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Preface

Lot of thanks to Almighty ALLAH Who enabled me to write these standard notes for class 10th chemistry. These notes are written in accordance with the new syllabus for 10th class students. In presenting these notes, care has been taken to fill a gap which often develops in teaching the students of chemistry. Very easy sentences have been used which are very easy to understand. I hope it will play a leading role in getting outstanding marks in the examination.

I dedicated my academic success and progress in life to my family whose endless prayers are source of encouragement and determination for me throughout the long years of my education and to my teachers whose guidance and hard work made me such a person who I could not be able to be without them.

It is hoped that factual errors are not present in these notes. The author and Publisher will appreciate having errors, if any, called to his attention and would welcome all types of suggestions for the approval of these notes.

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Chapter No.09 Chemical Equilibrium

Q.1: Explain irreversible and reversible reactions?

Ans. Irreversible reactions:

"Those chemical reactions which proceed in forward direction only are called irreversible reactions." OR

"Those chemical reactions in which reactants are changed into products only and products are not changed to reactants are called irreversible reactions."

Characteristics of irreversible reactions:

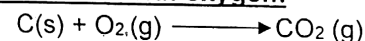
Irreversible reactions have the following characteristics:

- These reactions proceed in one direction only.
- They are represented by a single arrow sign ($\longrightarrow$)
- No equilibrium state is established in irreversible reactions.
- These reactions go to completion.

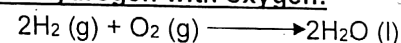
Examples:

A few examples of irreversible reactions are given below:

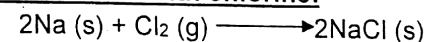
i. Reaction of carbon with oxygen:



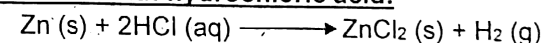
ii. Reaction of hydrogen with oxygen:



iii. Reaction of sodium with chlorine:



iv. Reaction of zinc with hydrochloric acid:



Reversible reactions:

"Those chemical reactions which proceed both in forward and backward directions are called reversible reactions." OR

"Those chemical reactions in which the reactants react to form the products and the products react to form the reactants back are called reversible reactions."

Characteristics of reversible reactions:

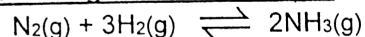
A reversible reaction has the following characteristics:

- These reactions proceed in two directions i.e. forward and backward
- These reactions never go to completion i.e. the reactants are not fully converted into products.
- Their reversibility can exist in closed containers only.

- iv. A state of dynamic equilibrium is established in all reversible reactions.
v. These reactions are represented by double arrow sign ($\rightleftharpoons$).

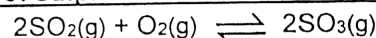
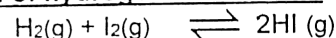
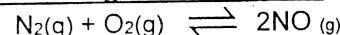
Examples:

Following are a few examples of reversible reactions:

i. Reaction of nitrogen with hydrogen:

At the start, reaction goes in forward direction but as soon as some amount of ammonia is formed, the ammonia molecules dissociate to nitrogen and hydrogen. Thus the reaction is reversed.

Some other examples are:

ii. Reaction of sulphur dioxide with oxygen:**iii. Reaction of hydrogen with iodine:****iv. Reaction of nitrogen with oxygen:**

Q.2: Explain chemical equilibrium/Dynamic equilibrium with examples?

Ans. Chemical equilibrium/Dynamic equilibrium:

History:

Chemical equilibrium (Dynamic equilibrium) was first discovered by a French chemist Claude Louis Berthollet in 1803.

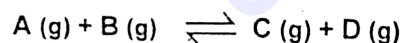
Definition:

"The state of a reversible chemical reaction in which the rate of forward reaction becomes equal to the rate of reverse reaction is called chemical equilibrium/Dynamic equilibrium." OR

"The state of a reversible chemical reaction at which the reactants are continuously changing to products and the products are continuously changing to the reactants back but the concentrations of reactants and products remain constant is called chemical equilibrium/Dynamic equilibrium."

Explanation:

Consider a general chemical reaction in which reactant A reacts with reactant B in gaseous state, in a closed container, to form products C and D.



