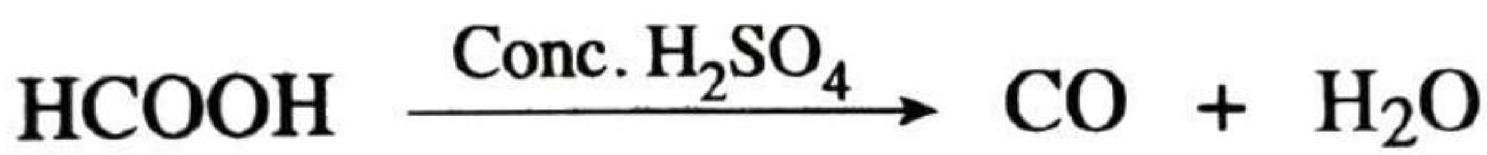
➢ **Sulphuric acid as dehydrating agent :-**

- Oxalic acid is react in the presence of con H_2SO_4 then, carbon dioxide and carbon monoxide is formed.



Oxalic acid

- Formic acid is react in the presence of con. H_2SO_4 then, carbon monoxide is formed.



Formic acid

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or) Explain the principle and well labelled diagram of manufacture of H_2SO_4 by contact process.

- The principle involved in contact process for the manufacture of sulphuric acid which is commonly known as king of chemicals are listed below.

i) At first, sulphur is burnt in air to produce sulphur dioxide. Sulphur dioxide may also be prepared by roasting iron pyrites or sulphide ores.

$$\underset{(s)}{S_8} + \underset{(g)}{8O_2} \longrightarrow \underset{(g)}{8SO_2}$$

$$\underset{(s)}{4FeS_2} + \underset{(g)}{11O_2} \longrightarrow \underset{(s)}{2Fe_2O_3} + \underset{(g)}{8SO_2}$$

ii) Sulphur dioxide is then catalytically oxidized to sulphur trioxide by the oxygen of air at a temperature of 450°C in the presence of platinum asbestos or divanadium pentaoxide (V_2O_5) as catalyst under a pressure of only 2-3 atmosphere. The reaction is reversible and exothermic in nature.

$$\underset{(g)}{2SO_2} + \underset{(g)}{O_2} \underset{\substack{450°C \\ 2\text{-}3\ atm}}{\overset{V_2O_5}{\rightleftharpoons}} \underset{(g)}{2SO_3} + 196\ KJ$$

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iii) The sulphur trioxide thus produced is absorbed in conc. H_2SO_4 (about 94%) to form oleum' which is also called Pyrosulphuric acid.

$$\underset{(g)}{SO_3} + \underset{(aq)}{H_2SO_4} \longrightarrow \underset{(aq)}{H_2S_2O_7}$$

iv) Oleum is then diluted with the required amount of water to Get conc. H_2SO_4.

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

As conc. H_2SO_4 being dehydrating agent it absorbs the water from the paper which cause charring sound.

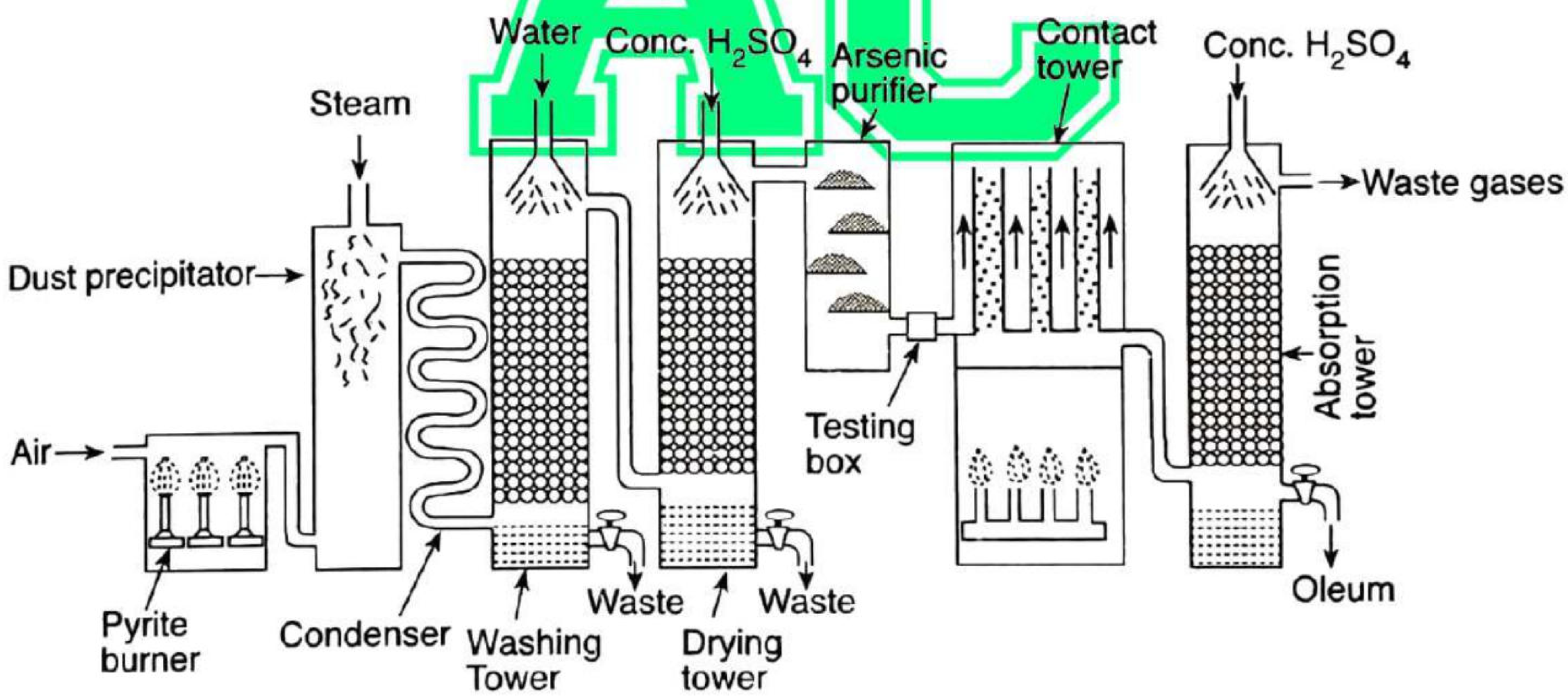

Fig :- Manufacture of H_2SO_4 by contact process.

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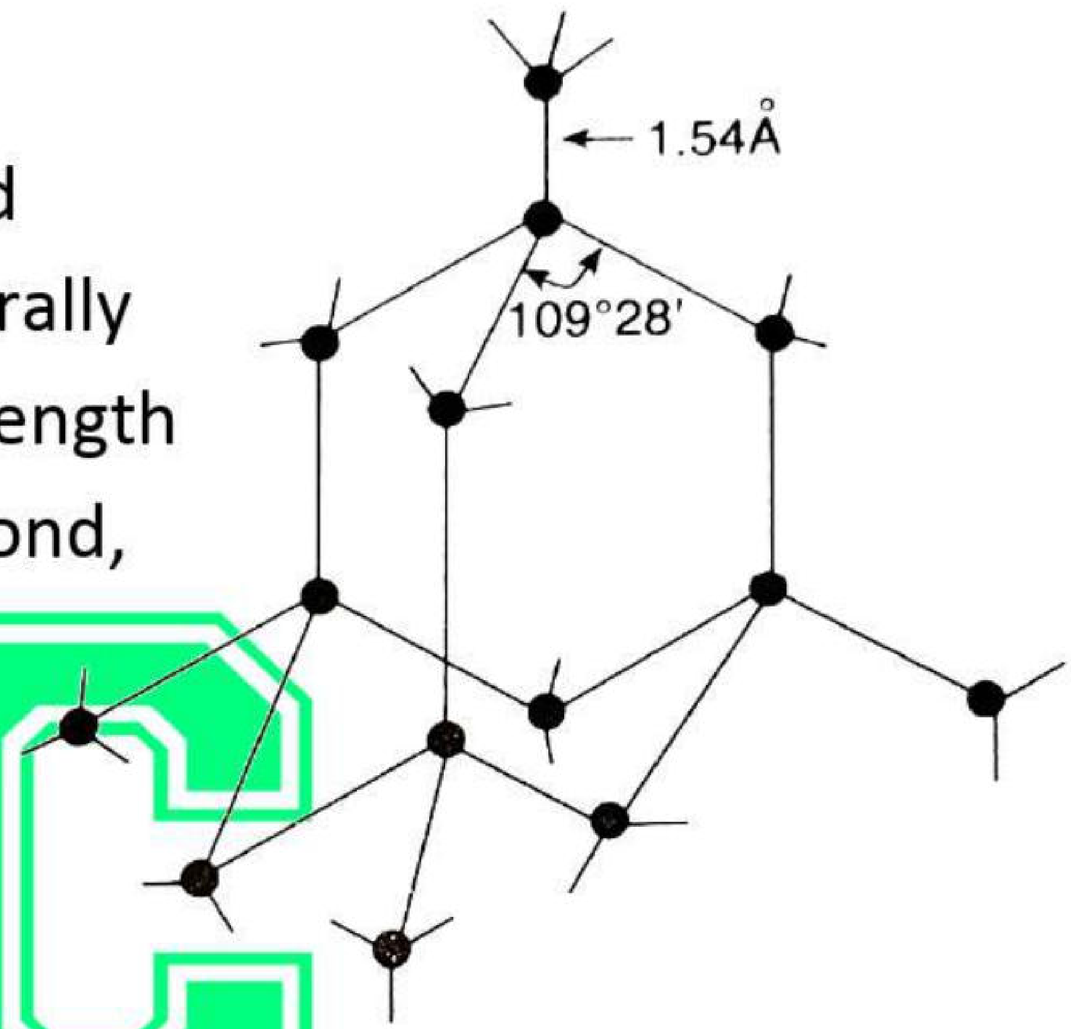
8. What do you mean by allotropic of carbon? Explain the structure of diamond.

- The two or more forms of the Carbon having same chemical properties but different physical properties are called allotropes of carbon.

❖ Structure of Diamond



- It is a crystalline allotropes of carbon in which each carbon atom is combined with other four carbon atoms tetrahedrally having an angle of 109°, 28' and bond length of 1.54 Å. As there is strong covalent bond, it is considered as hardiest substance. It is considered to be the purest form of carbon and is believed to be formed when very high pressure develops on coal beds in the earth. As there are no electrons, it is bad- conductor of heat and electricity.

9. What do you mean by alloys? Distinguish between metals and non-metals.

- An alloy is a homogenous mixture of two or more metals or metals with non-metals. Alloy possesses metallic properties.

For Example:- *Brass* is an alloy of copper and zinc.
Bronze is an alloy of copper and tin.
German silver is an alloy of copper, zinc and nickel.
Steel is an alloy of iron and carbon.
Stainless steel is an alloy of iron, chromium and carbon.

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Metals	Non-Metals
They are generally found in solid state except Hg which is found liquid state.	They are found in all three states $i.e.$, solid, liquid and gas.
They are malleable and ductile in nature.	They are brittle in nature.
They possess brilliant lustrous properties.	They possess no luster except iodine and graphite.
They are good conductor of heat and electricity.	They are poor conductor of heat and electricity.

10. Explain the chemical properties of sodium. What are the uses of aluminum.

➢ **The properties of sodium are listed below :-**

- Sodium is a silvery white soft solid and can be cut with a knife.
- It is less dense than water.
- The density of sodium is 0.97 g/cm³.
- It is good conductor of heat and electricity.
- Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \longrightarrow 2Na_2O + Si$$

- Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

- Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \longrightarrow 2NaCI$$

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➢ The uses of aluminium are listed below :-

- It gives foils of extreme thinness which are used as wrappers for chocolates and cigarettes.
- The fine dust of the metal is used in paints and lacquers.
- Aluminium utensils are also very common.
- Mixed with iron oxide, aluminium powder forms thermite which is employed for welding purposes.
- The great affinity of aluminium for oxygen is made use of in the extraction of chromium and manganese from their oxides.

11. What are the properties of calcium? Mention the uses of zinc.

➢ The properties of calcium are listed below :-

- Calcium is silvery white metal.
- It is very soft metal of a low density.
- It is good conductor of heat and electricity.
- Calcium react with water evolving hydroxides gas.

$$Ca + 2H_2O \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2} + H_2$$

- It reacts with hydrogen to give Calcium hydride.

$$Ca + H_2 \longrightarrow CaH_2$$

- It reacts with halogen to give calcium halide.

$$Ca + Cl_2 \longrightarrow CaCl_2$$

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➢ **The uses of zinc are listed below :-**

- Zinc is used in the preparation of alloys such as brass and German silver.
- It is used as cathode in dry cells.
- Its compounds are used in the manufacture of paints.
- It is used for the galvanization of iron.

12. What are the general characteristics of coinage metals? What do you mean by plumbosolvency?

➢ **The general characteristics of coinage metals are listed below :-**

- They occur in native as well as in combined state.
- They are hard, malleable, ductile and possess high melting points.
- They are good conductors of heat and electricity.
- They have tendency to form complex salts as tetra amine copper II sulphate $[Cu(NH_3)_4]SO_4$ etc.
- General electronic configuration of these metals is $(n-1)\ d^{10}ns^1$.

➢ The process in which lead undergoes reaction with water containing oxygen to form a sparingly soluble plumbous hydroxide and this solvent action of water on lead is called **plumbosolvency**.

The reaction occurs as follows:-

$$2Pb + O_2 + 2H_2O \longrightarrow 2Pb(OH)_2$$

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13. What do you mean by saturated hydrocarbon? Explain the properties of methane.

- The hydrocarbons which have general formula C_nH_{2n+2} and have only one covalent sigma bond between carbon atoms called saturated hydrocarbons.

  For example: – ethane (CH_3CH_3), propane (C_3H_8). All alkanes are saturated hydrocarbons.

- **The properties of methane are listed below :-**

  - ***Nitration:-*** This involves the replacement of a hydrogen atom of an alkane with $-NO_2$ group. At room temperatures, alkanes do not react with nitric acid.

    The nitration of methane can be carried out in vapour phase by heating to very high temperature $(450 - 500°C)$.

$$CH_4 + HNO_3 \xrightarrow{450\text{-}500°C} \underset{\text{Nitromethane}}{CH_3NO_2} + H_2O$$

  - ***Combustion of Methane :-*** Methane burns in air or oxygen to produce carbon dioxide and water vapour with liberation of heat energy.

$$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2O + \text{Energy}$$

  - ***Action of CH_4 with Steam :-*** When a mixture of methane gas and steam is passed over heated nickel at about $800°C$, a mixture of carbon monoxide and hydrogen (water gas) is obtained.

$$CH_4 + H_2O \xrightarrow[\text{Ni}]{800°C} CO + 3H_2$$

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or) How does vital force theory decline? What do you mean by homologous series? Explain its characteristics.

- Wohler, a German chemist made an accidental discovery of urea (organic compound) decomposing ammonium chloride and potassium cyanate. Which prove that vital force was not required to prepare organic compounds

$$NH_4Cl + KCNO \xrightarrow{\Delta} NH_4CNO + KCl$$

$$NH_4CNO \xrightarrow{\text{Rearrangement}} NH_2CONH_2$$

Urea

- A series obtained by placing the member of organic compound of same functional group from lower to higher is called **homologous series** and this phenomenon is known as homology.

- **The Characteristics of homologous series are listed below :-**
  - All the members of homologous series contain the same functional group.
  - The subsequent member of homologous series is differentiated by $-CH_2$ unit or 14 a.m.u. mass.
  - Melting and boiling point in homologous series increases gradually from lower to higher member.
  - The member of homologous series has almost similar chemical properties.
  - The first member of homologous series is somewhat different from other member in chemical properties.

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14. What do you mean by Markonikov's rule and peroxide effect? Explain with examples.

- The rule in which hydrogen atom goes to that unsymmetrical carbon atom of an alkene which already contains higher number of hydrogen atom is called as *Markovnikov's rule*.

  $for\ E.g$:- $\mathrm{HC}l$ is treated with propene then, H-atom of $\mathrm{HC}l$ goes to the carbon atom of propene which contains larger number of hydrogen atom which can be shown as:-

$$\underset{\text{Propane (substrate)}}{\mathrm{CH_3-CH=CH_2}} + \mathrm{HC}l \xrightarrow[\text{rule}]{\text{Markovnikov's}} \underset{\text{2-chloro propane}}{\mathrm{CH_3-CH(Cl)-CH_3}}$$

- It states that, "The addition of unsymmetrical reagent such as HBr to unsymmetrical alkene (or alkyne) in presence of organic peroxide occurs in such a way that the positive part of the reagent goes to add with the multiply bounded carbon atom which contains lesser number of hydrogen atoms."

