Q. No. 2 (i) **TEMPORARY HARDNESS:** "It is named so because it can be removed by boiling." It is caused by Calcium and Magnesium Hydrogen carbonates.

**REMOVAL OF HARDNESS BY BOILING:**

Temporary hardness can be easily removed by boiling. The soluble hydrogen carbonates are decomposed into insoluble carbonates. $Mg^{+2}$ and $Ca^{+2}$ ions are removed as insoluble carbonates

**PRODUCTS:** The products formed are metal carbonate ($MCO_3$), carbondioxides ($CO_2$) and water ($H_2O$).

**REACTION:** $M(HCO_3)_{2(aq)} \longrightarrow MCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$ (M: $Ca^{+2}$, $Mg^{+2}$)

- $Ca(HCO_3)_2 \longrightarrow CaCO_3 + CO_2 + H_2O$
- $Mg(HCO_3)_2 \longrightarrow MgCO_3 + CO_2 + H_2O$

It is an expensive method and cannot be used on large scale.

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Q. No. 2 (ii) **ARRHENIUS CONCEPT:** In 1887, Svante Arrhenius proposed the first successful theory for acids and bases.

**ACID:** An acid is a substance that ionizes in water to produce $H^+$ ions

Example: $HCl \overset{H_2O}{\rightleftharpoons} H^+_{(aq)} + Cl^-_{(aq)}$

$HNO_3 \overset{H_2O}{\rightleftharpoons} H^+_{(aq)} + NO_3^-{}_{(aq)}$

$H_2SO_4 \overset{H_2O}{\rightleftharpoons} 2H^+_{(aq)} + SO_4^{-2}{}_{(aq)}$

**BASE:** A base is a substance that ionizes in water to produce $OH^-$ ions.

Example: $NaOH \overset{H_2O}{\rightleftharpoons} Na^+_{(aq)} + OH^-_{(aq)}$

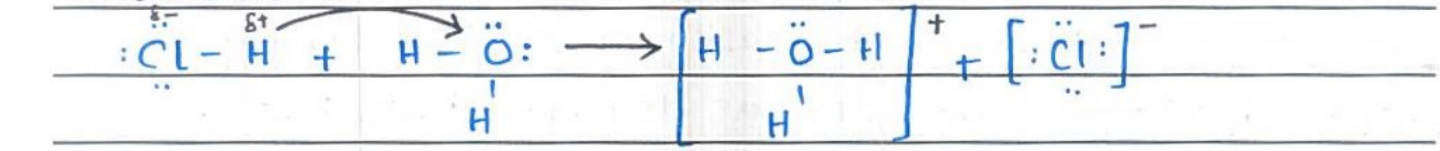
$KOH \overset{H_2O}{\rightleftharpoons} K^+_{(aq)} + OH^-_{(aq)}$

$NH_4OH \overset{H_2O}{\rightleftharpoons} NH_4^+{}_{(aq)} + OH^-_{(aq)}$

Q. No. 2 (iii) **BRONSTED-LONERY ACID:** An acid is a proton donor.

**BRONSTED-LONERY BASE:** A base is a proton acceptor.

**REACTION:**



- HCl + water → Hydronium ion + Chloride ion

$HCl + H_2O \rightarrow [H_3O]^+ + [Cl]^-$

**EXPLANATION:** In this reaction, HCl converts into $Cl^-$ ion by donating a proton ($H^+$) so it is an acid. $H_2O$ is converted into $[H_3O]^+$ by accepting a proton, due to the free availibility of lone pairs that attract the $\delta^+$ $H^+$ ion, so it is base

**ACID:** HCl is acid **BASE:** $H_2O$ is base.

.....

Q. No. 2 (iv) Given; NaOH, $H_2SO_4$, NaCl

**ACID:** An acid is a substance that contain replaceable Hydrogen atoms, so $H_2SO_4$ (Sulphuric acid) is an. **ACID**.

- $H_2SO_4 \xrightleftharpoons{H_2O} 2H^+ + SO_4^{-2}$

**BASE:** A base is a substance that contains replaceable Hydroxyl group ($OH^-$), so NaOH (Sodium hydroxide) is a **BASE**.

