Q. No. 2 Part (i) **Urea:** Urea is a nitrogenous substance, white crystalline solid, that is soluble in water, and widely used as a fertilizer. **Reasons why urea is widely used as a fertilizer:-**

1) It has the highest percentage of nitrogen among all synthetic fertilizers i.e., **46.6%**.

2) It does not affect the soil texture.

3) When added to soil, urea rapidly converts into ammonium carbamate. which further decomposes into NH_3 (ammonia) and NH_3 further decomposes to give N_2 and H_2.

Nitrogen is required by plants to make proteins and nitrogen also imparts green color to its leaves, and it is also required by young leaves and stems.

Q. No. 2 Part (ii) ***Reason why ice floats on top of water:-**

The density of most of the solids and liquids ~~decreases~~ increases on cooling or freezing. But water shows a strange behaviour called **anomalous expansion of water.** On freezing upto **4°C**, the density of water increases and it reaches its maximum value i.e., **1gcm^{-3}** at 4°C. But on further cooling, or freezing, density of water ~~increases~~ decreases and water expands. This is the reason why ice floats on top water because ice is less dense than water and on freezing at Temperature lower than 4°C, the density of ice decreases. ***Benefit:-** The benefit of this strange behaviour of water is that ice forms on the upper layer of lakes and rivers and floats over water and hence, insulates the lower layers of water, making survival of marine organisms possible in winters. It is of immense importance.

Q. No. 2 Part (iii) **Lipids:** Any component of plant or animal tissue that is insoluble in water but is soluble in solvents of low polarity like ether, benzene, etc is called lipid. Lipids exist in these forms: 1) Oils and fats, 2) Sex hormones, 3) Cholestrol, 4) Component of cell membrange i.e., phospholipid, & etc. ★ **Sources of Lipids:-**

① **Animal Sources of Lipids** include milk and dairy products like butter, cheese, etc, and beef fat.

② **Plant Sources of Lipids:** They are mostly obtained from plant seeds like cotton seed, coconut oil, ~~olein~~ corn oil, etc.

③ **Lipids from Marine Organisms** like whales and salmon are also obtained. For example, Cod liver oil is an example of such lipid obtained from marine organisms.

Q. No. 2 Part (iv) **Classification as Lewis acid or Lewis base:-**

(a) NH_3 : Lewis base: NH_3 is lewis base because its central atom i.e., N has a lone pair of $\bar{e}$s which it can donate to form coordinate covalent bond. **(b) Ag^+ : Lewis acid:** Ag^+ is a lewis acid because it is electron deficient and can accept a lone pair of electrons **(c) H_2S : Lewis acid:** H_2S is lewis acid because its central atom S is electron deficient and can accept a lone pair of electrons. **(d) $AlCl_3$: Lewis acid :** $AlCl_3$ is lewis acid because its central atom Al is electron deficient and it can it can accomodate a lone pair of electrons in its valence shell.

(e) Cl^- : Lewis base: Cl^- is lewis base because it is an anion, and it has the ability to donate a pair of electrons.

(f) $FeCl_3$: Lewis acid: $FeCl_3$ is lewis acid because Fe is electron deficient and can accept a lone pair of electrons.

Q. No. 2 Part (v) **IUPAC Naming of following Compounds:-**

(a) $CH_3CH_2CH_3$: * Number of carbon atoms = 3 C-atoms

* So, Stem = Prop-

* Class of compound = Alkanes, so, suffix = -ane

Name of Compound: Propane.

(b) $CH_3CH_2CH_2CH_2CH_3$: * Number of carbon atoms = 5

* So, stem : Pent-

* Class of compound = Alkane, so, * suffix : -ane

Name of Compound : Pentane

(c) $CH_3CH_2CH_2CH_3$: * Number of C atoms = 4

So, * stem : But- * Class of compound = alkane, so * suffix: -ane.

(because it satisfies general formula of alkanes i.e., C_nH_{2n+2}).

* **Name of Compound: Butane**

Q. No. 2 Part (vi) **Chemical Equilibrium:** Chemical equilibrium is a state of chemical reaction in which the rate of forward reaction becomes equal to the rate of reverse reaction.

Necessary Conditions for Chemical Equilibrium:

Necessary conditions for a chemical equilibrium established in a reversible reaction taking place in a closed container suggest that chemical equilibrium will be observed as long as these conditions are followed:

① The concentration of reactants and products at equilibrium remains constant.

② The temperature of the ~~the~~ chemical system at equilibrium remains constant.

③ The pressure or volume of a chemical system at equilibrium remains same and it is not disturbed.