  $For\ example: -$

$$\mathrm{CH_3-CH=CH_2 + HBr} \xrightarrow{\text{Peroxide}} \underset{\text{1-Broma Propane}}{\mathrm{CH_3-CH_2-CH_2-Br}}$$

This reaction follows free radical mechanism. The peroxide effect is observed for HBr reagent only.

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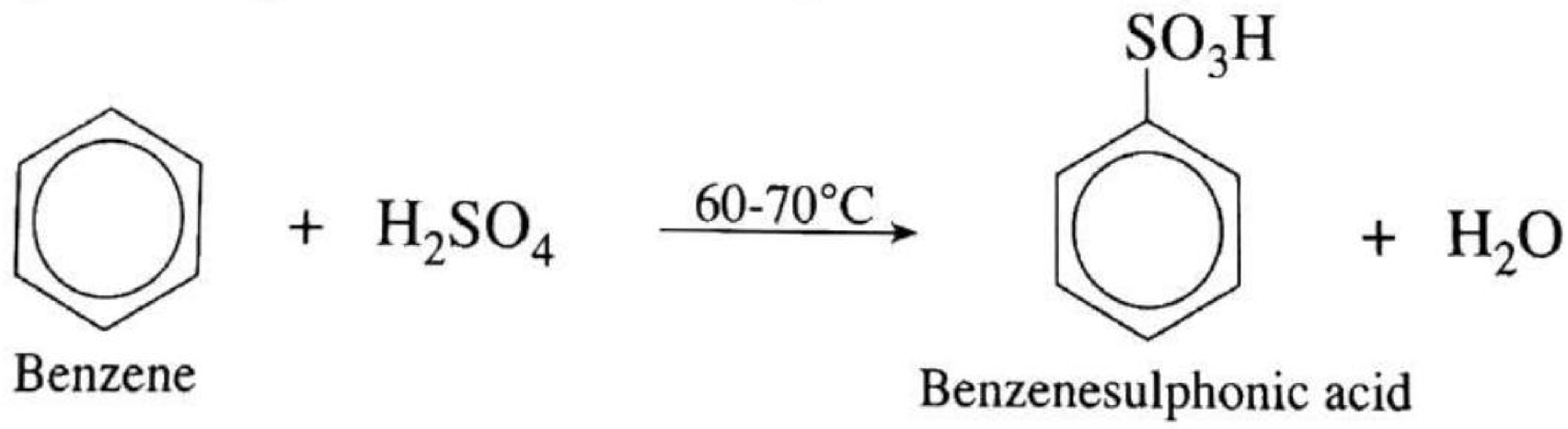
15. Write short notes on:

a) Chemical Properties of Benzene

➢ **The chemical properties of benzene are :-**

- **Sulphonation** :- Benzene on heating with fuming sulphuric acid (concentrated sulphuric acid containing some dissolved SO_3) undergoes sulphonation forming benzenesulphonic acid.



- **Nitration** :- It is carried out by heating benzene with a mixture of concentrated nitric acid and sulphuric acid (nitrating mixture) to 50-60°C.

b) Aliphatic and Aromatic Compounds

➢ The compounds derived from animal fats are called as *Aliphatic compounds.* The aliphatic compounds are non-cyclic. These compounds do not follow Huckel's rule. They are obtained from fats. They do not have sweet smell. They may be saturated or unsaturated.

$For\ eg: -\ CH_4, C_2H_4, C_2H_2$, etc.

➢ The compounds which give as sweet smell are known as *Aromatic compounds.* The Aromatic compounds are cyclic. They are obtained from coals, petroleum, etc. They follow Huckel's rule with alternate single and

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double bond. They have sweet odour. They are almost unsaturated and contain at least one benzene ring.

$For\ eg: -$ Benzene , Phenol , Nitrobenzene etc.

c) Polyethene

- It is an addition polymer of ethylene monomers. It is obtained by two varieties viz. low density polythene (LPD) and High density polythene (HPD).

Low density polythene can be produced by heating at about 250°C and applying 1500 atmospheric pressure in the presence of trace amount of oxygen.

$$nCH_2 = CH_2 \xrightarrow[250°C]{1500\ atm} (-CH_2 - CH_2 -)_n$$

High density polythene is produced at relatively lower temperature $(50 - 75°C)$ and lower atmospheric pressure $(6.7\ \text{atm.})$ in the presence of triethyl aluminium $[Al(C_2H_5)_3]$ and titanium tetrachloride $[TiCl)_4]$ as the catalyst.

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(New Course Model Question Paper Solution)

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1. a) What do you mean by hard water? How can you remove hardness of water? Explain any two types?

- Water containing dissolved salt ions like SO_4^{--}, Cl^-, HCO_3^- of calcium (Ca^{++}) or magnesium (Mg^{++}) which doesn't produce enough lather easily with soap is called hard water.
- It can be removed by following process:-

i) By the application of heat

The hardness of water is eliminated by heating the water sample due to which the soluble bicarbonates of calcium and magnesium change into respective insoluble calcium and magnesium carbonate.

$$Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3\downarrow + CO_2 + H_2O$$

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3\downarrow + CO_2 + H_2O$$

ii) By reacting with calcium hydroxide

In this process the hard water is treated with lime water due to which soluble bicarbonates change into insoluble carbonate.

$$Ca(OH)_2 + Ca(HCO_3)_2 \longrightarrow CaCO_3 \downarrow + H_2O$$

$$Ca(OH)_2 + Mg(HCO_3)_2 \longrightarrow MgCO_3 \downarrow + H_2O$$

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b) How a chlorine gas prepared in lab without applying heat?

- **Without application of heat:** Chlorine can be conveniently prepared without application of heat by dropping conc. HCl on powdered $KMnO_4$.

$$2KMnO_4 + 6HCl \longrightarrow 2KCl + 2MnCl_2 + 3H_2O + 5[O]$$

$$2HCl + [O] \longrightarrow H_2O + Cl_2] \times 5$$

$$2KMnO_4 + 16HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + 5Cl_2$$

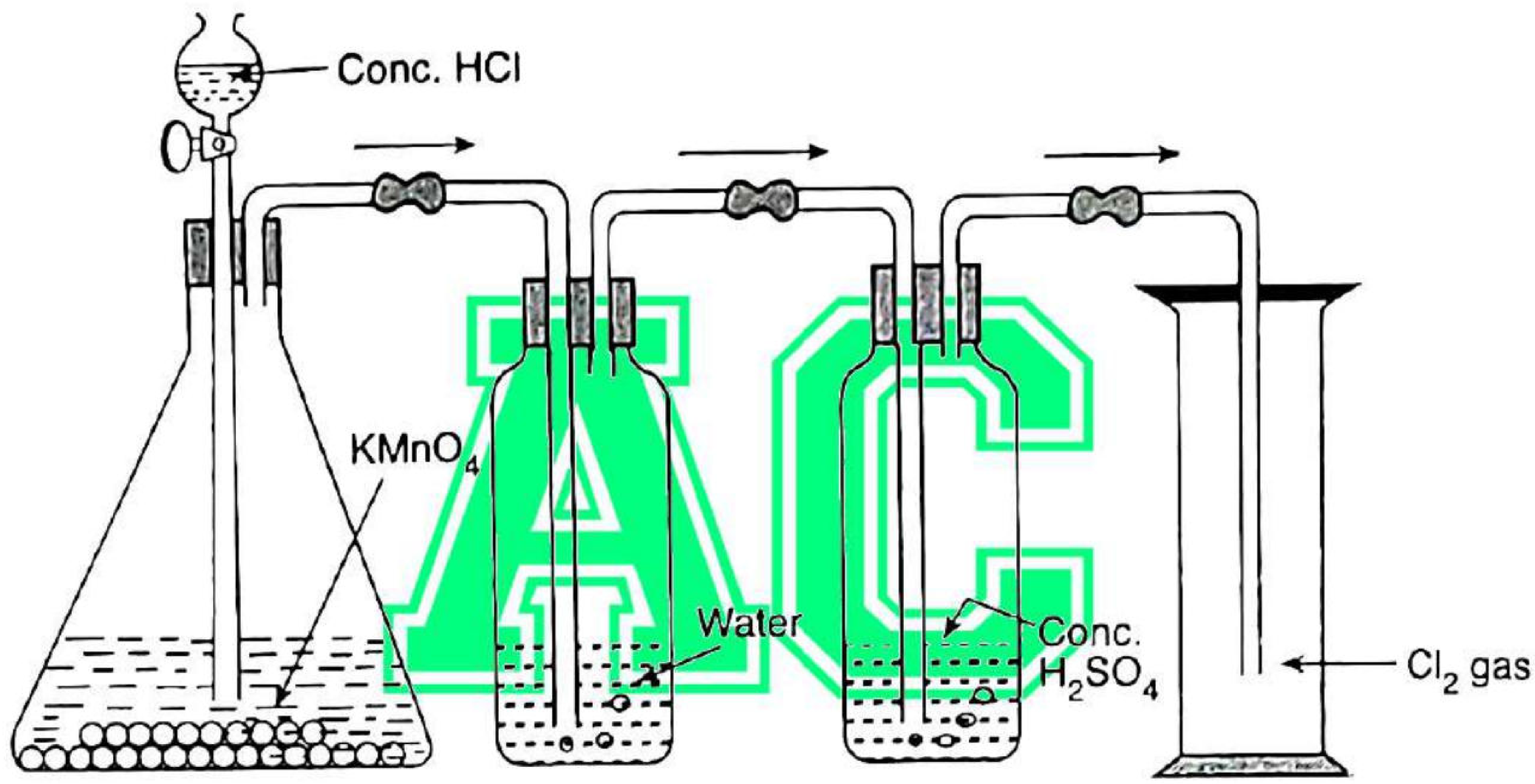

Fig :- Laboratory preparation of Cl_2 from $KMnO_4$ and conc. HCl.

Chlorine liberated is bubbled through water to dissolve out any hydrogen chloride gas and then dried by passing through concentrated sulphuric acid. Water absorbs Cl_2 also, but it soon becomes saturated with chlorine which then passes on.

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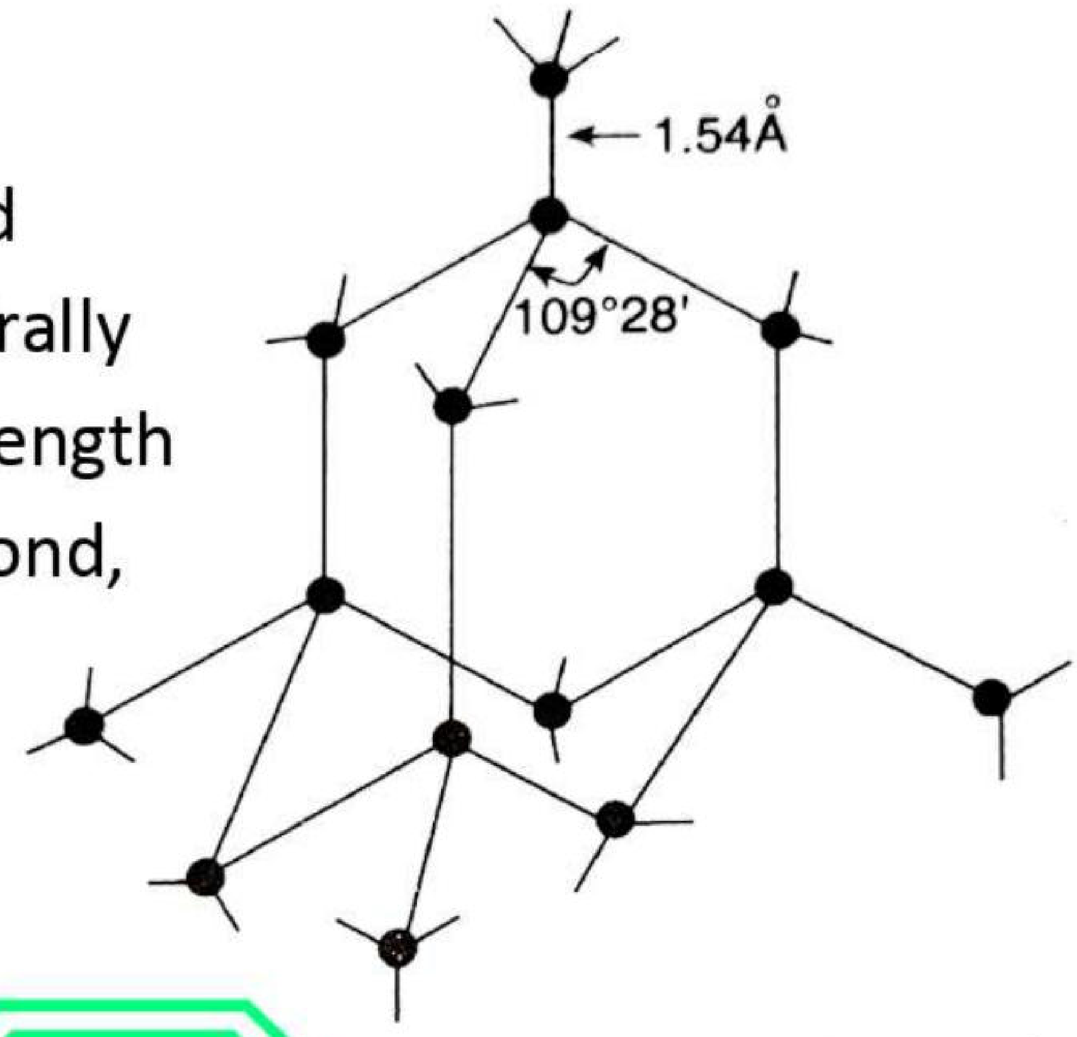
b) Explain the structure of diamond.

❖ **Structure of Diamond**



➢ It is a crystalline allotropes of carbon in which each carbon atom is combined with other four carbon atoms tetrahedrally having an angle of 109°, 28' and bond length of 1.54 Å. As there is strong covalent bond, it is considered as hardiest substance. It is considered to be the purest form of carbon and is believed to be formed when very high pressure develops on coal beds in the earth. As there are no electrons, it is bad- conductor of heat and electricity.

AC

3. a) Describe the manufacture of sulphuric acid by contact process.

➢ See the solution of 2079 R/B of Q.no 7 (OR) on page.no. 47

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b) Give two reaction to show the reducing behaviours of Hydrogen sulphide gas.

➢ **The reducing behaviours of Hydrogen sulphide gas are:-**

- It reduces acidified solutions of potassium permanganate.

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$

$$[H_2S + [O] \longrightarrow H_2O + S] \times 5$$

$$2KMnO_4 + 3H_2SO_4 + 5H_2S \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5S$$

(Purple) (Colourless)

- It reduces sulphur dioxide to sulphur.

$$SO_2 + 2H_2S \longrightarrow 2H_2O + 3S$$

4 a) What are the properties of sodium? Explain.

➢ **The properties of sodium are listed below :-**

- Sodium is a silvery white soft solid and can be cut with a knife.
- It is less dense than water.
- The density of sodium is 0.97 g/cm³.
- It is good conductor of heat and electricity.
- Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \longrightarrow 2Na_2O + Si$$

- Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

- Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \longrightarrow 2NaCI$$

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b) What are the purposes of making alloy?

➢ **The Purpose of making alloys is as follows:-**

- To get a product possessing desirable properties which the constituent elements do not possess.
- To improve the mechanical strength, electrical and magnetic properties and resistant to corrosions.
- To improve colour. $Eg.$, Al $-$ golden yellow colour.
- To lower melting point of metals.

c) What do you mean by synthetic polymers? Explain about preparation and use of polythene.

➢ The man made polymers prepared in laboratories or factories are called synthetic polymers. Most of the synthetic polymers are long chain organic molecules containing thousands of monomer units.

The common synthetic polymers are: -

- Polythene
- Polystyrene
- Polyvinyl chloride

When ethylene is heated at high pressure and temperature in the presence of acid catalyst, its monomers about 600 to 1000 get combined giving polyethylene as the polymer of ethylene.

$$\mathrm{CH_2 = CH_2} \xrightarrow[\text{Acid}]{\text{High temp/high pressure}} (-\mathrm{CH_2} - \mathrm{CH_2}-)\mathrm{n}$$

Where, n = 600 to 1000.

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Polythene is generally used for manufacturing of plastics, polythene bags, buckets, pipes, etc.

5 a) Explain various functional groups in brief.