- $NaOH \rightarrow Na^+ + OH^-$

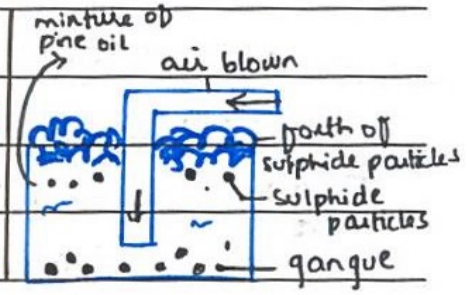
**SALT:** A salt is a substance that contains a metal atom which replaces $H^+$ in an acid. The first part is that of metal and second is the negative part of acid. So, NaCl (Sodium Chloride) is a **SALT**.

- $HCl + NaOH \rightarrow NaCl + H_2O$

Q. No. 2 (v) **CONCENTRATION:** In the second step of mettalurgy, the mineral is separated from the gangue by some physical processes called concentration. Floatation process is one of the types of concentration.

**FLOATATION PROCESS:** In this process, the pulverized (powdered) ore is placed into a tank containing water oil-detergent mixture. The mixture is agitated with air. The particles wet the minerals and not the silicate slag. The wet mineral particles move to the top of tank as porth, from where it is skimmed off. The gangue particles move and settle to the bottom of tank.

Example: Copper ore is generally concentrated by floatation.

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Q. No. 2 (vi) a) $CH_3 - CH = CH_2$ : It is an **alkene** (propene)

→ **ALKENES:** They are the unsaturated hydrocarbons containing carbon to carbon double bonds ($C=C$).

• **Functional group:** $C=C$ is the functional group ($R-\overset{R'}{\underset{|}{C}}=\overset{R''}{\underset{|}{C}}-R'''$)

b) $CH_3 - \overset{O}{\overset{\|}{C}} - OH$ : It is a **carboxylic acid** (Ethanoic acid / acetic acid)

→ **CARBOXYCLIC ACID:** They contain the carboxyl group.

• **Functional group:** $-\overset{O}{\overset{\|}{C}}-OH$ (or $-COOH$) is the functional group.

c) $H - \overset{O}{\overset{\|}{C}} - CH_2 - CH_2 - CH_3$ : It is an **aldehyde**. (Butanal)

→ **ALDEHYDE:** It contains one or more hydrogen atom attached to the carbonyl carbon atom.

• **Functional group:** $-\overset{O}{\overset{\|}{C}}-H$ ($-CHO$) is the functional group.

Q. No. 2 (vii) **MACROSCOPIC CHARACTERSTICS:**

**FORWARD REACTION:**

Direction: It is written from left to right

Formation: The reactants react together to form the products

Rate of reaction: Rate is fastest in the beginning and gradually slows down.

**REVERSE REACTION:**

Direction: It is written from right to left.

Formation: Products react to re-form the original reactants.

Rate of reaction: Rate is zero is the beginning and gradually speeds up.

E.g: $2SO_2 + O_2 \longrightarrow 2SO_3$ (Forward reaction)

$2SO_3 \longrightarrow 2SO_2 + O_2$ (Reverse reaction)

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Q. No. 2 (viii) **PROPERTIES OF WATER:**

1) Water is the only substance that exists in 3 states of matter (solid, liquid, gas)

2) Water is colourless, odourless and tastless. It boils at 100°C and freezes at 0°C.

3) It has high heat capacity. Large amount of heat is required to raise 1°C temperature of 1g of water. Conversely, large heat is given off by a small drop in temperature. It keeps the climate moderate. This is why water is used as coolant in industries.

4) It has high vapourization. Large amount of heat is required to evapourate small amount of water. So, large heat is released from our bodies by small amount of perspiration. This is the reason land near water bodies are cooler than inlands

Q. No. 2 (ix) **PREPARATION OF ALKENES:**

**1) BY DEHYDRATION OF ALCOHOLS:** Dehydration means the loss of water. Alcohols dehydrate when their vapours are passed over heated alumina.

$$H_3C - CH_2 - OH \xrightarrow[340-450^\circ C]{Al_2O_3} H_2C = CH_2 + H_2O$$ (ethyl alcohol → ethene + $H_2O$)

Catalyst: $H_3PO_4$, $P_4O_{10}$, $H_2SO_4$ may also be used for process.