Q. No. 2 Part (vii) **Functional Group:** An atom or a group of atoms that gives a family of organic compounds its characteristic chemical and physical properties is called functional groups.

Identification of Functional Groups in following Compounds:-

(a) CH_3NH_2 : *Functional group: $-NH_2$ (amine group)

* Class of compound: Amines * General Formula: $R-NH_2$

* Name of compound: methyl amine.

(b) CH_3COOCH_3 : * Functional group: $-\overset{O}{\overset{\|}{C}}-O-\overset{|}{\underset{|}{C}}-$ (Functional group of esters)

* Class of compound: Esters

* General Formula: $R-COOR'$

* Name of compound: methyl ethanoate

Q. No. 2 Part (viii) **Reaction:** $CO + 2H_2 \rightleftharpoons CH_3OH$

***Derivation of equilibrium constant expression:-**

Forward reaction: $CO + 2H_2 \rightarrow CH_3OH$

Rate of forward reaction $\propto [CO][H_2]^2$

Rate of forward reaction $= k_f [CO][H_2]^2$

Reverse reaction: $CH_3OH \rightarrow CO + 2H_2$

Rate of ~~forward~~ reverse reaction $\propto [CH_3OH]$

Rate of reverse reaction $= k_r [CH_3OH]$

At equilibrium, Rate of forward reaction = Rate of reverse reaction

$\Rightarrow k_f [CO][H_2]^2 = k_r [CH_3OH]$

$\frac{k_f}{k_r} = \frac{[CH_3OH]}{[CO][H_2]^2}$

$\therefore K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$

∴ The K_c expression is given above.

***Units of K_c:**

$K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$

$K_c = \frac{(mol\,dm^{-3})}{(mol\,dm^{-3})(mol\,dm^{-3})^2}$

$K_c = \frac{1}{(mol\,dm^{-3})^2}$

$\Rightarrow K_c = (mol\,dm^{-3})^{-2}$

Result:

$\therefore \Rightarrow K_c = mol^{-2}\,dm^6$

∴ So, the unit of K_c is $mol^{-2}\,dm^6$

Q. No. 2 Part (ix) **Preparation of Tetrachloroethane from Ethyne :-** Tetrachloroethane can be prepared from ethyne by the process of "halogenation of alkynes" which is an addition reaction and is done in 2 steps.

Step 1:

$$HC \equiv CH + Cl_2 \longrightarrow HCl = CHCl$$

ethyne — chlorine molecule — (1,2-dichloroethene)

Step 2:

$$HCl = CHCl + Cl_2 \longrightarrow H-CCl_2-CCl_2-H$$

1,2-dichloroethene — chlorine molecule — 1,1,2,2-tetrachloroethane

∴ So, in this way by complete halogenation of ethyne, tetrachloroethane is produced.

Q. No. 2 Part (x) **Balanced neutralization reaction between carbonic acid and potassium hydroxide.**

Carbonic acid + potassium hydroxide ⟶ potassium carborate + water.
(acid) (base) (salt)

∴ word equation

Since carbonic acid is a dibasic acid, its neutralization (complete) occurs in two steps as stated below:

1) Step 1:

$$H_2CO_{3(aq)} + KOH_{(aq)} \longrightarrow KHCO_{3(aq)} + H_2O_{(l)}$$

carbonic acid — potassium hydroxide — potassium bicarbonate (acidic salt)

2) Step 2:

$$KHCO_{3(aq)} + KOH_{(aq)} \longrightarrow K_2CO_{3(aq)} + H_2O_{(l)}$$

potassium bicarbonate — potassium hydroxide — potassium carbonate — water

Hence, the above two steps show complete balanced neutralization reaction between H_2CO_3 and KOH. We need two moles of KOH to completely neutralize H_2CO_3.

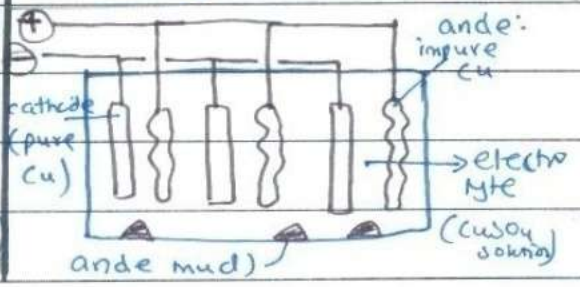
Q. No. 2 Part (xi) **Electro-refining of Copper:-** After copper has been extracted from its ore, now it still has some impurities and for this reason refinig or purification of **Cu** is done by electrorefining. In this process, impure Cu acts as anode and pure Cu as cathode. Reaction takes place in an electrolytic tank powered by battery and is filled with electrolyte i.e., acidified $CuSO_4$ solution. When electricity is supplied, Cu^{+2} ion from anode ~~the~~ come out of anode and ~~dissolve in the then~~ then Cu^{+2} ion go to cathode, from where they ~~get~~ accept electrons and deposit on cathode as pure copper. 99.9% pure copper is obtained by this process. Impurities like Au and Ag fall off as anode mud.