(i) Hydroxyl group (-OH)

- The characteristic properties of alcohols are due to the presence of -OH group, which largely determines the properties of an organic compound, is known as the functional group of the organic compound. The remaining part (known as hydrocarbon group) of the molecule mainly determines the physical properties such as melting point, boiling point, density etc. Thus, -OH group is the functional group of alcohols.

Similarly,

Carboxylic group $(-\mathbf{COOH})$

The characteristic properties of carboxylic acids are due to the presence of $-\mathrm{COOH}$ group in them. Therefore, the functional group of carboxylic acids is $-\mathrm{COOH}$.

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b) Differentiate between aliphatic and aromatic Compound.

Aliphatic Compounds	Aromatic Compounds
These are organic compounds containing closed chain.	These are organic compounds containing open chain.
Generally, they burn without smoky flame on burning.	Generally, they burn with smoky flame on burning.
In these compounds, order of single and double bonds are not definite.	In these compounds, single and double bonds are present in alternative order.
These are more reactive.	These are less reactive.
In these compounds, presence of specific fragrance (smell) is not necessary.	These compounds contain specific fragrance (smell).
These compounds do not show substitution reactions easily.	In these compounds, halogenation, sulphonation, nitration etc. substitution reactions are done easily.

c) Give the IUPAC Name of following compound.

i) HCOOH ii) CH_3-CH_2-CH_2-OH iii) CH_3-CH=CH-CH_3

- **Compound IUPAC name**

i) HCOOH : Methanoic acid

ii) CH_3-CH_2-CH_2-OH : Propan-1-ol

iii) CH_3-CH=CH-CH_3 : But-2-ene

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6. What happens when: (Any Five)

i) Zinc is treated with caustic soda solution.

- When zinc is boiled with caustic soda solution, hydrogen gas is evolved along with formation of sodium zincate.

$$\underset{\text{Caustic soda}}{Zn + 2NaOH} \xrightarrow{\Delta} \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2\uparrow$$

ii) Copper sulphate solution is trented with excess of ammonia solution.

- When ammonia gas is passed into copper sulphate solution, at first a bluish white precipitate is formed which dissolves in excess of ammonia forming a deep blue coloured solution due to formation of a soluble complex compound tetramminecopper (II) sulphate.

$$CuSO_4 + 2NH_4OH \longrightarrow Cu(OH)_2 + (NH_4)_2SO_4$$

$$Cu(OH)_2 + (NH_4)_2SO_4 + 2NH_4OH \longrightarrow \underset{\substack{\text{Tetramminecopper(II) sulphate}\\ \text{(Deep blue)}}}{[Cu(NH_3)_4]\,SO_4} + 4H_2O$$

iii) Ethylene gas is treated with alkaline potassium permanganate solution.

- When ethylene gas is passed into alkaline $KMnO_4$ solution (Baeyer's reagent), ethylene glycol is formed and the pink colour of Baeyer's reagant is discharged.

$$\underset{\text{Ethylene}}{CH_2 = CH_2} + H_2O + [O] \longrightarrow \underset{\substack{\text{Ethylene glycol}\\ \text{Ethane-1, 2-diol}}}{\begin{array}{c} CH_2 - CH_2 \\ | \qquad\quad | \\ OH \quad\; OH \end{array}}$$

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viii) Iron is treated with very dilute Nitric acid.

- When iron is allowed to react with very dilute HNO_3, a mixture of ferrous nitrate and ammonium nitrate is obtained.

$$Fe + 2HNO_3 \longrightarrow Fe(NO_3)_2 + 2[H]] \times 4$$
$$HNO_3 + 8[H] \longrightarrow NH_3 + 3H_2O$$
$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

$$4Fe + 10HNO_3 \longrightarrow \underset{\text{Ferrous nitrate}}{4Fe(NO_3)_2} + \underset{\text{Ammonium nitrate}}{NH_4NO_3} + 3H_2O$$

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(2080 *Old + Very Old*) Question Paper Solution.

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1.a) Define hardness of water. How can you remove permanent hardness of water by permutit process?

➢See the solution of 2076 R/B of Q.no 1 (a) on page.no. 3

b) Describe the manufacture process of ammonia by Haber's process.

Principle :

➢ Nitrogen does not combine hydrogen under ordinary conditions. But when a mixture of nitrogen and hydrogen in the ratio 1:3 by volume is heated to about 450°C under a pressure of 200-500 atmospheric pressure in the presence of finely divided iron as catalyst and some molybdenum as promoter, ammonia is obtained.

$$\underset{(g)}{N_2} + \underset{(g)}{3H_2} \rightleftharpoons \underset{(g)}{2NH_3} + 98.6\text{KJ mol}^{-1}$$

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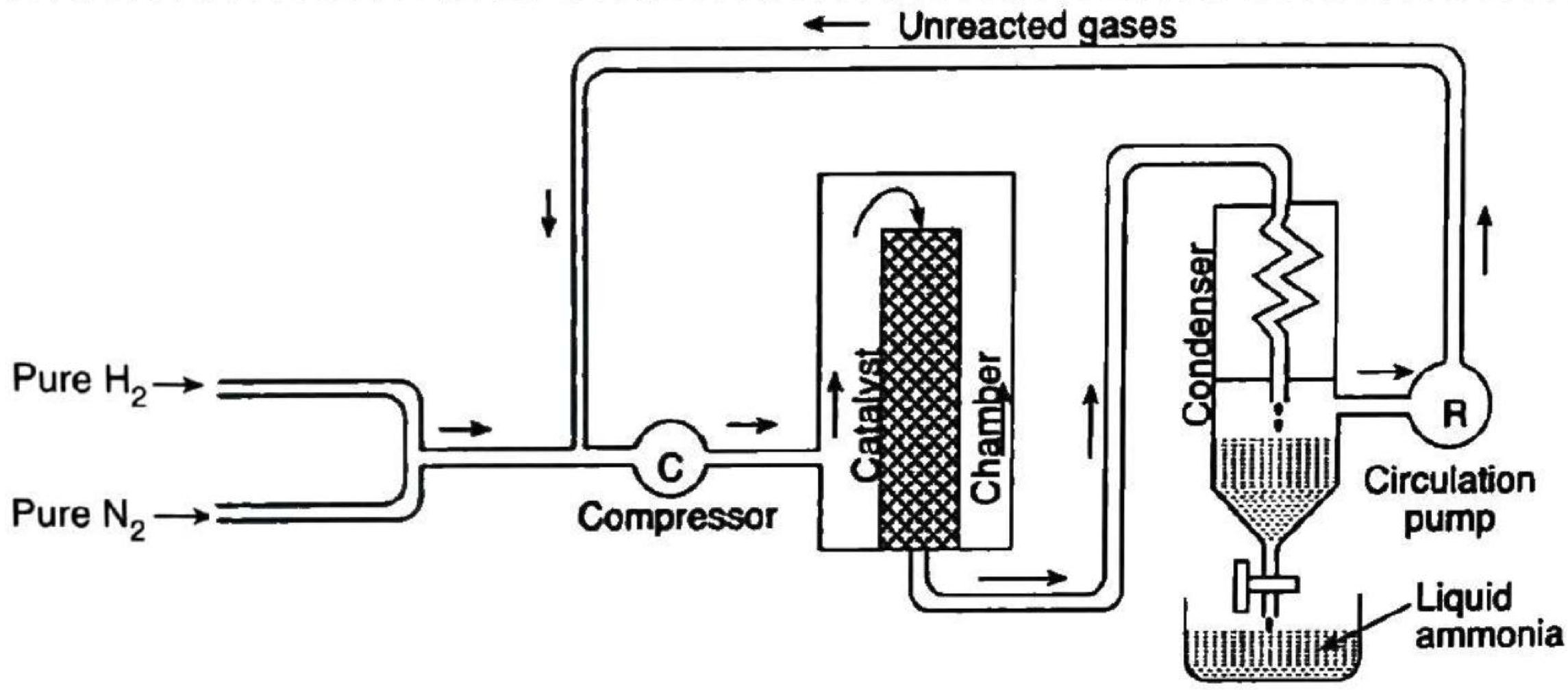

Fig :- Haber's process for the manufacture of ammonia.

- **What happens when excess amount of ammonia reacts with chlorine.**

➢ When excess ammonia react with chorine then Nitrogen gas and ammonium chloride.

$$2NH_{3(g)} + 3Cl_{2(g)} \longrightarrow N_{2(g)} + 6HCl_{(g)}$$

$$6(NH_{3(g)} + HCl_{(g)} \longrightarrow NH_4Cl_{(g)})$$

$$8NH_{3(g)} + 3Cl_{2(g)} \longrightarrow N_{2(g)} + 6NH_4Cl_{(g)}$$

2. a) How do you prepared hydrochloric acid in laboratory? Describe with labelled diagram.

➢ In the laboratory, hydrogen chloride gas is prepared by heating sodium chloride with concentrated sulphuric acid.

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl \text{ (On gentle heating)}$$

$$NaHSO_4 + NaCl \longrightarrow Na_2SO_4 + HCl \text{ (On Strong heating)}$$

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Here, sodium chloride is taken a powdered form in a round bottomed flask fitted with a dropping funnel and delivery tube. Conc. H_2SO_4 is poured in sufficient quantity so that salt is covered. At first, HCl and sodium hydrogen sulphate are formed and at red heat normal sodium sulphate and more HCl is formed.

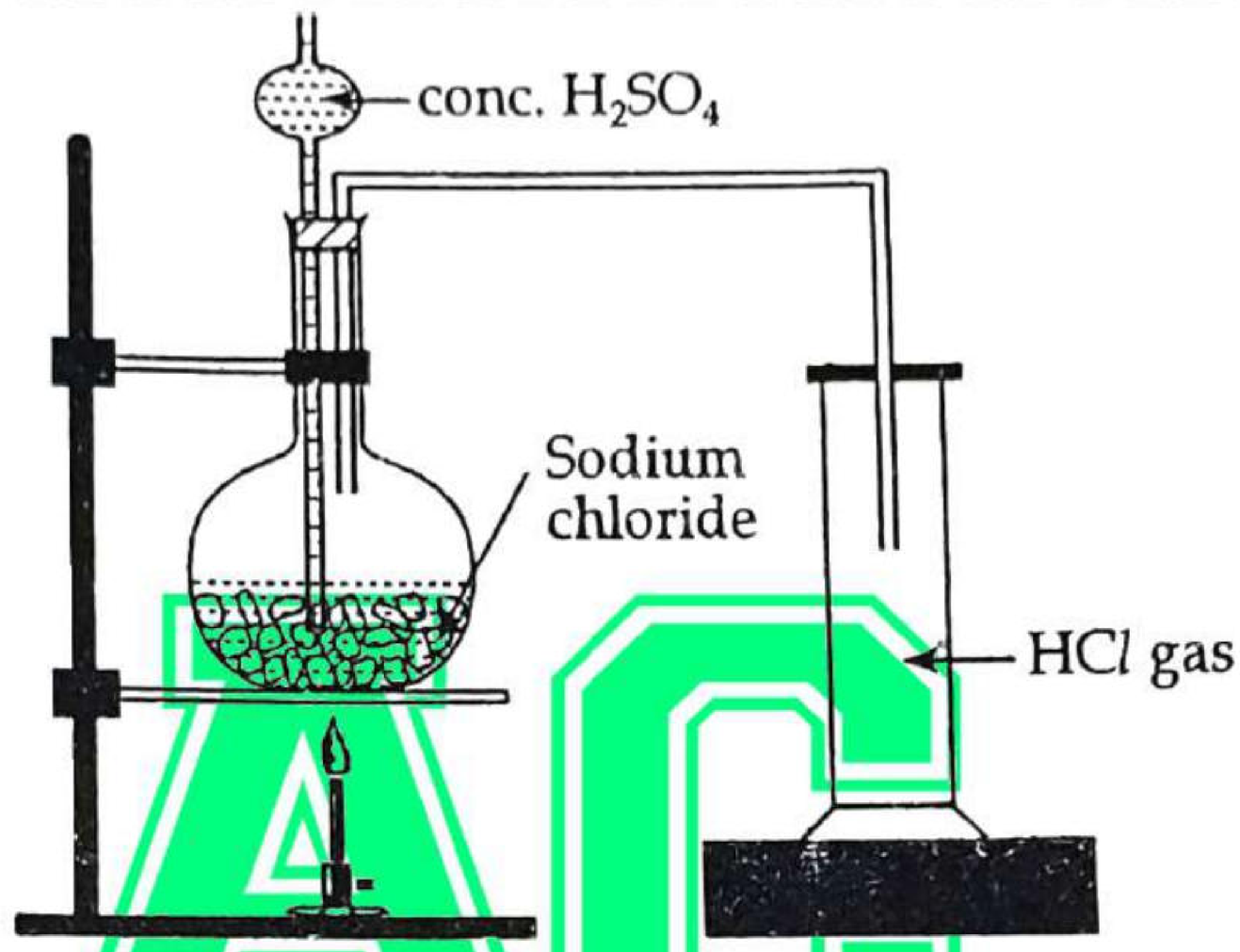

***Fig* :- Laboratory preparation of HCl gas.**

Hydrogen chloride gas is highly soluble in water. So, to prepare HCl solution care must be taken to see that the water is not sucked back into the generating flask. To avoid that, an anti-suction device is made by connecting an inverted funnel to the delivery tube with rubber tubing to the stem of the funnel dipped just under the surface of water in a beaker.

In this way after adjusting all apparatus HCl gas is passed into water which then forms aqueous hydrochloric acid.

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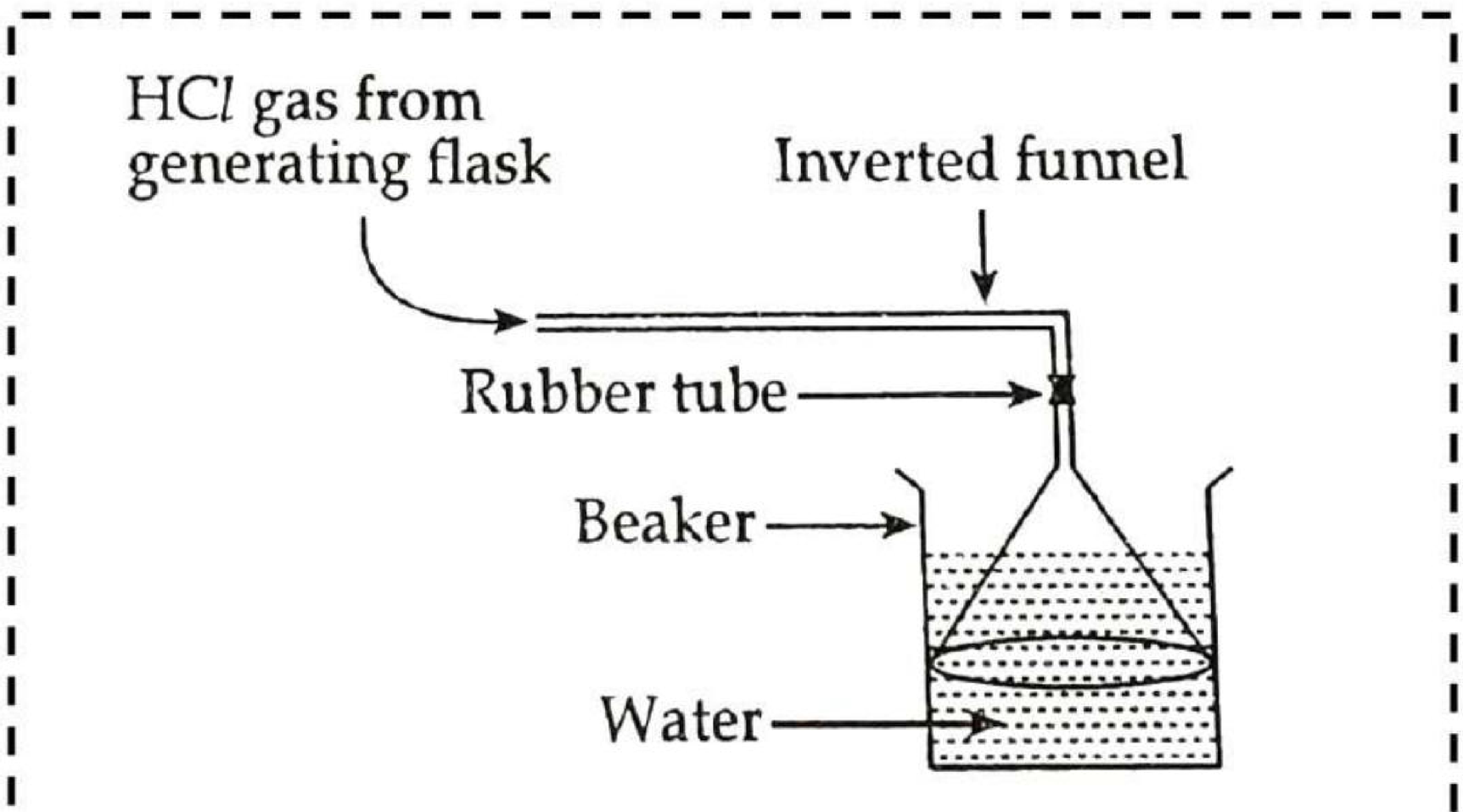

Fig:- **preparation of hydrochloric acid solution.**

b) Describe the manufacture process of nitric acid by Ostwald's process with a neat and labeled diagram.