The detail about this general reversible reaction is given below:

i. Concentrations at the start:

At the start of the reaction the concentrations of A and B are maximum while that of C and D are zero.

ii. Concentrations after some time:

With the passage of time the concentrations of C and D gradually increase while that of A and B gradually decreases.

iii. Variation of rate of forward and reverse reactions:

Change in concentrations of reactants or products per unit time is called rate of reaction.

In the beginning, the rate of forward reaction is maximum while rate of reverse reaction is almost zero but as the time passes and sufficient amounts of C and D are formed then the rate of backward reaction increases while that of forward reaction decreases until rate of forward reaction becomes equal to the rate of reverse reaction. Thus, a state of dynamic equilibrium is established.

iv. Concentration at equilibrium state:

The concentrations of reactants or products remain constant at equilibrium state. These concentrations are called equilibrium concentrations.

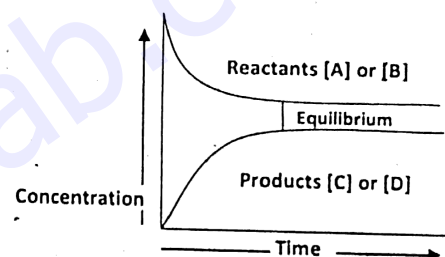
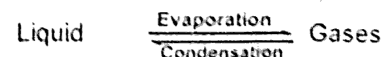
v. Graphical representation:

Figure: Graph showing Reversible reaction and equilibrium state

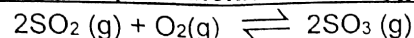
Examples:**i. Change of a liquid to gas in a closed container:**

Consider a closed container which is partially filled with a liquid at a given temperature. At the start, evaporation starts and the vapour molecules are collected at the liquid surface. At the passage of time the collected gas molecules over the liquid surface converts to liquid back (condensation starts). In the beginning rate of evaporation is faster than the rate of condensation but with the passage of time the rate of evaporation becomes equal to the rate of condensation and thus a state of dynamic equilibrium is established.

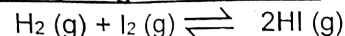


Equilibrium state is also established in the following chemical reactions;

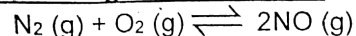
i. Reaction of sulphur dioxide with oxygen:



ii. Reaction of hydrogen with iodine:



iii. Reaction of nitrogen with oxygen:



Q.3. Discuss types of equilibrium?

Ans. Types of equilibrium:

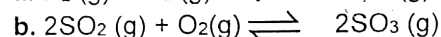
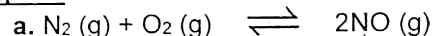
There are two types of equilibrium on the basis of physical state.

They are described below:

i. Homogeneous equilibrium:

"The type of equilibrium in which all the substances are in the same physical state is called homogeneous equilibrium."

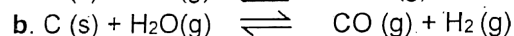
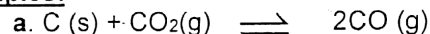
Examples:



ii. Heterogeneous equilibrium:

"The type of equilibrium in which the substances are present in different physical states is called heterogeneous equilibrium."

Examples:



Q.4. Define and explain law of mass action?

Ans. Law of mass action:

History:

This law was presented by two Norwegian chemists Cato Maximilian Guldberg and Peter Waage in 1864.

Definition/statement:

"This law states that the rate of a chemical reaction is directly proportional to the product of active masses of the reacting substances." A more general definition of law of mass action is given below:

"This law states the rate of a chemical reaction is directly proportional to the product of active masses of reacting substances raised to a power the number moles of the reacting substances from the balanced chemical equation."

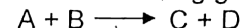
Active masses:

Active masses mean molar concentration of reacting substances. Molar concentration is the number of moles per dm^3 or litre. The molar

concentration of reacting substances is expressed by enclosing their symbols or formulas in square brackets i.e. []

For example:

Consider the following general chemical equation:



Then according to law of mass action:

$$r \propto [\text{A}][\text{B}]$$

$$\Rightarrow r = k[\text{A}][\text{B}]$$

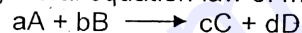
Where,

r = rate of reaction

$[\text{A}]$ and $[\text{B}]$ = molar concentrations of reacting substances

While, k = rate constant of the reaction

For a more general equation law of mass action can be written as:



$$r \propto [\text{A}]^a[\text{B}]^b$$

$$\Rightarrow r = k[\text{A}]^a[\text{B}]^b$$

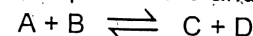
Where,

a and b = number of moles of reacting substances in the balanced chemical equation.

