Q. No. 2 (i) **Temporary hardness:** Temporary hardness is so called because it can be removed by boiling.

Products that are formed when temporary hard water is boiled: Temporary hardness in the water is caused due to the presence of dissolved calcium or magnesium hydrogen carbonates. Temporary hardness in the water can be removed by simply boiling the water. During boiling, the soluble magnesium and calcium bicarbonates are converted into insoluble carbomtes. As Ca^{+2} and Mg^{+2} ions are removed as insoluble carbonates so water becomes soft.

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

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

Unfortunately, this method is too expensive to remove the temporary hardness in the water at large scale.

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Q. No. 2 (ii) **Arrhenius concept of acids and bases:** According to Arrhenius concept of acids and bases:- "An acid is a substance that ionizes in water to produce H^+ ions whereas base is a substance that ionizes in water to produce OH^- ions".

Examples of Arrhenius acids:

$$HCl \overset{H_2O}{\rightleftharpoons} H^+ + Cl^-$$

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

Examples of Arrhenius bases:

$$KOH \overset{H_2O}{\rightleftharpoons} K^+ + OH^-$$

$$NaOH \overset{H_2O}{\rightleftharpoons} Na^+ + OH^-$$

Q. No. 2 (iii) According to Bronsted Lowry Concept:-
"An acid is a proton donor and ~~the~~ base is a proton acceptor".
H_2O is a bronsted base because it can accept a proton whereas HCl is a bronsted acid because it can donate a proton.

Chemical equation:-

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$

Bronsted acid — Bronsted base — conjugate acid — conjugate base.

.....

Q. No. 2 (iv) a) NaOH: It is a base because according to Arrhenius concept, it ionizes in water to produce OH^- ions.

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

b) H_2SO_4: It is an acid. According to Arrhenius concept, it ionizes in water to form H^+ ions.

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

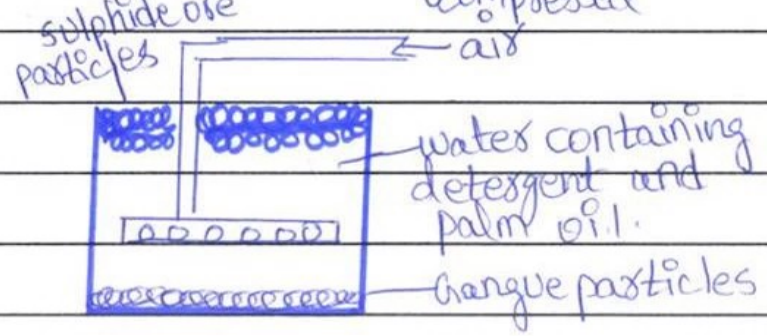
b) NaCl:- It is a salt. It is formed by the reaction of an acid (HCl) and a base (NaOH)

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

Acid + base $\longrightarrow$ Salt + water.

Q. No. 2 (v) **Froth Floatation process:** In this process, the pulverized ore is fed into a tank containing an oil detergent mixture. The mixture is agitated with the air. Detergents wet the mineral particles but not the gangue particles. So, mineral particles appear at the top of the mixture as froth, from where they are skimmed off. While, the gangue particles fall down to the bottom of the tank. Copper ore is generally concentrated by froth floatation process.

⇒ Diagram showing the concentration of sulphide ore:-



Q. No. 2 (vi) a) $CH_3-CH=CH_2$:- It is an alkene because it contains carbon-carbon double bond (C=C)

b) $CH_3-\overset{O}{\overset{\|}{C}}-OH$:- It is an organic acid / carboxylic acid because its functional group is $R-\overset{O}{\overset{\|}{C}}-OH$.

c) $H-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_3$: It is an aldehyde because it contains ~~the~~ this functional group $H-\overset{O}{\overset{\|}{C}}-R$

"Hydrocarbons having carbon-carbon double bonds are called alkenes". "Compounds having (-COOH) as the functional group are called carboxylic acids". "Aldehydes have atleast one H atom attached to the carbonyl carbon atom".