❖ **Principle**

i) Ammonia is oxidized to nitric oxide in presence of air at 800°C over the catalyst platinum gauze or a rhodium-platinum alloy.

$$4NH_3 + 5O_2 \xrightarrow[\text{Pt/Rh}]{\Delta} 4NO + 6H_2O + \text{Heat}$$

ii) Nitric oxide formed is cooled and allowed to come into contact with air and it gets oxidized to nitrogen dioxide.

$$2NO + O_2 \longrightarrow 2NO_2$$

iii) Nitric acid is obtained when nitrogen dioxide is dissolved in water in presence of air.

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

Working Process

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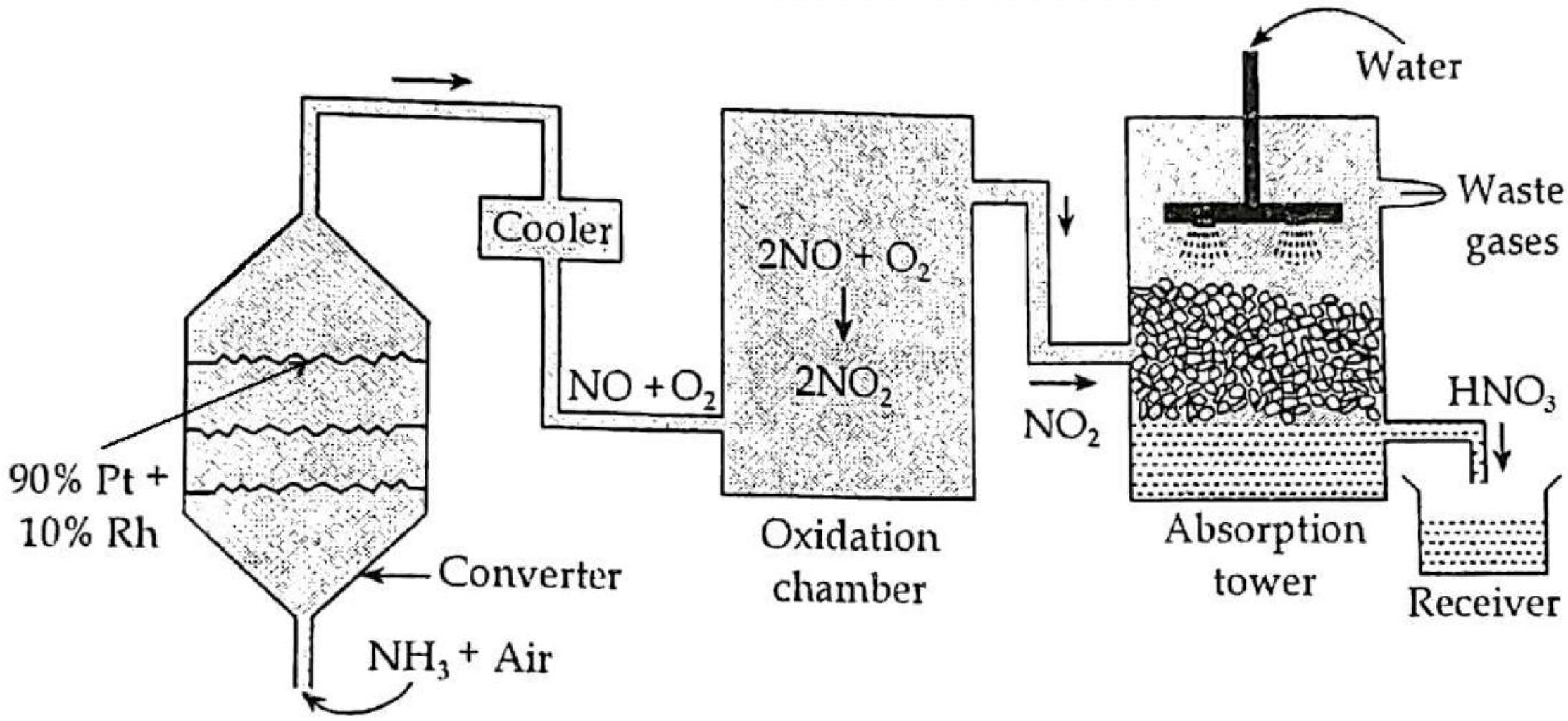

***Figure :-* Ostwald's process for manufacture of nitric acid.**

The mixture of ammonia and air is passed to converter which contains platinum gauge at $800°C$ and here NH_3 is oxidized to nitric oxide. This nitric oxide is passed to oxidation chamber through cooler where it oxidizes to nitrogen dioxide. The nitrogen dioxides from oxidation tower are passed through absorption tower which is packed with acid-proof stone or quartz. The nitrogen dioxide comes into contact with water and air and gets dissolved to form nitric acid which is collected at the foot of the tower in the receiver.

3. a) Define acid rain and discuss its effect. Why farmer focus on synthetic fertilizer over organic fertilizer.

- The Large amount of oxides of nitrogen and sulphur are evolved into the atmosphere from the industries, automobiles, oil refiners etc. which dissolve in rain water to give different acids like H_2SO_4, H_2SO_3, HNO_3 etc are called **acid rain**.

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For Example :- H_2SO_4

$$SO_2 + SO_2 \longrightarrow 2SO_3$$
$$SO_3 + H_2O \longrightarrow H_2SO_4$$

- **The effects of acid rain :-**
  - It increases the soil acidity and reduces crop yield.
  - It leaches various metals like copper, zinc, lead, aluminum, etc.
  - It corrodes buildings, bridges, monuments, etc.
  - Acidic may cause respiratory and skin diseases.
  - It increases the acidity of water in the pond, lakes and seas, etc and it may kill the aquatic animals.

- Farmers often prefer synthetic fertilizers over organic ones because they are cheaper, more efficient in delivering nutrients to crops quickly, easier to handle and apply with modern machinery, Synthetic fertilizers provide immediate results, which is crucial for high-yield farming.

b) Describe the manufacturing process of sulphuric acid by contact process (principle and diagram only).

- The principle involved in contact process for the manufacture of sulphuric acid which is commonly known as king of chemicals are listed below.

  i) At first, sulphur is burnt in air to produce sulphur dioxide. Sulphur dioxide may also be prepared by roasting iron pyrites or sulphide ores.

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$$S_8 + 8O_2 \longrightarrow 8SO_2$$

$$4FeS_2 + 11O_2 \longrightarrow 2Fe_2O_3 + 8SO_2$$

ii) Sulphur dioxide is then catalytically oxidized to sulphur trioxide by the oxygen of air at a temperature of 450°C in the presence of platinum asbestos or divanadium pentaoxide (V_2O_5) as catalyst under a pressure of only 2-3 atmosphere. The reaction is reversible and exothermic in nature.

$$2SO_2 + O_2 \underset{\substack{V_2O_5 \\ 450°C \\ 2\text{-}3\ atm}}{\rightleftharpoons} 2SO_3 + 196\ KJ$$

iii) The sulphur trioxide thus produced is absorbed in conc. H_2SO_4 (about 94%) to form oleum' which is also called Pyrosulphuric acid.

$$SO_3 + H_2SO_4 \longrightarrow H_2S_2O_7$$

iv) Oleum is then diluted with the required amount of water to Get conc. H_2SO_4.

$$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$$

As conc. H_2SO_4 being dehydrating agent it absorbs the water from the paper which cause charring sound.

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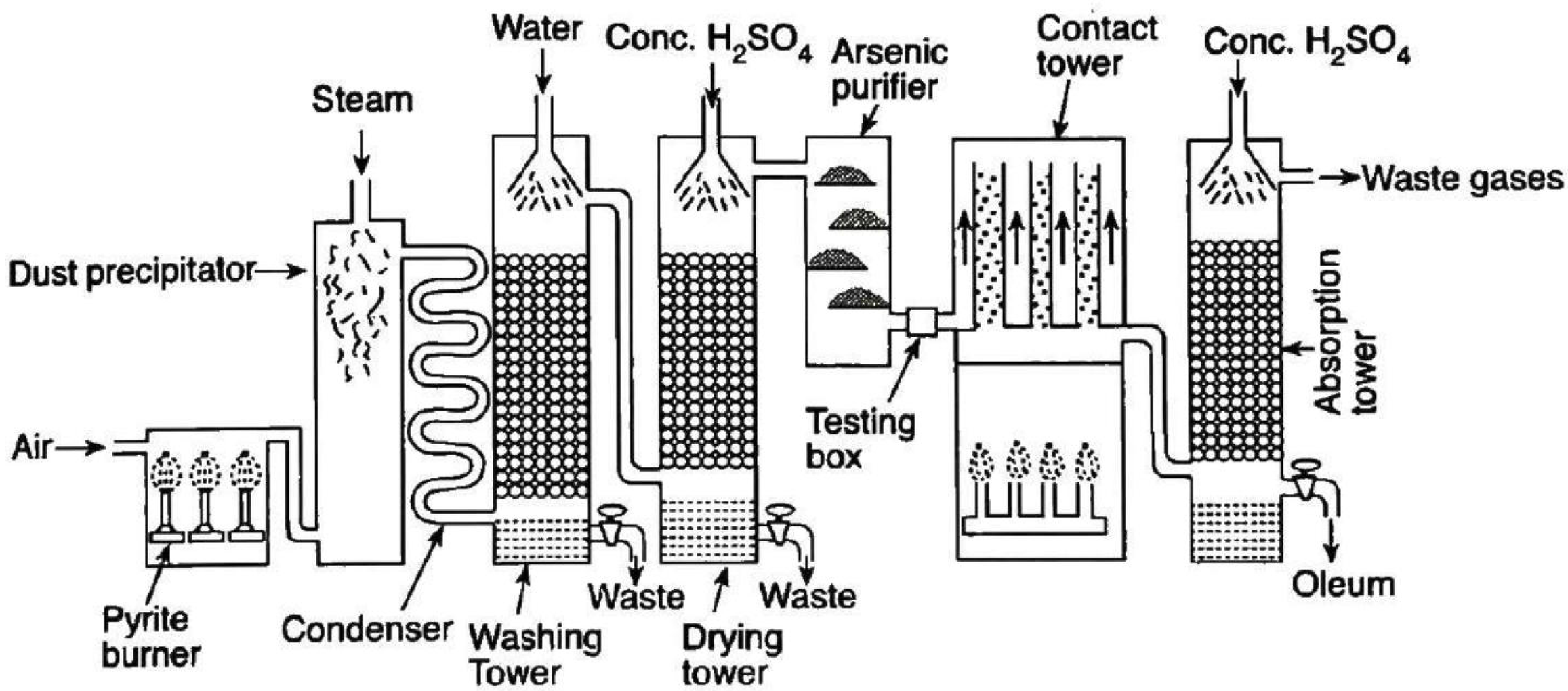

Fig:- **Manufacturing process of sulphuric acid by contact process**

4. a) What do you mean by amalgam? Why alloys a Prepared, and also explain the types of alloys.

- A homogeneous mixture of metals with mercury is called an ***amalgam.*** It is also defined as an alloy containing mercury as one of the constituents. *For example*:- sodium amalgam, zinc amalgam, etc.

- An alloy possesses metallic properties and is *prepared* to get a product possessing desirable properties which the constituent elements do not possess.

It is prepared to improve special properties :-

- *To increase hardness:-* Alloys are usually harder than their components.
- *To improve the colour:-* Aluminium bronze, an alloy of copper with aluminium has a beautiful golden yellow colour.

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- *To increase the strength:-* The strength of iron can be increased by alloying it with nickel. The alloy obtained is known as nickel steel.
- *To resist the corrosion:-* Alloys are generally non- corrosive and thereby increase their life and efficiency. For example, stainless steel.

➢ **Types of alloys :-**

- **Ferrous alloys:** An alloy in which one of the constituent elements is iron, is called ferrous alloy. The examples of ferrous alloys are steel $(Fe + C)$, manganese steel $(Fe + Mn)$, etc.
- **Non-ferrous alloys:** An alloy which does not contain iron as one of the constituents is called non-ferrous alloy. The example of non-ferrous alloys are brass $(Cu + Zn)$, bronze $(Cu + Sn)$, etc

b) What do you mean by alkali metals? Explain properties of sodium.

➢ The series of six chemical elements (lithium, sodium, potassium, rubidium, caesium and francium) in group I of the periodic table are called ***alkali metals.***

They are called alkali metals because they produce OH^- (hydroxide ions) when dissolved in water.

➢ **The properties of sodium are listed below :-**

- Sodium is a silvery white soft solid and can be cut with a knife.
- It is less dense than water.
- The density of sodium is 0.97 g/cm³.
- It is good conductor of heat and electricity.

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- Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \longrightarrow 2Na_2O + Si$$

- Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

- Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \longrightarrow 2NaCI$$

5. a) What do you mean by homologous series? Explain it's characteristics.

➢ A series obtained by placing the member of organic compound of same functional group from lower to higher is called ***homologous series*** and this phenomenon is known as homology.

$E.g:-$

$CH_3 - OH$	:	Methanol
$CH_3 - CH_2 - OH$	:	Ethanol
$CH_3 - CH_2 - CH_2 - OH$	:	Propanol

➢ **The Characteristics of homologous series are listed below :-**

- All the members of homologous series contain the same functional group.
- The subsequent member of homologous series is differentiated by $-CH_2$ unit or 14 a.m.u. mass.
- Melting and boiling point in homologous series increases gradually from lower to higher member.

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- The member of homologous series has almost similar chemical properties.
- The first member of homologous series is somewhat different from other member in chemical properties.
- The member of homologous series can be represented by the simple general formula. *For example;-*

  $C_nH_{2n+1}O$ for alcohol

  C_nH_{2n+2} for alkane

  C_nH_{2n} for alkene

b) What do you mean by saturated hydrocarbon? Explain the properties of methane.

➢ The hydrocarbons which have general formula C_nH_{2n+2} and have only one covalent sigma bond between carbon atoms called ***saturated hydrocarbons.***

For example: – ethane (CH_3CH_3), propane (C_3H_8). All alkanes are saturated hydrocarbons.

➢ **The properties of methane are listed below :-**

- ***Nitration:-*** This involves the replacement of a hydrogen atom of an alkane with $-NO_2$ group. At room temperatures, alkanes do not react with nitric acid.

  The nitration of methane can be carried out in vapour phase by heating to very high temperature $(450 - 500°C)$.

$$CH_4 + HNO_3 \xrightarrow{450\text{-}500°C} \underset{\text{Nitromethane}}{CH_3NO_2} + H_2O$$

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- ***Combustion of Methane :-*** Methane burns in air or oxygen to produce carbon dioxide and water vapour with liberation of heat energy.

$$CH_4 + 2O_2 \xrightarrow{\Delta} CO_2 + 2H_2O + \text{Energy}$$

- ***Pyrolysis :-*** The decomposition of compound by the action of heat in the absence of air is called pyrolysis. The pyrolysis of alkanes is known as cracking. For example,

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CHCH_3 + H_2$$

$$CH_3CH_2CH_3 \xrightarrow{500°C} CH_2 = CH_2 + CH_4$$

Under pyrolysis, alkanes change into alkene (i.e., from single bond to double bond).

- ***Action of CH_4 with Steam :-*** When a mixture of methane gas and steam is passed over heated nickel at about 800°C, a mixture of carbon monoxide and hydrogen (water gas) is obtained.

$$CH_4 + H_2O \xrightarrow[Ni]{800°C} CO + 3H_2$$

6. a) Write short notes on: (Any Two)

i) Functional group

- Functional group is an atom or radical which determines the characteristics of homologous series as well as that of homologues. Each class of the compound possess a similar properties which is because of the presence of particular group of atoms like $-COOH$, $-CHO$, etc.

For E. g.:- all the aldehydes have $-CHO$ as functional group.