**2) BY DEHYDROHALOGENATION OF ALKYL HALIDES:**

Dehydrohalogenation means the loss of hydrogen halide. Alkyl halides on treatement with alcoholic KOH undergo this reaction.

$$CH_3 - CH_2 - Cl + KOH \xrightarrow{\text{alcohol}} CH_2 = CH_2 + KCl + H_2O$$

ethyl chloride + KOH ⟶ ethene + KCl + $H_2O$

- Both of these are elimination reaction. In first, OH removes from one C-atom and H from adjacent. In second, Cl and H remove from adjacent C.

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Q. No. 2 (x)

Q. No. 2 (xi) **NUCLEIC ACIDS:** The nitrogen containing compounds discovered from the wounded pus firstly are called nucleic acids.

**STRUCTURE:** The are long chain molecules of nucleotides which consist of, nitrogenous base, pentose sugar and phosphate groups.

**IMPORTANCE:** Nucleic acids are found in every living cell. They are the essential molecules for life. They serve as the information and control centres of a cell. E.g. a single human fertilized egg contains information to make legs, hands, head, heart, liver, kidneys etc. They are classified as,

- Deoxyribonucleic acid (DNA): They store and transmit the **genetic information** and are essential for transmission of characteristics.
- Ribonucleic acid (RNA): They are synthesized by DNA to transmit genetic information. They are essential for **protein synthesis.**

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Q. No. 2 (xii) **OZONE LAYER:** It consist of ozone ($O_3$) which screens and filters out the harmful ultraviolet radiations of sun.

**FORMATION AND DESTRUCTION OF OZONE:** On absorbing UV radiations, $O_3$ splits into $O_2$ and O. $O_{3(g)} \xrightarrow{UV} O_{2(g)} + O_{(g)}$

Atomic oxygen is reactive and reacts: $O + O_2 \longrightarrow O_3 + heat$

In this way, it maintains the level of ozone is stratosphere. In absence of outside intervention, rate of formation and destruction are equal, which is disturbed by human activities.

**DEPLETION OF OZONE:** "The region in which there is reduction in the amount of ozone is called ozone hole." Chlorofluorocarbon (CFCs) diffuse into stratosphere and react with UV to form Cl radical

$CCl_3F \xrightarrow{UV} \dot{C}Cl_2F + \dot{C}l$. The radical reacts with $O_3$ and O as:

$\dot{C}l + O_3 \longrightarrow C\dot{l}O + O_2 \Rightarrow C\dot{l}O + O \longrightarrow \dot{C}l + O_2$

**NET REACTION:** $\boxed{O_3 + O_2 \longrightarrow 2O_2}$ Cl is regained and so destroys $O_3$.

Q. No. 2 (xiii) **REMOVENESS OF TEMPORARY HARDNESS :**

Temporary hardness is caused by Mg and Ca bicarbonates and can be removed by.

**CLARK'S METHOD :**

The addition of Slaked lime $Ca(OH)_2$ is called the Clark's method. Equal amounts of slaked lime are added to the soluble hydrogen carbonates which react to form insoluble carbonates and so $Ca^{+2}$ and $Mg^{+2}$ are removed.

**REACTIONS :**

- $Ca(HCO_3)_{2(aq)} + Ca(OH)_{2(s)} \longrightarrow 2CaCO_{3(s)} + 2H_2O_{(l)}$

Calcium bicarbonate + slaked lime → Calcium carbonate + water

- $Mg(HCO_3)_{2(aq)} + Ca(OH)_{2(s)} \longrightarrow MgCO_{3(s)} + CaCO_{3(s)} + 2H_2O_{(l)}$

Magnesium bicarbonate + slaked lime → Mg carbonate + Ca carbonate + $H_2O$

- It is used as an effective method on large scale.