Q. No. 2 (vii) Forward reaction:- (Macroscopic characteristics:

- It is written from left to right.
- Reactants produce produce.
- Rate of the reaction is higher at the beginning but it gradually slows down.

Example: $2SO_2 + O_2 \longrightarrow 2SO_3$

Reverse reaction: (Macroscopic characteristics):

- It is written from right to left.
- Products produce the reactants.
- Rate of the reaction is zero at the beginning but it gradually speeds up.

Example: $2SO_3 \longrightarrow 2SO_2 + O_2$

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Q. No. 2 (viii) Properties of water :-(three:-)

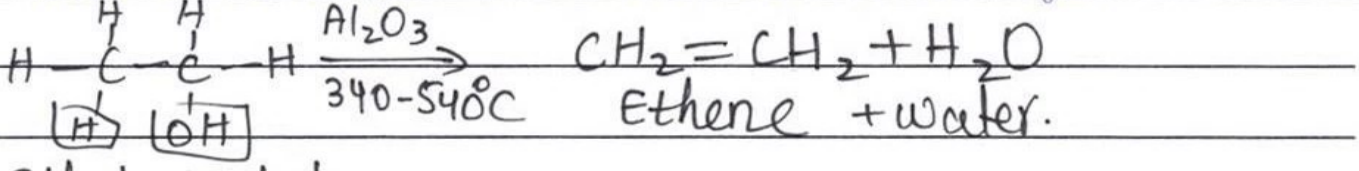
(1) Water is the only substance on Earth that exists in the form of three states : solid, liquid and gas.

(2) Pure water is colourless, odourless, transparent and tasteless. It boils at 100°C and freezes at 0°C at sea level.

(3) Water has a very high heat capacity. A large amount of heat is required to raise the temperature of 1g of water by 1°C. Conversely, too much heat is given off by the water for even a small drop in temperature. Due to this, the large amount of water on Earth acts as a giant heat reservoir to moderate daily temperature variations. Water is an excellent heat absorber. It is used as a coolear in industries.

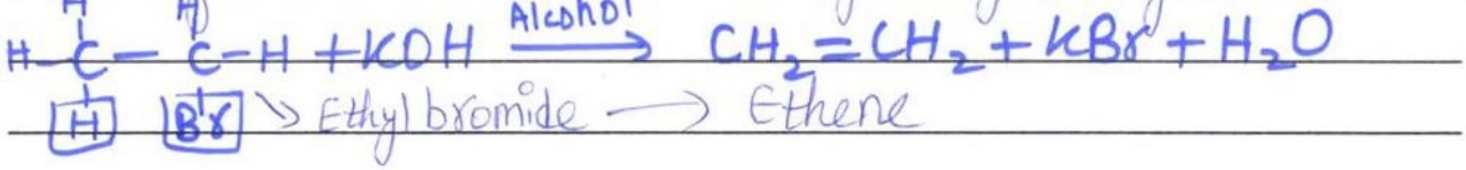
Q. No. 2 (ix) General methods for preparation of alkenes.

a) Dehydration of alcohols:- Dehydration means loss of water. Alcohols dehydrate when their vapours are passed over heated alumina. It is called elimination reaction.



Phosphoric acid (H_3PO_4), phosphorus pentaoxide (P_4O_{10}) and concentrated sulphuric acid (H_2SO_4) can also be used as catalyst for dehydration of alcohols.

b) Dehydrohalogenation of alkyl halides: Alkyle halides on treating with alcoholic KOH undergo dehydrohalogenation.



Q. No. 2 (x)

Q. No. 2 (xi) Nucleic acids are the vital components of all life. They are found in every living cell and act as the information and control centres of cells. ~~They~~ There are two types of nucleic acids:- Deoxyribonucleic Acid (DNA) and Ribonucleic Acid (RNA). They are very important. DNA is found in cells' nucleus and it stores the genetic information needed to build organisms. Whereas RNA is synthesized by the DNA. It is responsible for directing the synthesis of new proteins. RNA receives, ~~decoded~~ reads, decodes and uses the genetic information provided by the DNA to synthesize new proteins.