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ii) Polythene

- It is an addition polymer of ethylene monomers. It is obtained by two varieties viz. low density polythene (LPD) and High density polythene (HPD).

  Low density polythene can be produced by heating at about $250°C$ and applying 1500 atmospheric pressure in the presence of trace amount of oxygen.

$$nCH_2 = CH_2 \xrightarrow[250°C]{1500\ atm} (-CH_2 - CH_2 -)_n$$

  High density polythene is produced at relatively lower temperature $(50 - 75°C)$ and lower atmospheric pressure $(6.7\ atm.)$ in the presence of triethyl aluminium $[Al(C_2H_5)_3]$ and titanium tetrachloride $[Ti(Cl)_4]$ as the catalyst.

iii) Synthetic rubber

- It is artificial rubber. It is artificial elastomer (a polymer) is called synthetic rubber. An elastomer can be defined as a material having the property of elasticity. There are various types of polymers used for making synthetic rubber types. Due to this, different types of synthetic rubber have different properties that are tailored for specific needs of rubber products industries.

  Synthetic rubber is *used* in tires, clutches, engine bearings, conveyor belts, industrial goods, and seals for drinking water.

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b) What happen when: (Any Two)

i) Steam is passed over red hot iron.

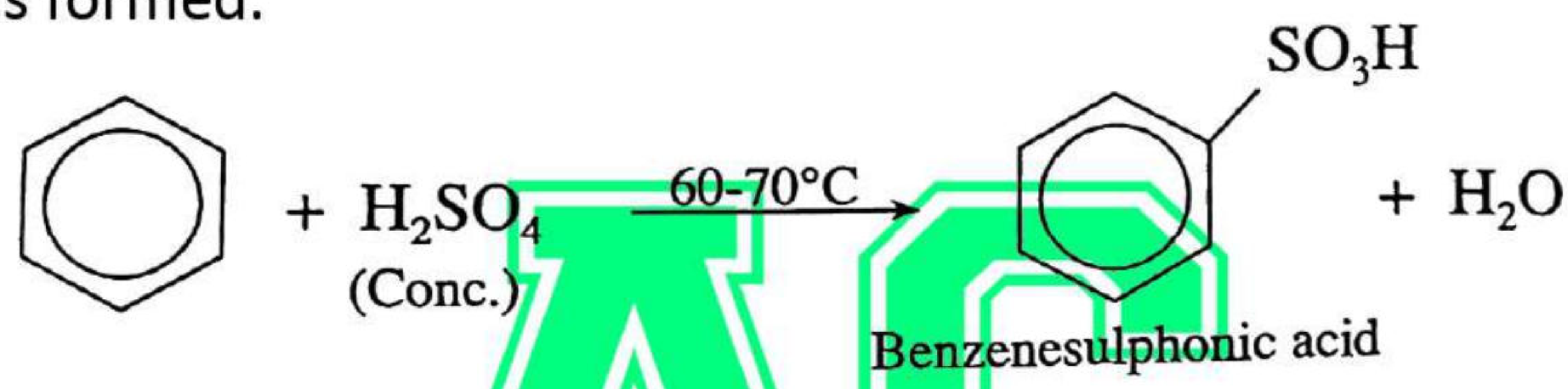
- When steam is passed over red hot iron then water is decomposed to given hydrogen gas as:

$$3Fe + 4H_2O \longrightarrow F_3O_4 + 4H_2 \uparrow$$

Steam — Ferrosoferric oxide

ii) Benzene reach with conc H_2SO_4

- When benzene is heated with concentrated H_2SO_4, benzenesulphonic acid is formed.



iii) Zinc reacts with dilute H_2SO_4

- When dilute sulfuric acid is poured on zinc granules, the acid is displaced by zinc, which is more reactive than hydrogen, resulting in zinc sulfate and hydrogen gas.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2 \uparrow$$

Zinc — Dill. Sulphuric acid — zinc Sulphurie

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(2080 *New Course*) Question Paper Solution.

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1) What is the cause of hardness in water? Describe permutit method for the removed of permanent hardness in detail.

- The hardness in water is caused by the presence of the soluble bicarbonates, sulphates and chlorides of calcium and magnesium, such as $Mg(HCO_3)_2, CaSO_4, MgSO_4, CaCl_2, MgCl_2$.

Permutit Method

- Permutit is a complex compound known as hydrated sodium aluminium silicate, $Na_2Al_2Si_2O_8 \times H_2O$. Sodium ion of this compound is exchanged by Ca^{++} and Mg^{++} ions of hard water and cause the precipitation of calcium and magnesium aluminium silicates in the form of zeolite. Soluble $NaCl$ and Na_2SO_4 are separated by distillation process.

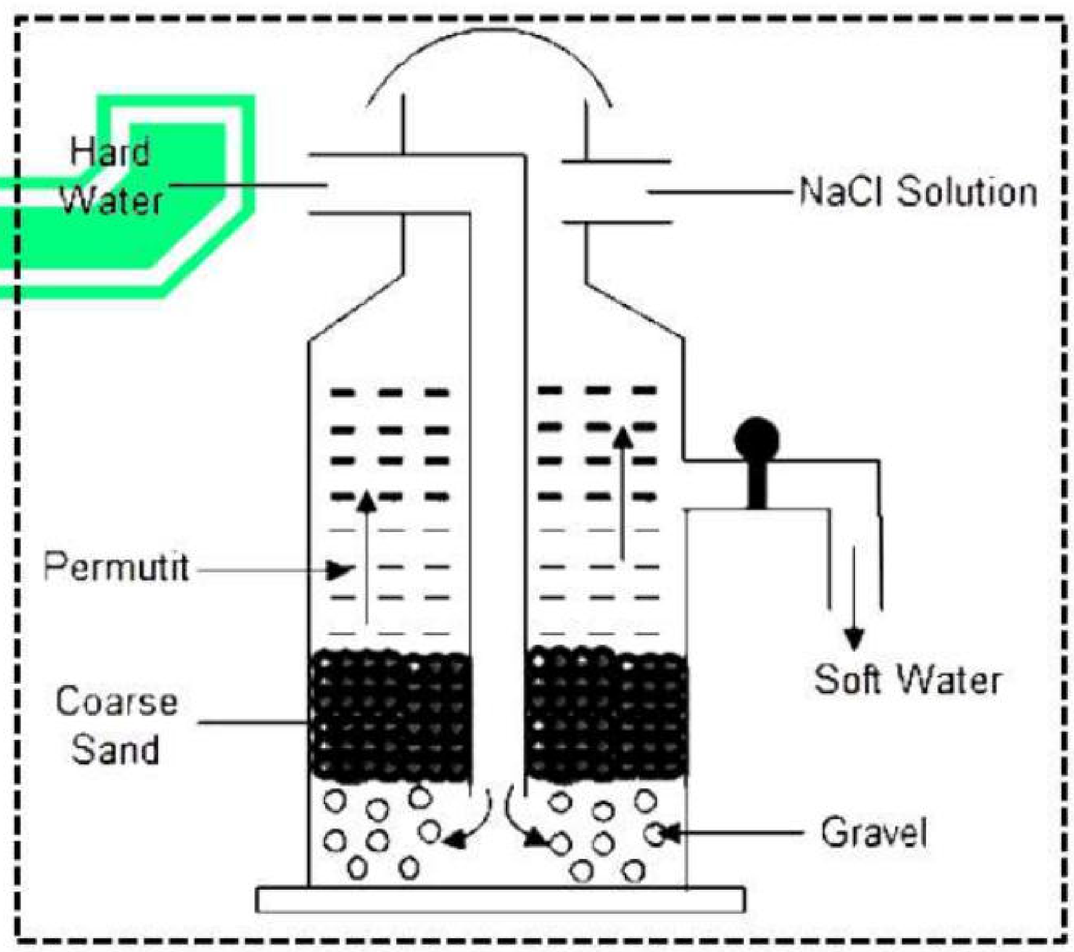

Fig:- **Permutit Process.**

$$CaCl_2 + Na_2Z \longrightarrow CaZ\downarrow + 2NaCl$$
$$MgSO_4 + Na_2Z \longrightarrow MgZ\downarrow + Na_2SO_4$$

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where, $Z = Al_2Si_2O_8 \times H_2O$.

After sometime, the whole of the $Na_2Al_2Si_2O_8$ gets changed into calcium and magnesium zeolites and the sodium ions are regenerated by adding 10% $NaCl$ solution to continue the reaction.

$$CaZ + 2NaCl \longrightarrow Na_2Z + CaCl_2$$
$$MgZ + 2NaCl \longrightarrow Na_2Z + MgCl_2$$

2) How can you prepare ammonia by Haber's process explain with diagram?

- See the solution of 2080 (Old) of Q.no 1 (b) on page.no. 68

3) Explain the principle of manufacture of nitric acid by Ostwald's process with labelled diagram.

- See the solution of 2080 (Old) of Q.no 2 (b) on page.no. 71

4) How does oxides of nitrogen $(NO \,\&\, NO_2)$ can act as pollutant's? Explain nitrogen cycle in brief.

- When NO & NO_2 are exposed into atmosphere, they are harmful to plants and animals. NO_2 gets dissolved into water to give nitric acid Which is a main cause of acid rain.

$$2NO + O_2 \longrightarrow 2NO_2$$
$$2H_2O + 4NO_2 + O_2 \longrightarrow 4HNO_3$$

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- The series of complex reactions by which nitrogen is slowly but continually recycled in the atmosphere is called ***nitrogen cycle***. Atmosphere is the reservoir of free nitrogen. The conversion of atmospheric nitrogen into useful nitrogenous compounds is known as fixation of nitrogen which occurs by:-

a) Lightening discharge

When the nitrogen and oxygen molecules collide in the atmosphere in the presence of lightning bolt, molecule NO is formed which reacts. with O_2 and water to form HNO_3.

$$N_2 + O_2 \longrightarrow 2NO + \text{heat}$$

$$2NO + O_2 \longrightarrow 2NO_2$$

$$4NO_2 + 2H_2O + O_2 \longrightarrow 4HNO_3$$

HNO_3 or HNO_2 dissolves in rain water and come down to the earth's surface where reacts with the soil component to form nitrates. The nitrates are assimilated by plants to form proteins.

b) By symbiotic bacteria

The class of plants called legumes has nodules in their root within which there live some bacteria that absorb nitrogen molecules directly from the air and convert them into NH_3.

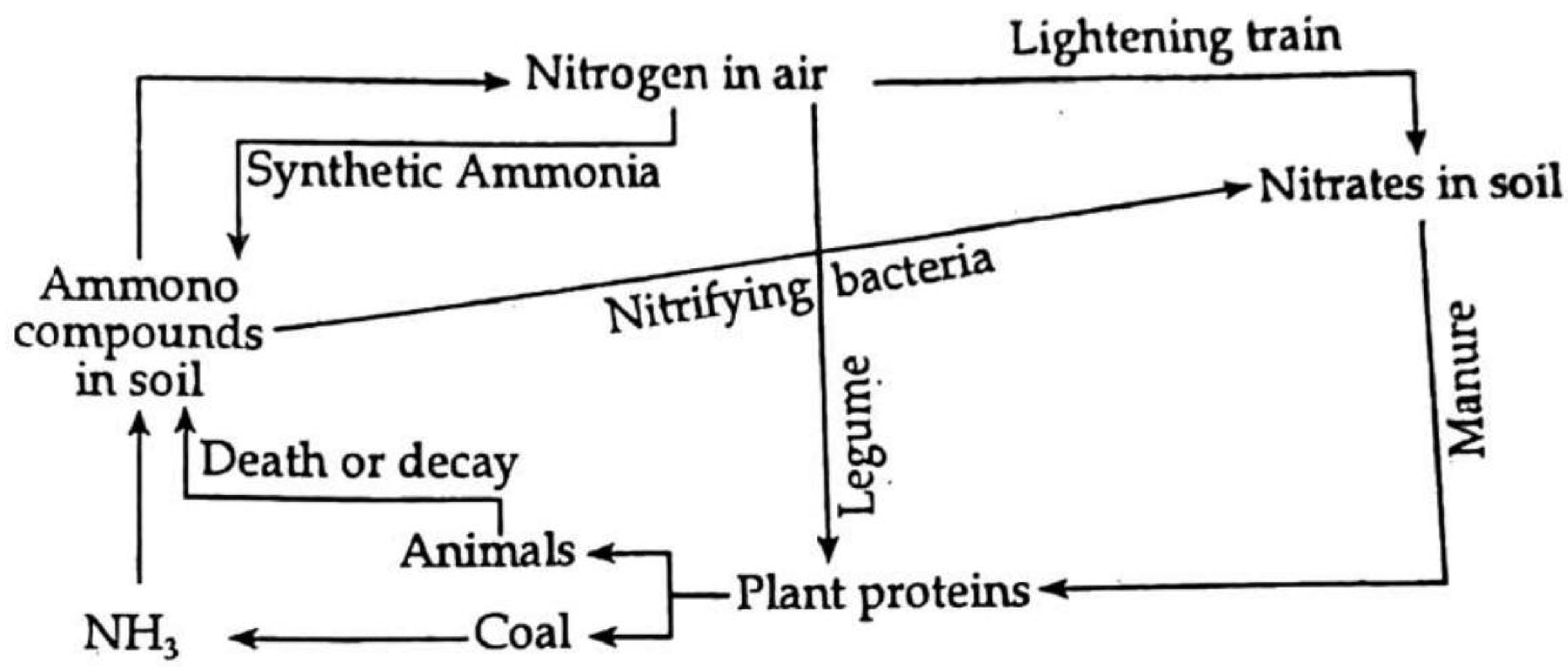

Figure: Flow chart of Nitrogen cycle.

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5) Write short notes on: (Any Two)

a) Hydrogen sulphide as analytical reagent.

- Salt analysis involves qualitative as well as quantitative salt analysis. Qualitative involves the detection of acidic and basic radicals. In the detection of basic radicals by wet ways, H_2S plays a key role. So it acts as an analytical reagent in wet test of basic radicals of group II and group IIIB.

i) H_2S as an analytical reagent for the detection of group II basic radicals: Group II basic radicals are precipitated in the form of sulphide in an acidic medium.

$$CuSO_4 + H_2S \longrightarrow \underset{\text{(Black)}}{CuS\downarrow} + H_2SO_4$$

ii) H_2S as an analytical reagent for the detection of group IIIB basic radicals: Group IIIB basic radicals are precipitated in the form of sulphide in an alkaline medium.

$$ZnCl_2 + H_2S \longrightarrow \underset{\text{(White)}}{ZnS\downarrow} + 2HCl$$

$$MnCl_2 + H_2S \longrightarrow \underset{\text{(Flesh Coloured)}}{MnS\downarrow} + 2HCl$$

$$CoCl_2 + H_2 \longrightarrow \underset{\text{(Black)}}{CoS\downarrow} + 2HCl$$

$$NiCl_2 + H_2S \longrightarrow \underset{\text{(Black)}}{NiS\downarrow} + 2HCl$$

b) Aqua-regia

- A mixture containing one part of conc. HNO_3 and three part of conc. HCI is Called **aqua-regia (Kingly Water).** It is able to dissolve noble metal like gold, Platinum, etc because nascent chlorine is generated.

$$HNO_3 + 3HCl \longrightarrow NOCl + 2H_2O + 2[Cl]$$

$$Au + 3[Cl] \longrightarrow AuCl_3$$

$$Pt + 4[Cl] \longrightarrow PtCl_4$$

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c) Lab preparation of HCl

- In the laboratory, hydrogen chloride gas is prepared by heating sodium chloride with concentrated sulphuric acid.

$$NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl \text{ (On gentle heating)}$$
$$NaHSO_4 + NaCl \longrightarrow Na_2SO_4 + HCl \text{ (On Strong heating)}$$

Here, sodium chloride is taken a powdered form in a round bottomed flask fitted with a dropping funnel and delivery tube. Conc. H_2SO_4 is poured in sufficient quantity so that salt is covered.