Reactions:

At anode: $Cu \longrightarrow Cu^{+2} + 2\bar{e}$ (oxidation)

At cathode: $Cu^{+2} + 2\bar{e} \longrightarrow Cu$ (reduction)

Diagram:



Use for rough work

ARRHENIUS ACID-BASE THEORY:-

Arrhenius Acid-Base theory was the first successful theory of acids and bases proposed by a scientist named Svante Arrhenius. According to Arrhenius theory of acids and base, acids and bases are defined as stated below:

Arrhenius Acid: A substance which gives / ~~forms~~ produces H^+ ions on dissociation in an aqueous solution is called arrhenius acid. e.g., H_2SO_4, HNO_3, etc.

Arrhenius Base: A substance that gives/ ~~forms~~ produces OH^- ions on dissociation in an aqueous solution is called arrhenius base. e.g., NaOH etc.

★ Classification of HNO_3, H_2SO_4, NaOH and KOH as Arrhenius acid or base (with chemical reactions):

@ HNO_3: Arrhenius acid:-

HNO_3 is classified as an arrhenius acid because when in aqueous solution, it dissociates to produce H^+ ion.

* **Chemical reaction:**

$$HNO_3 \xrightleftharpoons{H_2O} H^+ + NO_3^-$$

(nitric acid)

(b) H_2SO_4 : Arrhenius Acid:- H_2SO_4 is an arrhenius acid because in an aqueous solution, it produces H^+ ions. * **Chemical reaction:-**

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

(sulphuric acid)

(c) NaOH : Arrhenius Base: NaOH is a base because it produces OH^- ion in an aqueous solution. * **Chemical Reaction:**

$$NaOH \xrightleftharpoons{H_2O} Na^+ + OH^-$$

(sodium hydroxide)

(d) KOH : Arrhenius Base: KOH is an arrhenius base because it produces OH^- ions in aqueous medium. * **Chemical reaction:**

$$KOH \xrightleftharpoons{H_2O} K^+ + OH^-$$

(potassium hydroxide)

Limitations of Arrhenius Theory: Arrhenius Acid Base theory has following limitations:

① It is only ~~applicat~~ applicable in an aqueous medium / solution.

② It only tells the nature of those substances that have H^+ or OH^- in them and produce them on (in water) dissociation.

It cannot classify substances like CO_2, SO_2, NH_3, etc.

Q. No. 4 (Page 1) **HARD WATER:** Water that does not produce/give lather easily and forms scum is called hard water.

* Causes of Hardness of Water / Salts that make water hard:-

Rain dissolves considerable amount of CO_2 in it forming H_2CO_3 which is a weak acid. $CO_2 + H_2O \longrightarrow H_2CO_3$

Now, when rainwater containing H_2CO_3 passes through or over rocks or surfaces containg $CaCO_3$ or $MgCO_3$, it converts them into their soluble bicarbonates which cause temporary hardness of water.

* $CaCO_3 + H_2CO_3 \longrightarrow Ca(HCO_3)_2$
* $MgCO_3 + H_2CO_3 \longrightarrow Mg(HCO_3)_2$

So, Ca^{++} and Mg^{++} bicarbonates i.e., $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ are the salts which are the causes of temporary hardness of water. Rain water also passes through rocks containing gypsum ($CaSO_4 \cdot 2H_2O$), anhydride ($CaSO_4$) and Kieserite ($MgSO_4 \cdot H_2O$) and converts them into soluble sulphides and chlorides of Mg and Ca. Now, the sulphides and chlorides of Magnesium and Calcium are the causes of permanent hardness of water. So, temporary hardness is caused by theses salts: ① $Ca(HCO_3)_2$ ② $Mg(HCO_3)_2$ and permanent hardness is caused by these salts: ① $CaSO_4$ ② $MgSO_4$ ③ $CaCl_2$ ④ $MgCl_2$.

*Clark's Method (Addition of Slaked Lime) : a method of removing temporary hardness of H_2O :-

Clark's method is used for removing temporary hardness of water. Slaked lime i.e., $Ca(OH)_2$ is added in considerable amounts in a temporarily hard water and it converts soluble bicarbonates of Mg and Ca into their insoluble carbonates (salts). Since, this removes Mg^{+2} and Ca^{+2} as their insoluble salts, hardness is now removed.