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Q. No. 2 (xii) Certain human activities release clorofluorocarbons (CFCs) into atmosphere. They are gases or low boiling liquids that are so inert that they don't react with any chemical in ~~the~~ the troposphere. They slowly diffuse into ~~the~~ stratosphere. On absorbing UV radiation CFC molecule breaks down forming chlorine free radicals.

$$CCl_3F \xrightarrow{UV} \dot{C}Cl_2F + \dot{C}l$$

This $\dot{C}l$ leads to the depletion of ozone which is shown by following chemical equations:

$$\dot{C}l + O_3 \longrightarrow \dot{C}lO + O_2$$

$$\dot{C}lO + O \longrightarrow \dot{C}l + O_2$$

Net reaction: $O_3 + O \longrightarrow 2O_2$ The $\dot{C}l$ that is used in step 1 is regenerated in step 2. In this way, single $\dot{C}l$ can destroy thousands of ozone molecules.

Q. No. 2 (xiii) Adding slaked lime (Clark's method):-

Temporary hardness in water is caused by the presence of dissolved calcium or magnesium bicarbonates. Temporary hardness in water can be removed on large scale by adding slaked lime. The calcium and magnesium bicarbonates form insoluble carbonates. So, Ca^{+2} and Mg^{+2} ions are removed as insoluble carbonates, so water becomes soft.

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

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

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Q. No. 2 (xiv) **Urea:** Urea is a fertilizer that is added in the soil to provide the elements that are essential for plant growth. It is also used in pharmaceutical industry and is also used in industries for making synthetic fibres.

Manufacturing of Urea: Raw materials: Ammonia (NH_3) and carbon dioxide (CO_2).

Reactions: ① Reaction of NH_3 with CO_2 to form ammonium carbamate. $CO_2 + NH_3 \longrightarrow \underset{\text{Ammonium carbamate.}}{NH_2COONH_4}$

② Distillation of ammonium carbamate.

$$NH_2COONH_4 \xrightarrow{\text{distillation}} \underset{\text{Liquid urea.}}{NH_2-\overset{\overset{O}{\|}}{C}-NH_2} + H_2O$$

③ Liquid urea is concentrated in vacuum evaporators then it is sent to prilling station where urea prills are

Q. No. 2 (xv) **Fractional distillation:** It is the separation technique that is used to separate the components of a liquid based on the difference of their boiling points.

The crude oil is converted into useful products in a process which ~~are~~ is called refining. These useful products are called fractions.

Products obtained by fractional distillation of petroleum:-

1. Liquefied Petrolem Gas (LPG)
2. Gasoline or petrol.
3. Naphtha.
4. kerosene.
5. Diesel
6. Lubricating oils.
7. Fuel oils
8. Bitumen.

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(Section C)

Q. No. 3 (Page 1/4)

Q. No. 3 (Page 2/4)

Q. No. 3 (Page 3/4)

Q. No. 3 (Page 4/4)

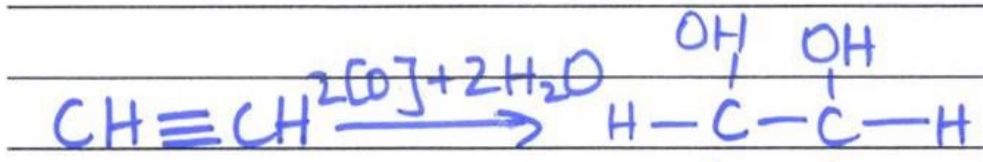
Q. No. 4 (Page 1/4)

(a) Reaction of $KMnO_4$ with Alkynes / Formation of Oxalic acid from Ethyne:- (Hydroxylation reaction ~~of $KMnO_4$~~):-

Alkynes do not react with the dilute alkaline aqueous solution of $KMnO_4$. They are oxidized by the strong alkaline aqueous solution of $KMnO_4$ to give oxalic acid. First four hydroxyl groups are added across the triple bond.