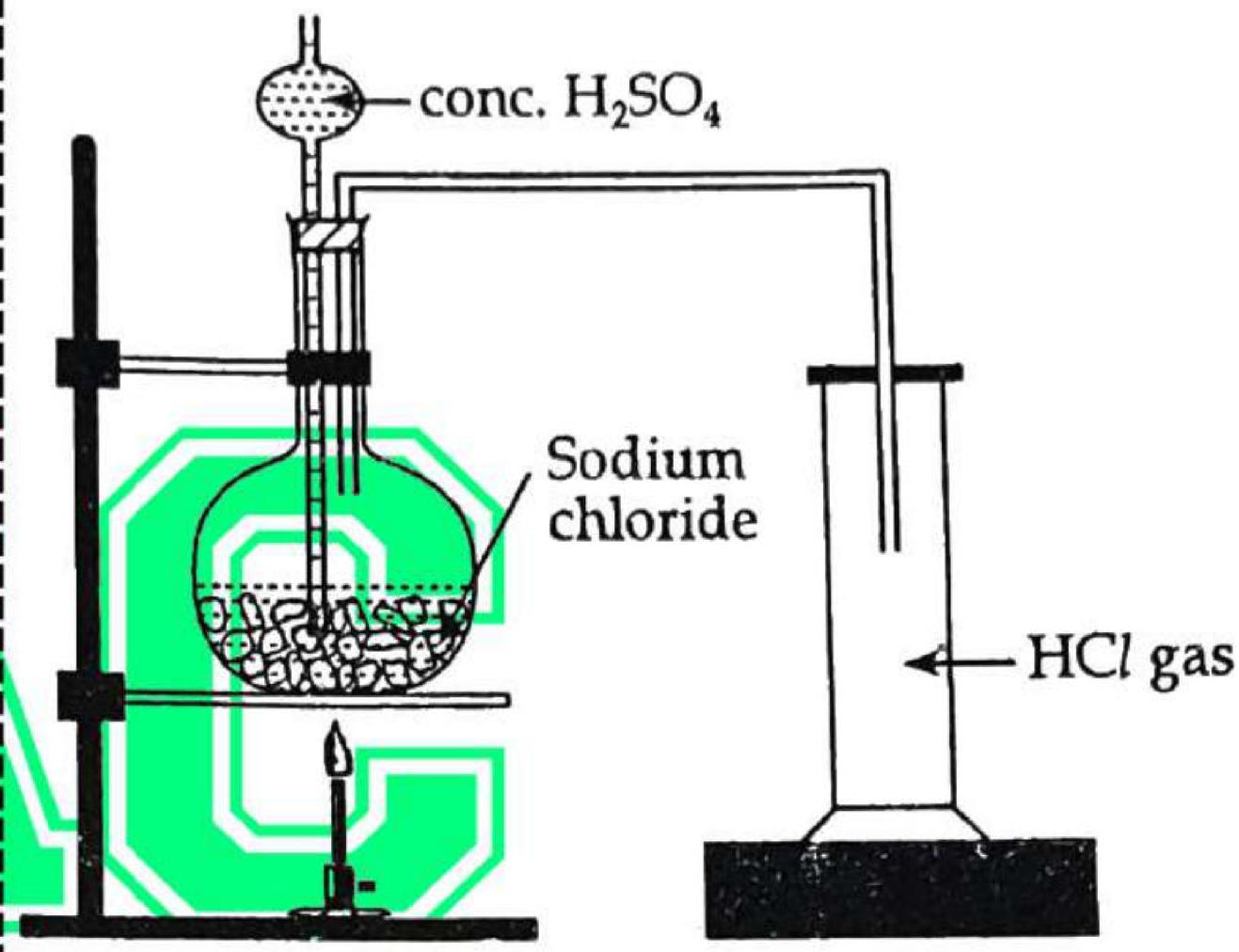

***Fig :-* Laboratory preparation of HCl gas.**

At first, HCl and sodium hydrogen sulphate are formed and at red heat normal sodium sulphate and more HCl is formed.

6) How can you prepare chlorine with application of heat in the laboratory? Explain.

- Chlorine is prepared in the laboratory by chemical oxidation of the respective halide or hydrogen chloride acid by using strong oxidizing agents like MnO_2.

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$$MnO_2 + 2HCl \longrightarrow MnCl_2 + H_2O + [O]$$
$$2HCl + O \longrightarrow Cl_2 + H_2O$$

$$\underset{(s)}{MnO_2} + \underset{(aq)}{4HCl} \longrightarrow \underset{(aq)}{MnCl_2} + \underset{(l)}{2H_2O} + \underset{(g)}{Cl_2}$$

During the preparation a round bottom flask containing MnO_2 is fitted with a thistle funnel and a delivery tube which is further connected with a gas jar. Now the conc. HCl is poured into the round bottom flask and then it is heated due to which Cl_2 gas is formed. This formed Cl_2 is collected in a gas jar by upward displacement of air.

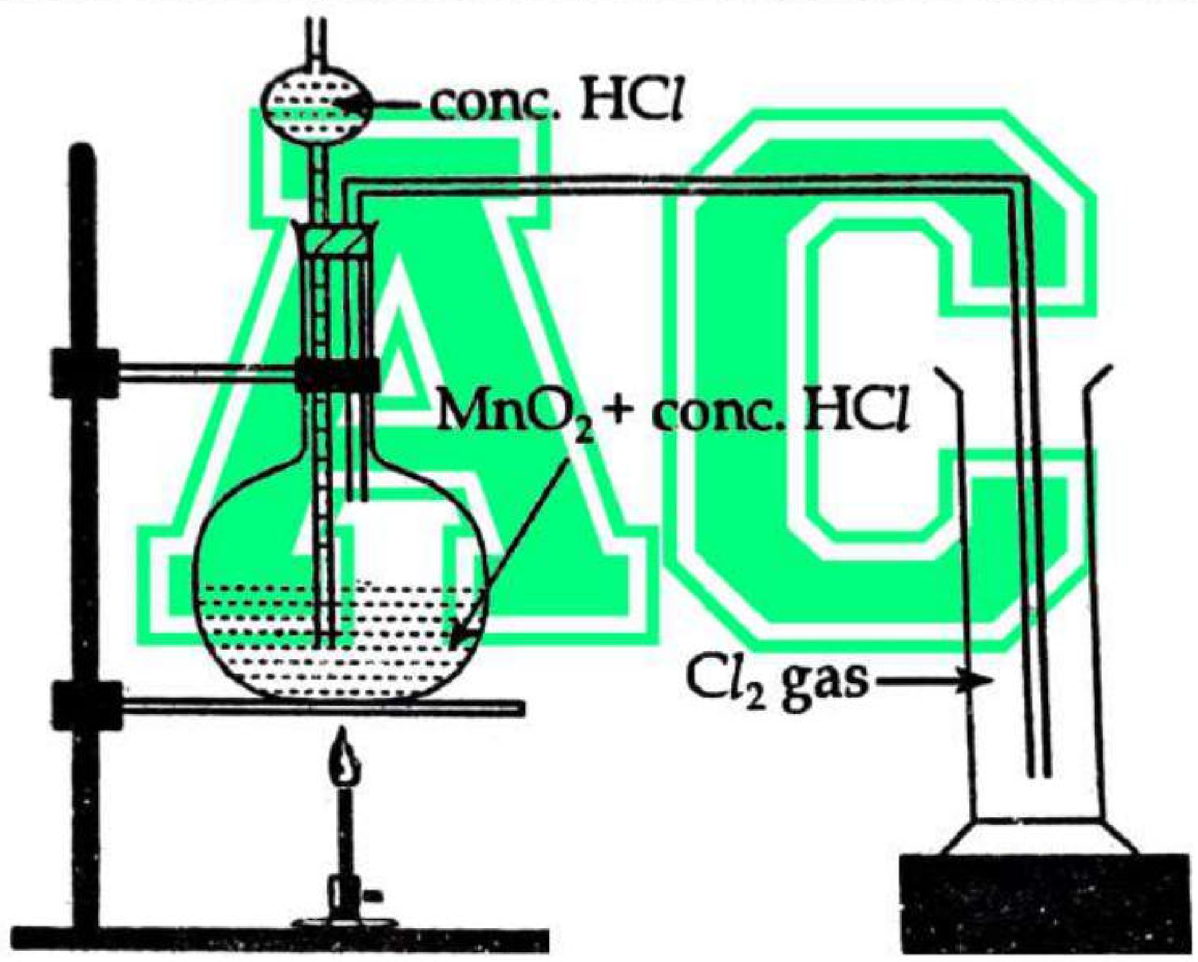

Figure: Laboratory preparation of Chlorine gas.

7) Define allotropy. Illustrate the structure of diamond and graphite in brief.

- The two or more forms of the same element having same chemical properties but different physical properties are called allotropes and phenomenon is known as ***allotropy***.

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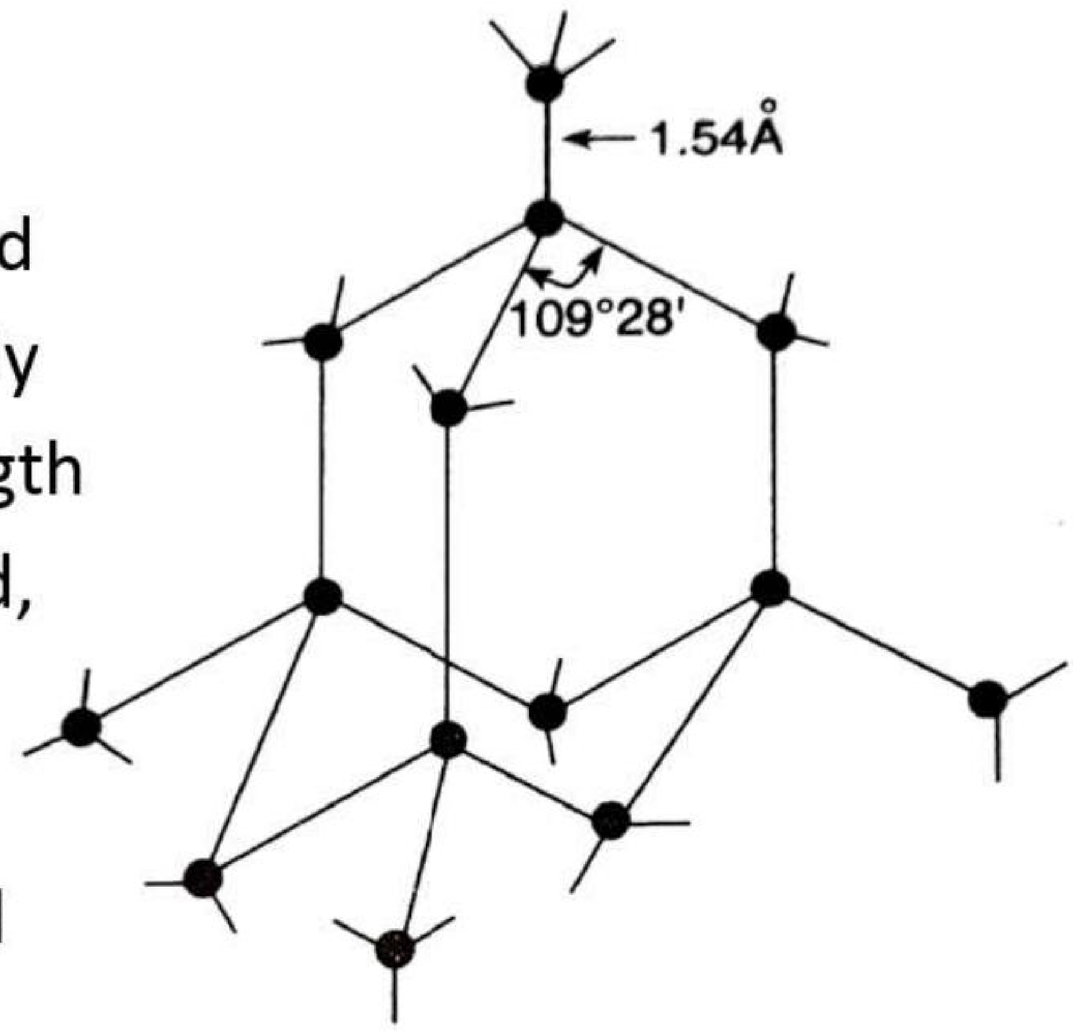
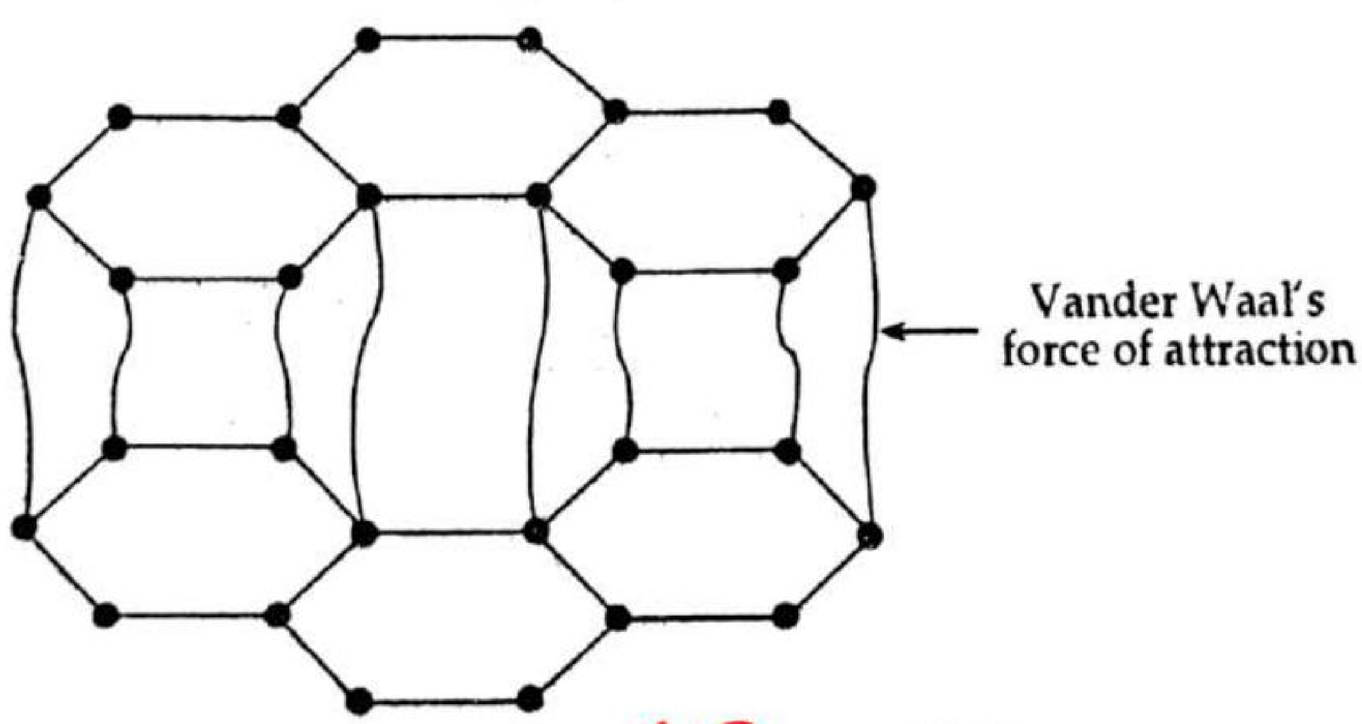
❖ Structure of Diamond



- It is a crystalline allotropes of carbon in which each carbon atom is combined with other four carbon atoms tetrahedrally having an angle of 109°, 28' and bond length of 1.54 Å. As there is strong covalent bond, it is considered as hardiest substance. It is considered to be the purest form of carbon and is believed to be formed when very high pressure develops on coal beds in the earth. As there are no electrons, it is bad- conductor of heat and electricity.

❖ Structure of Graphics

- In graphite each carbon atom is bonded with other three carbon atoms by a covalent bond forming an angle of 120° having bond length 1.42 Å. The slippery and soft nature of graphite is due to the presence of weak Vander Waal's force of attraction which is acting between the different layers of carbon hexagonally. As there is a presence of one electron free from each carbon atom and which are free to move. The structure of graphite is shown below:-



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8) Explain the principle of contact process in detail with well labelled flow chart diagram.