***Chemical Equations:**

① $Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O$

② $Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow MgCO_3 + CaCO_3 + 2H_2O$

*ION-EXCHANGE

Method: For removing permanent hardness: In this method, hard water is passed through a container filled with a suitable resin. Zeolite is one of natural ion exchangers and chemically it is sodium aluminium silicate. When hard water is passed through it, Mg^{+2} and Ca^{+2} ion of hard water are exchanged with Na^+ ions of zeolite. Zeolite is represented as Na_2Z. It removes permanet hardness of water. **Chemical Equations:**

* $Na_2Z + MCl_2 \longrightarrow MZ + 2NaCl$

* $Na_2Z + MSO_4 \longrightarrow MZ + Na_2SO_4$

∴ where M = Ca^{+2} or Mg^{+2}

Used zeolite can be regenerated again by heating with conc. NaCl solution.

Used up $CaZ + 2NaCl \xrightarrow{heat} Na_2Z + CaCl_2$

ACID RAIN:

"Acid rain is defined as rain having pH less than 5-6."

In polluted areas, during thunderstorms, SO_2 from burning fossil fuels and NO_2 from exhaust fumes of vehicles and factories react with O_2 in air and H_2O in clouds to form acids which remain in rain, causing rain to become acidic.

* $2SO_2 + O_2 \longrightarrow 2SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

* $2NO_2 + 3O_2 + 2H_2O \longrightarrow 4HNO_3$

HNO_3 and H_2SO_4 dissolved in rain cause rain to become acidic. Sometimes, pH of acidic rain can be as low as 2.1.

Acid rain falls further away from its sources and it has many harmful consequences.

HARMFUL EFFECTS OF ACID RAIN:

Acid rain is an environmental hazard and has negative effects on animals, plants, buildings, etc.

1) Effect on Metals: Acid H_2SO_4 in Acid rain corrodes metals causing many problems.

* $H_2SO_4 + Fe \longrightarrow FeSO_4 + H_2$

2) Effects on Buildings: Buildings and monuments containing $CaCO_3$ (limestone) suffer and are eaten away by acid rain.

* $H_2SO_4 + CaCO_3 \longrightarrow CaSO_4 + CO_2 + H_2O$

* $2HNO_3 + CaCO_3 \longrightarrow Ca(NO_3)_2 + CO_2 + H_2O$

These are soluble salts produced which wash off these buildings, eroding them eventually.

3) Effects on Soil: Acid rain makes soil acidic and such soil is not favorable for growth of plants and crops. Also it causes great metal content in soil, poisoning trees and stunting their growth.

4) Effect on Plants: It directly affects plants by attacking their leaves, and is retarding their growth.

5) Effect on Humans and Marine organisms: Acid rain washes off heavy metals like Al, Hg, etc into lakes and rivers ~~causing~~ which are fatal for marine life and if human drink this water, they develop many diseases.

VITAMINS:

Definition: "Vitamins are accessory growth factors. Vitamins are specific organic substances required by our bodies to ~~synthesize specific~~ prevent specific diseases but cannot be synthesized by our bodies." They must be present in our diet along with proteins, carbs, ~~fats~~ lipids and minerals.

Importance of Vitamins:-

Vitamins are of great importance in our bodies:

(1) **Vitamin A** is necessary for vision. It is necessary for chemical transmission of images from eyes to brain. Vitamin A can be obtained from leafy green veges, eggs, milk, butter, etc. Also, Vitamin A is essential for maintaining healthy skin. Its deficiency causes night blindness and dry skin.

(2) **Vitamin C:** It is required for blood formation and strengthening immune system. It is essential for blood vessels, gums. It prevents scurvy and its deficiency causes slow wound healing, etc. It can be obtained from oranges, lemons, citrus fruits and fresh green veges.

(3) Vitamin B-complex:

Vitamin B complex is also required by our body because it relugates nerve impulse transmission, regulates more than 100 enzymes and it is also involved in ~~haemog~~ haemoglobin formation. It can be obtained from ~~soy~~ to wholemeal ~~bream~~ bread, fresh green veges, rice, etc. Its deficiency causes ~~blee~~ ~~blee~~ nervous disorders.

(4) Vitamin D: Vitamin D is required by our body because it regulates blood Calcium levels. It helps in strengthening our teeth and bones and prevents us from diseases like osteomalacia and rickets. It can be obtained from fish liver oil, eggs, milk etc.

Vitamins are of two types: (1) fat soluble vitamins like A, D, E and K and (2) water soluble vitamins like C and B (complex).

In conclusion, our body needs vitamins in adequate amounts for preventing diseases and we should include them in our diet. Fat soluble vitamins shouldn't be taken in excess.