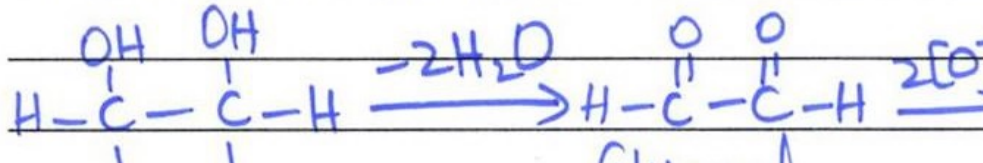
~~$4KMnO_4 + 4KOH \longrightarrow 4K_2MnO_4$~~

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



Ethyne — Tetrahydroxy ethane.

Tetrahydroxy ethane is an unstable compound. It quickly loses two water molecules to form glyoxal which further oxidizes to form oxalic acid.



Tetrahydroxy ethane — Glyoxal — Oxalic acid.

Q. No. 4 (Page 2/4)

b) Explain sources and uses of any two:-

1) Carbohydrates:-

Sources:- (1) Monosaccharides such as glucose and fructose are present in fruits, vegetables and cereals. They are also present in honey.

(2) Disaccharides such as sucrose is found in sugarcane and sugarbeet. Maltose is found in cereals. Lactose is found in milk and dairy products.

(3) Cellulose is obtained from plants. Cotton is pure cellulose.

(4) Starch is found in cereals, wheat, maize, barley, rice, potato and sweet potato etc.

Uses:-

(1) Carbohydrates store and transport energy in both plants and animals. For example 1g of glucose provides us 15.6kJ of energy.

(2) Carbohydrates serve as a food source for most of the organisms.

(3) Carbohydrates serve as a structural material for plants. Cellulose in human diet is referred to as fibre. We cannot digest it but it is very important for us. It helps the ~~muscles~~ muscles of our intestines to move the food efficiently through the digestive track. It absorbs and carries away the toxic chemicals in the food that can harm us. It regulates blood pressure and helps in

Q. No. 4 (Page 3/4) lowering the cholesterol.

(4) Sucrose is used as common table sugar.

(5) Glucose ~~in the~~ is stored in the animal muscle cells and liver cells in the form of glycogen. Glycogen serves as a long term energy reservoir. It can be converted back into glucose when needed for energy. Plants store this excess energy as starch.

(6) Starch is used to make rectified spirit by the fermentation process.

(7) Starch is converted into dextrin which is used as adhesive in stamps and as a wallpaper glue.

(8) Cows, deer, sheep, termites and cattle derive their nutrition from cellulose.

(9) We use cellulose in the form of wood ~~four~~ for housing, heating and for making furniture.

(10) Wood is also used to make paper and wood pulp.

(11) Cellulose fibre of cotton is used to make rayon and cellulose acetate which are used in the textile industry for making clothes.

Sources of lipids.-

Animals, plants and marine organisms such as salmon and whales are rich sources of lipids. Milk is an important source of animal fat from which butter, ghee and cheese are obtained. Seeds of many plants such as sunflower, corn, cotton, coconut groundnut

Q. No. 4 (Page 4/4) Uses of lipids:-

(1) Butter, ghee and vegetable oil are used for cooking and frying food, preparing bakery products and sweets.

(2) In mammals a layer of fat is present under the skin. This layer acts as a thermal insulator.

(3) Layers of fat prevents our delicate organs from shock. A layer of fat is present around our kidneys and heart which protect these organs from injury.

(4) Lipids provide some important vitamins (A, D and E) which are essential for our health.

(5) Fats and oils are important food source in living organisms. They provide about twice as much energy per gram as do carbohydrates.

(6) Vegetable oil is converted into vegetable ghee or margarine by the catalytic hydrogenation.

(7) Fats and oils are used in the manufacturing of soaps and detergents, cosmetics, paints, polishes and varnishes.

(8) Cholesterol is important in our body for the production of several hormones, vitamin D and bile acids.

Q. No. 5 (Page 1/4)

a) Types of hardness of water:- The hardness in water can be of two types:-

(1) Temporary hardness.
(2) Permanent hardness.

Temporary hardness is so called because it can be removed by boiling. Permanent hardness is so called because it cannot be removed by boiling.

Causes:- Temporary hardness in the water is caused due to the presence of dissolved calcium and magnesium hydrogen carbonates. Permanent hardness in the water is caused due to the presence of dissolved sulphates and chlorides of calcium and magnesium.