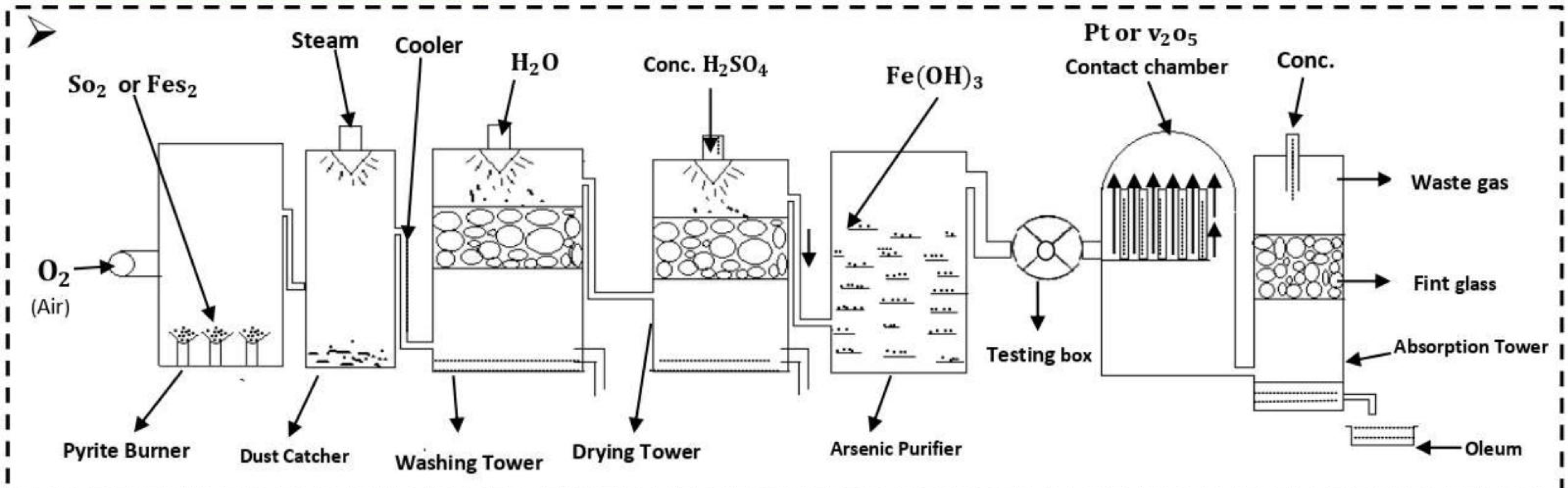

Fig :- Flow Chart diagram of Manufacture of sulphuric acid by contact process.

Principle :-

1. **By the Heating of Iron pyrite or sulphur:-** When iron pyrite or sulphur is heated o_2 then, so_2 gas is obtained.

$$4Fes_2 + 11o_2 \longrightarrow 2Fe_2o_3 + 8so_2$$

$$\text{or, } s + o_2 \longrightarrow so_2$$

2. **Catalytic oxidation of so_2 to so_3:-** When pure so_2 gas is treated with o_2 in the presence of Pt or v_2o_5 at 450°C then, sulphur trioxide is obtained.

$$2So_2 + o_2 \underset{450°C}{\rightleftharpoons} 2so_3 + \text{Heat energy}$$

3. **Absorption of so3 in H_2SO_4 :-** When So_3 is passed into Conc.H_2SO_4 containg tower then oleum is obtained.

$$So_3 + H_2SO_4 \longrightarrow H_2S_2O_7 \text{ (pyrosulphuric acid)(oleum)}$$

4. **Dillution of oleum :-** It is diluted by adding calculated amount of water to oleum to obtain conc. H_2SO_4.

$$H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4 \text{ (Sulphuric acid)}$$

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➢ The different components during contact process are:-

- **Pyrite or sulphur burner:** For the production of SO_2 by burning of sulphur or iron pyrites.
- **Dust catcher**: For removal of dust parties by Downward blow of stream.
- **Cooling pipes:** For cooling the gases by passage through isolated pipes.
- **Washing tower:** For further removal of impurities and Dust parties by the Downward spray of water.
- **Drying tower:** For drying moist gases by downward spray of conc.H_2SO_4.
- **Arsenic purifier:** for removing arsenic oxide by passage over ferric hydroxide. In order to remove traces of As_2O_3.

$$As_2O_3 + 2Fe(OH)_3 \longrightarrow 2FeAsO_3 + 3H_2O$$

- **Testing Box:**- In this box a strong beam of light is thrown against the gas. If there is no scattering of light in the box, it indicates that gas is free from As_2O_3 .
- **Contact tower:** For catalytic Oxidation of So_2 to So_3 by passage of So_2 & o_2 through iron packed vanadium pentoxide catalyst initially heated to 450°C
- **Absorption Tower:** For absorption of So_3 vapours by spray downward of conc. H_2SO_4 (98%).
- **Dilution tank:** For dilution of oleum by flow of required amount of water.

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9) Differentiate between metals and non-metals in six points with exceptional cases.

➢

Properties	Metals	Non-metals
State	Metals are solids at ordinary temperature except mercury, which is a liquid.	Non-metals exist in all the three states, that is, solid, liquid and gas.
Lustre	They possess lustre or shine.	They possess no luster except iodine and graphite.
Malleability and Ductility	Metals are generally malleable and ductile.	Non-metals are neither malleable nor ductile.
Hardness	Metals are generally hard. Alkali metals are exception.	Non-metals possess varying hardness. Diamond is an exception. It is the hardest substance known to occur in nature.
Density	They have high densities.	They generally possess low densities.
Conductivity	Metals are good conductors of heat and electricity.	Non-metals are poor conductors of heat are electricity. The only exception is graphite which is a good conductor of electricity.
Melting and boiling point	They usually have high melting and boiling point.	Their melting and boiling point are usually low. The exceptions are boron, carbon and silicon.

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10) What do you mean by alkali metals? Describe the properties of sodium.

- The series of six chemical elements (lithium, sodium, potassium, rubidium, caesium and francium) in group I of the periodic table are called ***alkali metals.***
  They are called alkali metals because they produce OH^- (hydroxide ions) when dissolved in water.

- **The properties of sodium are listed below :-**

  - Sodium is a silvery white soft solid and can be cut with a knife.
  - It is less dense than water.
  - The density of sodium is 0.97 g/cm³.
  - It is good conductor of heat and electricity.
  - Sodium acts as a powerful reducing agent. It reduces silicon dioxide to silicon.

$$4Na + SiO_2 \rightarrow 2Na_2O + Si$$

  - Sodium violently reacts with water giving sodium hydroxide and hydrogen.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

  - Sodium combines with halogen to form sodium halides, which are ionic crystalline solids.

$$2Na + CI_2 \rightarrow 2NaCI$$

11) Describe the chemical properties of calcium.

- **The chemical properties of calcium are :-**

  - Calcium reacts with water evolving hydrogen gas.

$$Ca + 2H_2O \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2} + H_2$$

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- Calcium is slowly attacked by air. On heating it burns to form calcium oxide and calcium nitride.

$$2Ca + O_2 \longrightarrow 2CaO$$
$$3Ca + N_2 \longrightarrow Ca_3N_2$$

- It reacts with dilute mineral acids liberating hydrogen gas.

$$Ca + 2HCl \longrightarrow CaCl_2 + H_2$$

- It reacts with hydrogen to give calcium hydride.

$$Ca + H_2 \longrightarrow CaH_2$$

- It reacts with halogens to give calcium halide.

$$Ca + Cl_2 \longrightarrow CaCl_2$$

12) What are coinage metals? Discuss about chemical properties of copper metal.

➢ Coinage metals are copper ($_{29}Cu$), silver ($_{47}Ag$) and gold ($_{79}Au$) from group IB (11) of the periodic table. These metals are called coinage metals because of their use in making coins.

➢ **The chemical properties of copper metal are :-**

- ***Action of chlorine:-*** Chlorine attacks copper forming cupric chloride.

$$Cu + Cl_2 \longrightarrow CuCl_2$$

- ***Displacement reaction:-*** Copper displaces less electropositive metals like Ag, Pt, Au from their water soluble salts.

$$Cu + 2AgNO_3 \longrightarrow 2Ag\downarrow + Cu(NO_3)_2$$

- ***Action of water:-*** Water at ordinary temperature has no action on copper but at high temperatures reaction takes place.

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$$Cu + \underset{\text{(Steam)}}{H_2O} \longrightarrow CuO + H_2$$

- ***Action with Con. H_2SO_4*** :- When heated with concentrated sulphuric acid it produces sulphur dioxide.

$$Cu + 2H_2SO_4 \xrightarrow{\Delta} CuSO_4 + 2H_2O + SO_2$$

13) What are functional groups and homologous series?

➢ *Functional group* is an atom or radical which determines the characteristics of homologous series as well as that of homologues. Each class of the compound possess a similar properties which is because of the presence of particular group of atoms like $-COOH$, $-CHO$, etc.

For E. g.:- All the aldehydes have $-CHO$ as functional group.

➢ A series obtained by placing the member of organic compound of same functional group from lower to higher is called ***homologous series***.

****Give the IUPAC name for following compound.**

i) $CH_3 - \underset{|}{\overset{C_2H_5}{CH}} - COOH$

➢ **IUPAC ⇒ 2-Methylbutanoic acid**

ii) $CH_3 - O - CH_2 - CH_3$

➢ **IUPAC ⇒ Methoxyethane**

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14) Describe Markonikov's rule and peroxide effect. Also suggest a chemical reaction to differentiate, wheather the given compound is ethane or ethene.

- The rule in which hydrogen atom goes to that unsymmetrical carbon atom of an alkene which already contains higher number of hydrogen atom is called as *Markovnikov's rule*.

  $for\ E.g$:- $\mathrm{HC}l$ is treated with propene then, H-atom of $\mathrm{HC}l$ goes to the carbon atom of propene which contains larger number of hydrogen atom which can be shown as:

$$\underset{\text{Propane (substrate)}}{\mathrm{CH_3-CH=CH_2}} + \mathrm{HC}l \xrightarrow[\text{rule}]{\text{Markovnikov's}} \underset{\text{2-chloro propane}}{\mathrm{CH_3-CH(Cl)-CH_3}}$$

AC

- It states that, "The addition of unsymmetrical reagent such as HBr to unsymmetrical alkene (or alkyne) in presence of organic peroxide occurs in such a way that the positive part of the reagent goes to add with the multiply bounded carbon atom which contains lesser number of hydrogen atoms."

  $For\ example:-$

$$\mathrm{CH_3-CH=CH_2} + \mathrm{HBr} \xrightarrow{\text{Peroxide}} \underset{\text{1-Broma Propane}}{\mathrm{CH_3-CH_2-CH_2-Br}}$$

This reaction follows free radical mechanism. The peroxide effect is observed for HBr reagent only.

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- Add a few drops of alkaline potassium permanganate $KMnO_4$ solution to the given hydrocarbons. The hydrocarbon in which no change in colour is observed is ethane and the hydrocarbon which purple colour of $KMnO_4$ fades is ethene.
  - **Alkaline potassium permanganate oxidation:** This reaction takes place in cold and glycol is obtained. Alkaline potassium permanganate is called **Baeyer's reagent** and its colour is discharged. Therefore, this reaction has been used to detect carbon- carbon double bond (or unsaturation) in a molecule.

$$\underset{\text{Ethylene}}{CH_2 = CH_2} + H_2O + O \xrightarrow[KMnO_4]{OH^-} \underset{\text{Ethylene glycol}}{\begin{array}{c} CH_2 - CH_2 \\ | \qquad\quad | \\ OH \qquad OH \end{array}}$$

AC

15) What do you mean by polymer? Explain the properties of benzene.

- A polymer is a large molecule of which is formed by repeated linking of the small molecules called "monomers".

$$\underset{\text{ethylene}}{n(CH_2 - CH_2)} \longrightarrow \underset{\text{polyethylene}}{(-CH_2 - CH_2 -)_n}$$

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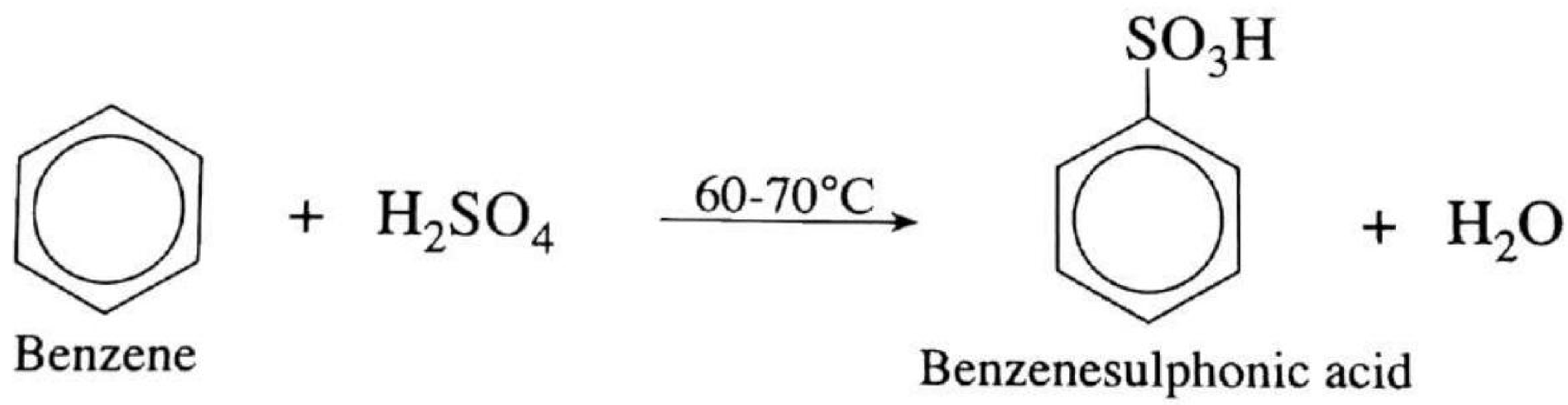
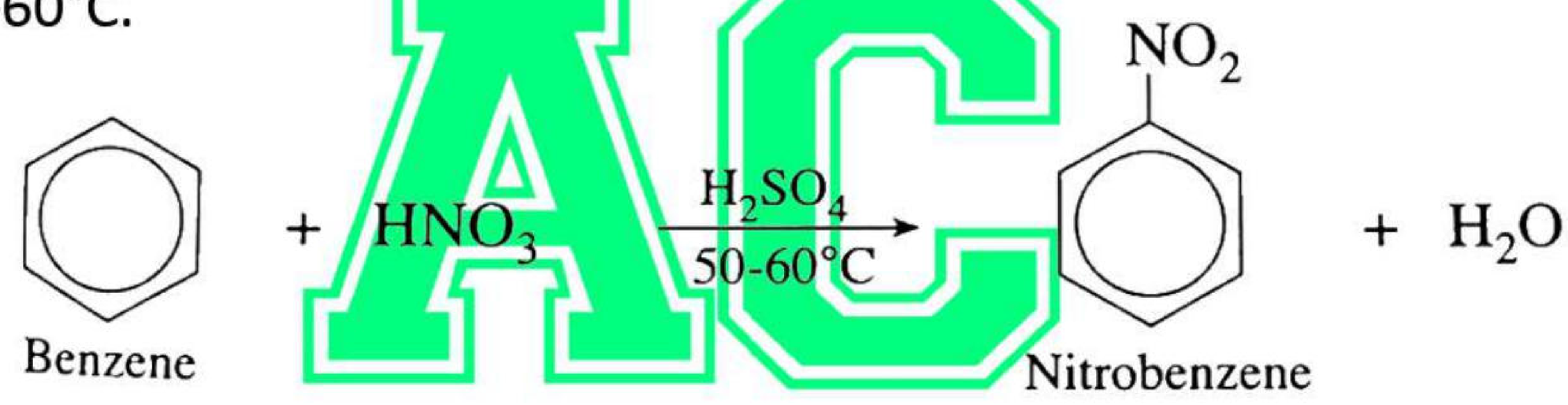
➢ The Properties of benzene are :-

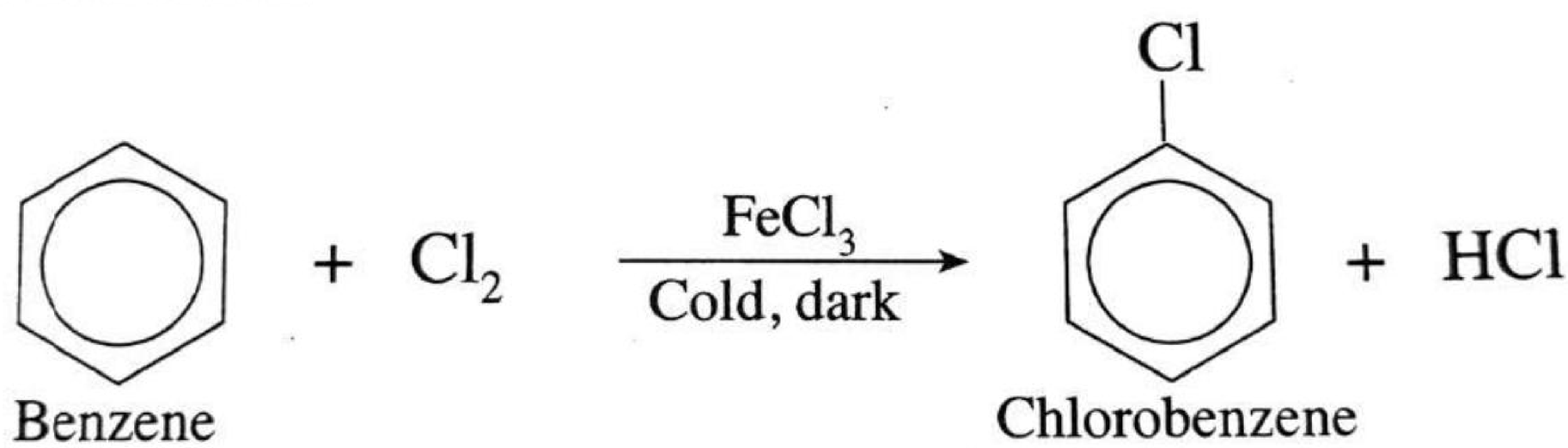
- **Sulphonation** :- Benzene on heating with fuming sulphuric acid (concentrated sulphuric acid containing some dissolved SO_3) undergoes sulphonation forming benzenesulphonic acid.