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Q. No. 2 (xiv) **UREA :** "Urea is a fertilizer which is added to the soil to provide elements essential for plant's life. It is added to make up for the deficiency caused by previous crops."

- It is a synthetic fertilizer which contains the highest percentage of $N_2$ (46.6 %). It doesnot effect the texture of soil and hydrolysis in soil to give $N_2$ ;essential for proteins and growth.

**FORMATION OF UREA :** Raw materials : Ammonia ($NH_3$), $CO_2$

1) Preparation of ammonium carbamate : $NH_3$ reacts with $CO_2$ to give carbamate. $2NH_3 + CO_2 \longrightarrow NH_2COONH_4$ (carbamate)

2) Distillation : Ammonium carbamate is distilled to form urea.

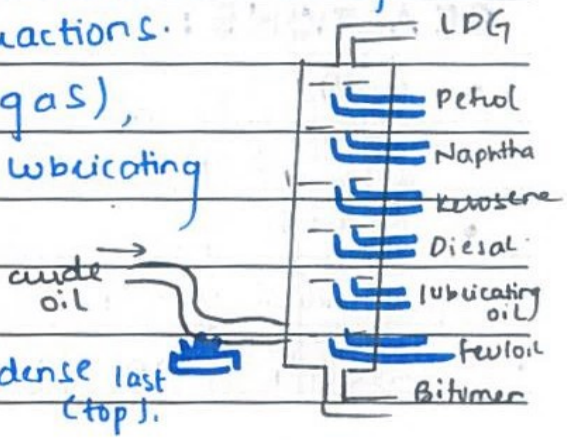
$$NH_2COONH_4 \longrightarrow \underset{\text{(urea)}}{NH_2-\overset{O}{\overset{\|}{C}}-NH_2} + H_2O$$

3) Evaporation and granulation : The urea solution is placed in vaccuum evaporaters. It is cooled and sent to prilling towers.

Q. No. 2 (xv) **REFINING OF PETROLEUM**: Petroleum is an energy rich possil fuel containing hydrocarbons. The separation of petroleum into its usepul products is called refining. The products are called fractions. It is done by fractional distillation in distillation tower. Crude oil is heated to 400° C and sent to the distillation column. Every fraction is not a pure compound but a mixture of hydrocarbons which boil at a certain temp. The vapours condense according to their boiling points and separate into fractions.

**FRACTIONS**: LPG (Liquified petroleum gas), Petrol, Naphtha, Kerosene oil, Diesal, Lubricating oil, fuel oil, Bitumen (residue).

- Compounds with highest B.P condense first near bottom. Compounds with lowest condense last (top).



Q. No. 3 (Page 1/4) (a)

## - LAW OF MASS ACTION -

**INTRODUCTION:** Chemists determine the composition of equilibrium mixtures by numerical values. The values describe the amount of products to reactants. They can be determined by law of mass action.

**DISCOVERY:** In 1864, CM Guldburg and P. Waage proposed the law of mass action.

**DEFINITION:** It states that,

"The rate at which a substance reacts in directly proportional to its active mass and the rate at which a reaction proceeds is directly proportional to the product of active masses of reactants"

**ACTIVE MASS:** It represents the concentration of reactant and products in $mol \cdot dm^{-3}$ for a dilute sol., represented by square brackets [ ].

## - DERIVATION -

Consider a hypothetical reaction in which 'a' moles of 'A' react with 'b' moles of 'B' to form 'c' moles of product 'C' and 'd' moles of product 'D'.

~~Acco~~

$$aA + bB \longrightarrow cC + dD$$

According to law of mass action

- Rate of forward reaction $\propto [A]^a [B]^b$

Rate of forward reaction $= K_f [A]^a [B]^b$

Q. No. 3 (Page 2/4)

Rate of reverse reaction $\propto [C]^c[D]^d$

Rate of reverse reaction $= K_R[C]^c[D]^d$

where $K_f$ and $K_R$ are rate constants.