Methods of removing permanent hardness in water:-

(1) **By adding washing soda:-** The permanent hardness in the water can be removed on large scale by adding an estimated amount of washing soda ($Na_2CO_3 \cdot xH_2O$) in it. Since the Ca^{+2} and Mg^{+2} ions are removed as insoluble carbonates, so water becomes soft.

$$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3 + Na_2SO_4$$
$$MgSO_4 + Na_2CO_3 \longrightarrow MgCO_3 + Na_2SO_4$$

(2) **By ~~adding~~ ion exchange resins:**
The hard water is passed through a tank filled with suitable resins containing sodium

Q. No. 5 (Page 2/4)

exchanger. Chemically, it is called sodium aluminium silicate. It is represented by Na_2Z. The Ca^{+2} and Mg^{+2} ions present in the hard water are replaced with the sodium ions present in the resin.

$$Ca^{+2} + Na_2Z \longrightarrow 2Na^+ + CaZ$$
$$MgSO_4 + Na_2Z \longrightarrow MgZ + Na_2SO_4$$
$$CaSO_4 + Na_2Z \longrightarrow CaZ + Na_2SO_4$$
$$Mg^{+2} + Na_2Z \longrightarrow 2Na^+ + MgZ$$

~~The used up zeolite is treated with concentrated sodium chloride~~

The used up zeolite can be regenerated by heating it with ~~so~~ concentrated sodium chloride. This makes the process economical.

$$CaZ + 2NaCl \xrightarrow{heat} Na_2Z + CaCl_2 + H_2O$$

b) Solvay process:-

Sodium carbonate (Na_2CO_3) or soda ash is an important industrial chemical. It is used in the manufacturing of glass, soap, detergents, paper and other important chemicals. It is manufactured in a continuous process called solvay process.

Raw materials:

Soda ash is ~~manu~~ produced in a continuous process that uses:

(1) Ammonia (NH_3)
(2) Brine (concentrated sodium chloride solution).

Q. No. 5 (Page 3/4) ③ Limestone ($CaCO_3$) as a source of carbon dioxide (CO_2) and slaked lime ($Ca(OH)_2$)

Basic Reactions:- The following are the main steps in the solvay process:-

① Preparation of ammonical brine:- Ammonical brine is prepared by dissolving the ammonia gas in brine. Then, ammonical brine is fed into the carbonating tower.

② Carbonation: In carbonating tower, the carbon dioxide is passed through ammonical brine. Following reactions take place in the carbonating tower.

$$NH_3 + CO_2 + H_2O \longrightarrow NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \xrightarrow{15^\circ C} NaHCO_3 + NH_4Cl$$

In the lower compartments of the carbonating tower, the temperature is lowered to 15°C. At this temperature, $NaHCO_3$ precipitates out.

③ Filtration:

The precipitates of $NaHCO_3$ are separated from the milky solution by filtration. It is used as baking soda.

④ Calcination:

Sodium hydrogen carbonate ($NaHCO_3$) is heated to get sodium carbonate (Na_2CO_3)

$$2NaHCO_3 \xrightarrow{heat} Na_2CO_3 + CO_2 + H_2O$$

The carbondioxide that is released is re-used in the process. This makes the process economical.

Q. No. 5 (Page 4/4)

(5) Preparation of carbon dioxide and slaked lime: Carbondioxide is produced by heating ~~limestone~~ limestone in a kiln.

$$CaCO_3 \xrightarrow{heat} CaO + CO_2$$

This carbon dioxide is fed into the carbonating tower from the ~~bo~~ top. Equal amounts of lime (CaO) and water are mixed together to get slaked lime ($Ca(OH)_2$).

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

This slaked lime is pumped into the ammonia recovery tower.

(6) Recovery of Ammonia: Ammonium chloride (NH_4Cl) that is produced in the carbonating tower is reacted with slaked lime to get ammonia.

~~$2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O$~~

$$2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + 2H_2O$$

The ammonia is recovered almost 100%. It is reused in the process. This makes the process economical.

Flowsheet diagram:-