- **Nitration** :- It is carried out by heating benzene with a mixture of concentrated nitric acid and sulphuric acid (nitrating mixture) to 50-60°C.



- **Halogenation:-** Benzene reacts with halogen(chlorine,bromine) in cold, dark and in presence catalyst $AlCl_3$, $FeBr_3$ to form Halobenzene.



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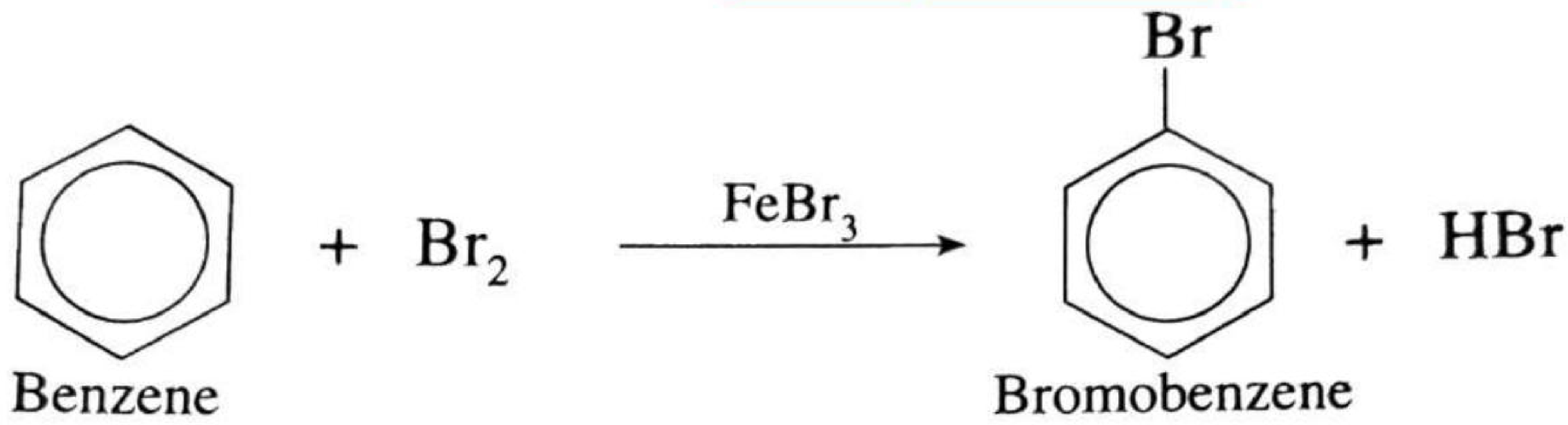

But direct iodination is not possible as it reaction is reversible.

← The End →

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Engineering Chemistry–II__(Engg. All) 2nd Sem

(2081 *Special_Scholarship*) Question Paper Solution.

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1. a) Mention the salts responsible for hardness of water? A tap water contains soluble bicarbonates of magnesium and calcium. How can it be made soft? Explain.

- The salts responsible for hardness of water are
  - Bicarbonate, Sulphate and chloride salts of magnesium and calcium.

    Examples :-
    - Calcium sulphate ($CaSO_4$)
    - Magnesium sulphate ($MgSO_4$)
    - Calcium chloride ($CaCl_2$)
    - Calcium bicarbonate [$Ca\ (HCO_3)_2$]
    - Magnesium bicarbonate [$Mg(HCO_3)_2$]
    - Magnesium chloride ($MgCl_2$)

- **By boiling:** Soluble bicarbonates of Ca and Mg on boiling are converted into insoluble carbonates of Ca and Mg.

$$Mg(HCO_3)_2 \longrightarrow MgCO_3 \downarrow + CO_2 + H_2O$$

$$Ca(HCO_3)_2 \longrightarrow CaCO_3 \downarrow + CO_2 + H_2O$$

After boiling, the soft water can be obtained either by decantation or filtration process.

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b) Write down chemical reaction involved in manufacture of ammonia by Haber's process.

➢ See the solution of 2080 (Old) of Q.no 1 (b) on page.no. 68

2. a) Describe in detail the manufacture process of nitric acid by Ostwald's process with labelled diagram.

➢ See the solution of 2080 (Old) of Q.no 2 (b) on page.no. 71

b) Explain nitrogen cycle with flow chart diagram.

➢ See the solution of 2080 (New) of Q.no 4 on page.no. 83

3. a) How is chlorine prepared in a laboratory with application of heat?

➢ See the solution of 2080 (New) of Q.no 6 on page.no. 86

AC

**** Write down action of chlorine with NaOH at different conditions.**

➢ With cold and dil. sodium hydroxide solution.

$$2NaOH + Cl_2 \longrightarrow NaCl + NaClO + H_2O$$

➢ With hot and conc. sodium hydroxide solution.

$$2NaOH + Cl_2 \longrightarrow NaCl + NaClO + H_2O$$
$$3NaClO \longrightarrow NaClO_3 + 2NaCl$$
$$6NaOH + 3Cl_2 \longrightarrow NaClO_3 + 5NaCl + 3H_2O$$

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b) Write down action of hydrogen sulphide with:

i. Acidified potassium permanganate

- When H_2S react with acidified Potassium permanganate $(KMnO_4)$ then, purple color of soution turns into colorless (Mn^{+2}) and sulphur is produced.

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$$
$$[H_2S + [O] \longrightarrow H_2O + S] \times 5$$

$$2KMnO_4 + 3H_2SO_4 + 5H_2S \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5S$$

(Purple) (Colourless)

ii. Sulphur dioxide

- When H_2S react with SO_2 then, sulphur is produced.

$$2H_2S\,(g) + SO_2\,(g) \longrightarrow 2H_2O\,(l) + 3S\,(s)$$

Hydrogen sulfide Sulphuric acid Water Sulphur

iii. Ferric chloride

- When H_2S is react with $FeCl_3$ then , it reduced to ferrous chloride.

$$2FeCl_3 + H_2S \longrightarrow 2FeCl_2 + 2HCl + S$$

iv. Lead acetate

- H_2S reacts with lead acetate paper [$(CH_3COO)_2Pb$] to form a black compound (Lead sulphide) Which is used in lab to detection of hydrogen sulphide gas.

$$H_2S + (CH_3COO)_2Pb \longrightarrow PbS + 2CH_3COOH$$

(Black)

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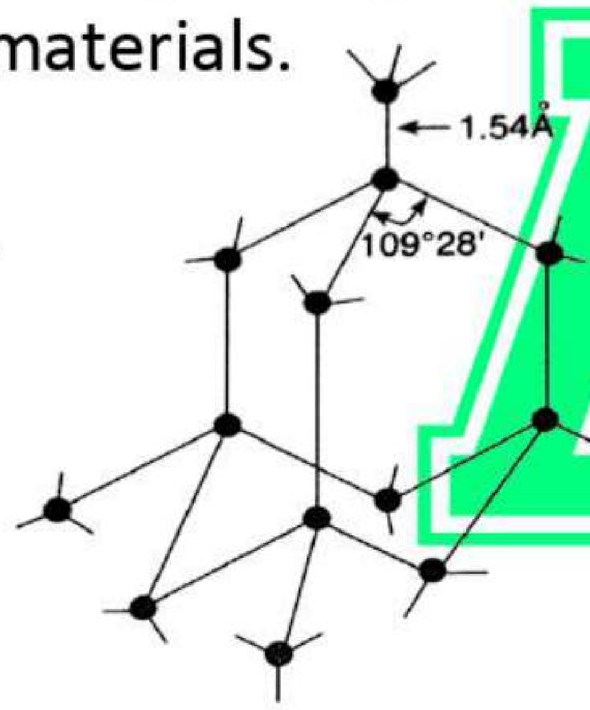
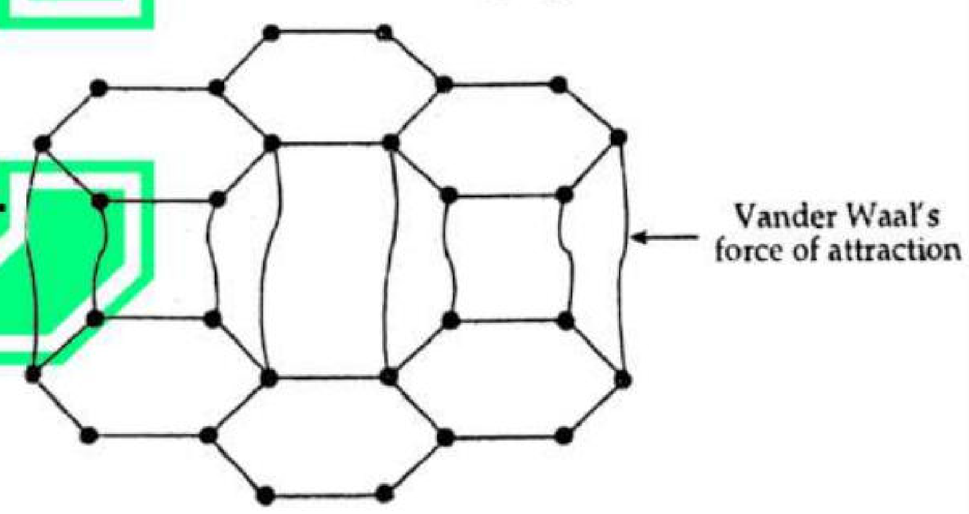
4. a) Write down principle and conditions for manufacture of sulphuric acid by Contact process.

➢ See the solution of 2080 (New) of Q.no 8 on page.no. 89

b) Draw structure of diamond. Write down uses of diamond and graphite.

Uses Of Diamond	Used of Graphite
▪ It is used in jewellery as a gem because of its ability to reflect light. ▪ It is used for cutting glass and making borer for rock drilling. ▪ It is used for grinding and polishing of hard materials. **Structure:-** 	▪ It is used as a lubricant for machines working at high temperatures. ▪ Since graphite is a good conductor of heat and electricity, it is used in making electrodes. ▪ It is used in making crucibles. ▪ It is also used in making 'pencil leads'. **Structure:-** 

5. a) Write one general method for the preparation of metallic carbonate. Describe in brief types of alloys.

➢ **By heating Bicarbonates:-** When Calcium Bicarbonates On heating , gives Calcium carbonates (Metallic Carbonates).

$$Ca(HCO_3)_{2(aq)} \xrightarrow{\Delta} CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$$

➢ **2nd Part**__See the solution of 2080 (Old) of Q.no 4 (a) on page.no. 76

b) Alkali metal always exhibit +1 oxidation state. Why? Why is aluminium used for making parts of air craft.

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- Because ,there is only one electron in the valence shell. By losing this electron they can acquire stable configuration of the nearest noble gas. Therefore, alkali metals exhibit +1 oxidation state.

$$Na \longrightarrow Na^{+} + e^{-}$$

- Aluminium used for making parts of air craft because It is a light weight metal and Strong with Specific gravity 2.7. and Its melting point is 658°C.

6. a) Write the differences between alkali metals and alkaline earth metals.

Alkali Metals	Alkaline Earth Metals
The series of six chemical elements (lithium, sodium, potassium, rubidium, caesium and francium) in I A group of the periodic table are called ***alkali metals.***	The series of six chemical elements (Beryllium, Strontium, Magnesium , Calcium, Barium and Radium) in II A group of the periodic table are called ***alkaline Earth metals.***
Alkali Metals are soft with oxidation state of +1.	Alkaline Earth Metals are hard having oxidation state of +2.
They are highly reactive metals.	They are less reactive metals.
The outermost electronic configuration is ns^1.	The outermost electronic configuration is ns^2.
They have low melting points.	They have relatively high melting points.
Their carbonates are soluble in water except Li_2CO_3 .	Their carbonates are insoluble in water.

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b) What are coinage metals? Can copper displace hydrogen from dil. sulphuric acid? Justify.

- ***Coinage metals*** are copper ($_{29}Cu$), silver ($_{47}Ag$) and gold ($_{79}Au$) from group IB (11) of the periodic table. These metals are called coinage metals because of their use in making coins.
- Copper is placed below hydrogen in the reactivity series, This indicates that copper is less reactive than hydrogen. Therefore, copper is will not displace Hydrogen gas from dilute H_2SO_4.

$$Cu + \underset{\text{Dil.}}{H_2SO_4} \longrightarrow \text{No reaction}$$

c) Mention position of alkali metal and alkaline earth metal in periodic table.

- Alkali metals are located in the group IA (1) on s-block.
- Alkaline Earth metals are located in the group IIA (2) on s-block.

7. a) Define homologous series. Write down characteristics of homologous series.

- See the solution of 2080 (old) of Q.no 5 (a) on page.no. 89

b) Write short notes on: (any FOUR)

i. Functional group

- See the solution of 2080 (New) of Q.no 13 on page.no. 94

ii. Markovnikovs's rule

- See the solution of 2080 (New) of Q.no 14 on page.no. 95

iii. Saturated hydrocarbon

- See the solution of 2080 (old) of Q.no 5 (b) on page.no. 78

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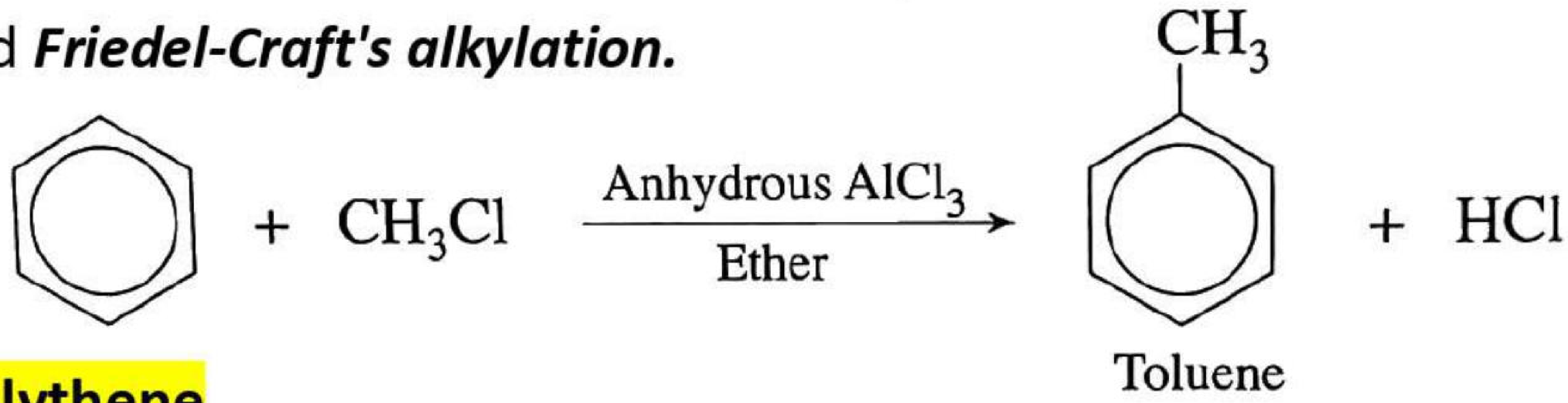
iv. Friedel craft alkylation reaction

- Benzene on treatment with an alkyl halide in the presence of anhydrous aluminium chloride in ether forms an alkyl benzene. The reactions are called ***Friedel-Craft's alkylation.***



v. Polythene

- See the solution of 2080 (old) of Q.no 6-a.(ii) on page.no. 80

vi. Natural rubber

- The elastic material which is obtained from the nature i.e., latex sap of trees is called ***natural rubber***. Natural rubber can be vulcanized and finished into various types of rubber products to use. The rubber molecules present in these latex tubes are made up of 5 carbon and 9 hydrogen atoms.

-Best of Luck-

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