**AT EQUILIBRIUM:**

Rate of forward reaction = Rate of reverse reaction

$$K_f[A]^a[B]^b = K_R[C]^c[D]^d$$

$$\frac{K_f}{K_R} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

$$\boxed{K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}} \quad \text{— (i)}$$

where $K_c = K_f / K_r$ is called the equilibrium constant and the expression is called equilibrium constant expression, defined as,

**DEFINITION:**

"The equilibrium constant expression is the ratio of the products of concentration of products to the product of concentration of reactants each raised to a power equal to the coefficient in balanced chemical equation."

**In eq (i),**

- [ ] represent the concentration of species in $mol \cdot dm^{-3}$.
- Equilibrium constant expression can be written from any balanced chemical equation
- Products are taken in numerator and reactants in denominator
- In $K_c$, the subscript c show molar concentration at equilibrium.

Q. No. 3 (Page 3/4)

## PROPERTY OF Kc :

- Kc is independent of initial concentration of reactants but depends on temperature.

**REACTION :** $PCl_3 + Cl_2 \rightleftharpoons PCl_5$

## DERIVATION OF EXPRESSION :

Rate of forward reaction $\propto [PCl_3][Cl_2]$

Rate of forward reaction $= k_f [PCl_3][Cl_2]$

Rate of reverse reaction $\propto [PCl_5]$

Rate of reverse reaction $= k_R [PCl_5]$

At equilibrium :

Rate of forward = Rate of reverse reaction

$$k_f [PCl_3][Cl_2] = k_R [PCl_5]$$

$$K_c = \frac{[PCl_5]}{[PCl_3][Cl_2]} \qquad \therefore K_c = \frac{K_f}{K_R}$$

## UNITS OF Kc :

Units for above expression will be

$$\text{Unit} = \frac{[mol \cdot dm^{-3}]}{[mol \cdot dm^{-3}][mol \cdot dm^{-3}]}$$

$$\text{unit} = \frac{1}{[mol \cdot dm^{-3}]}$$

$$\text{unit} = dm^3 \cdot mol^{-1}$$

. As total no. of moles of reactants ≠ No. of moles of product, so Kc will have unit ($mol^{-1} \cdot dm^3$)

Q. No. 3 (Page 4/4) (b)

## FUNCTIONAL GROUPS:

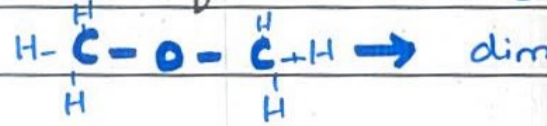
"A group of atoms giving a class of organic compound its characteristic physical and chemical properties are called functional group."

i) $CH_3OCH_3$:

**ETHERS:** The compound containing 2 alkyl groups bonded to same O-atom is called ether.

Functional group: C-O-C

General formula: ROR'



→ dimethyl ether

ii) $CH_3COOH$:

**CARBOXYLIC ACID:** The functional group of organic acid is carboxylic acid

Functional group: $-\overset{O}{\overset{\|}{C}}-OH$ (Carboxyl group)

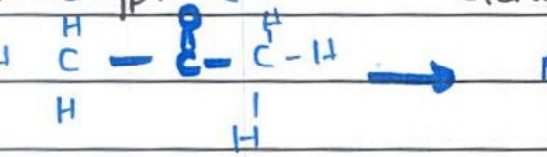
General formula: RCOOH

→ ethanoic acid (acetic acid)

iii) $CH_3COCH_3$:

**KETONE:** Contain 2 alkyl group bonded to carbonyl C-atom.

Functional gp: $-\overset{O}{\overset{\|}{C}}-$ General formula: R-COR'



→ propanone (acetone)

iv) $CH_3COOCH_3$:

**ESTER:** $-\overset{O}{\overset{\|}{C}}-O-C$ is the functional group for ester.

→ methyl ethanoate (acetate) (RCOOR')

Q. No. 4 (Page 1/4) (a)

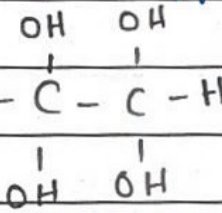
## REACTION OF ALKYNE WITH $KMnO_4$ :

- Alkynes react with strong alkaline solution $KMnO_4$. It forms oxalic acid.
- It first reacts with $KMnO_4$ and 4 hydroxyl groups are attached over $C \equiv C$.

1. $4KMnO_4 + 4KOH \longrightarrow 4K_2MnO_4 + 4[O] + 2H_2O$

($KMnO_4 + KOH \longrightarrow K_2MnO_4$ + oxygen + water)

2. $CH \equiv CH + 2[O] + 2H_2O \rightarrow$

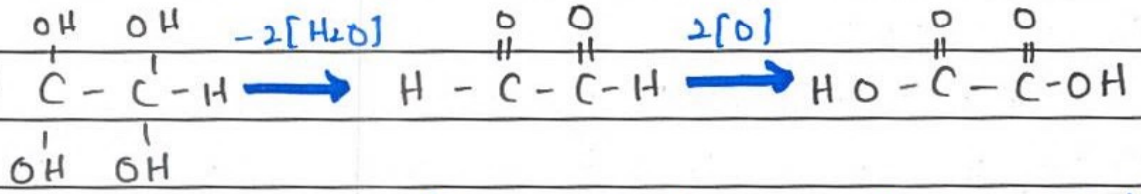


(ethyne)

(1,1,2,2 - Tetrahydroxy ethane)

Tetrahydroxy ethane is reactive compound and loses 2 water molecules to form glyoxal and oxidizes to oxalic acid.

3.



(Glyoxal) (oxalic acid)

→

Q. No. 4 (Page 2/4) (b)

## SOURCES AND USES:

### 1) CARBOHYDRATES:

- **SOURCES:**

1. Glucose, Gluctose and fructose are found in cereals, fruit and vegetables, honey.
2. Disaccharides such as sucrose is obtained from ~~table~~ sugar cane, sugar beet, fruits. Maltose is found in cereals. Lactose is main sugar in milk and dairy products.
3. Cellulose is found in plants. E.g Cotton is pure cellulose
4. Starch is found in bread, rice, potatato, maize etc.

- **USES:**

1. Main source of energy. 1g of carbohydrates provide 15.6KJ of energy
2. Major energy food source.
3. Cellulose in human diet is refered as fibre. It comes from bran, whole meal bread, fruits and vegetables. It is indigestable but helps in contraction of intestinal walls to move food efficiently in digestive track. It also lowers cholestrol and maintains blood pressure.
4. Sucrose is the main table sugar.
5. Sucrose is converted into dextrin which serves as adhesive in stamps and glue.
6. Sucrose is used to make rectified spirit by fermentation process.
7. Cattles, cows, deer etc feed on cellulose

Q. No. 4 (Page 3/4)

8. We use cellulose as wood for heating and cooking purpose.
9. Wood is used to make wood pulp and paper
10. Cotton cellulose is used to make cellulose acetate and nylon, used in textile industry

## ii) PROTEINS :

- **SOURCES :**

1. Animal sources of proteins contain all the essential amino acids. E.g, meat, fish, egg, milk cheese

2. Proteins are also found in plants e.g, beans, pulses

- **USES:**

1. We require protein to give amino acid to our bodies for making hair, enzymes and repair body tissues
2. Proteins are necessary for physical and mental growth, especially in children.
3. The are important component of protoplasm and components of cell.
4. A protein called gelatin is obtained by heating bones and tendons in water. It is used in bakery goods.
5. Enzymes are proteins which catalyze biochemical reactions which make life possible.
6. Antibodies which help us to fight against diseases are large protein molecules.

## iii) LIPIDS :

- **SOURCES :**

Q. No. 4 (Page 4/4)

- Milk from animal used to make butter, ghee etc
- Seeds of plants ( cotton, corn, etc) are a source of vegetable oil.
- **USES :**
  - used in cooking, frying ( ghee and oil)
  - protect organs from shock, injury.
  - serve as thermal insulator.
  - source of vitamins ( A, D, E, K)
  - good energy source
  - manufacture of soaps, paint etc.

Q. No. 5 (Page 1/4)

**Q. No. 5 (Page 2/4)**

Q. No. 5 (Page 3/4)

Q. No. 5 (Page 4/4)