Q.5. Derive an expression for equilibrium constant.

Ans. Derivation of the expression for the equilibrium constant:

Consider a general reversible reaction in which two reactants A and B react to form two products C and D.



Law of mass action for forward reaction:

Let the molar concentrations of both reactants be represented by $[\text{A}]$ and $[\text{B}]$. Then according to law of mass action the rate of forward reaction (r_1) is directly proportional to the product of active masses (molar concentrations) of reactants A and B. By applying law of mass action to forward reaction we get:

$$r_1 \propto [\text{A}][\text{B}]$$

$$\Rightarrow r_1 = k_f[\text{A}][\text{B}]$$

Where r_1 represents rate of forward reaction while k_f is the rate constant of forward reaction.

Law of mass action for reverse reaction:

As the above reaction is reversible therefore, when sufficient C and D are formed, they react to form the reactant A and B again. Applying law of mass action for reverse reaction:

$$r \propto [\text{C}][\text{D}]$$

$$\Rightarrow r_2 = k_r[\text{C}][\text{D}]$$

Where r_2 represents rate of reverse reaction while k_r is the rate constant of reverse reaction.

At equilibrium:

The rate of forward reaction = The rate of reverse reaction

$$r_1 = r_2$$

Putting the values of r_1 and r_2 we get:

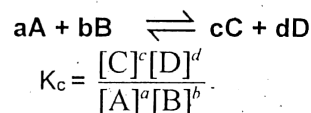
$$k_f[A][B] = k_r[C][D]$$

On rearranging:

$$\frac{k_f}{k_r} = \frac{[C][D]}{[A][B]}$$

$$\Rightarrow K_c = \frac{[C][D]}{[A][B]} \text{ where } K_c = \frac{k_f}{k_r}$$

For more general reaction K_c is written as:



Where **a**, **b**, **c** and **d** represent the number of moles from the balanced chemical equation.

Note:

If the number of moles is one, then it is not written.

Equilibrium constant (K_c):

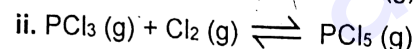
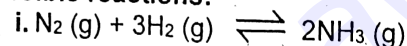
K_c is called equilibrium constant. The equilibrium constant is defined as "The ratio of the product of the active masses of the products to the product of active masses of reactants is called equilibrium constant."

A large value of K_c means that at equilibrium products concentration is greater than the reactants and vice versa.

The equilibrium constant is independent of pressure, concentration and catalyst and its value is constant for a particular reaction.

Activity:

Write equilibrium constant expressions for the following reversible reactions:



Solution:

As we know that:

$$K_c = \frac{[\text{Product of products concentrations}]^{\text{number of moles}}}{[\text{Product of reactants concentrations}]^{\text{number of moles}}}$$

Therefore, equilibrium constant for the above reactions are given below:

i. $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

ii. $K_c = \frac{[PCl_5]}{[PCl_3][Cl_2]}$

Q.6. What is equilibrium constant? Explain its units.

Ans. Equilibrium constant:

"The ratio of the product of the active masses of the products to the product of active masses of reactants is called equilibrium constant."

Denotation:

It is denoted by K_c where the subscript c indicates the equilibrium concentrations of various species in term of mole/dm³ or litre.

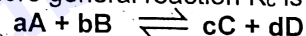
For example consider the following general reaction



Then K_c for this reaction will be:

$$K_c = \frac{[C][D]}{[A][B]}$$

For more general reaction K_c is written as:



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

Where $[A]$, $[B]$, $[C]$ and $[D]$ represents molar concentration of reactants and products while **a**, **b**, **c** and **d** represents the number of moles from the balanced chemical equation.

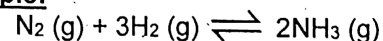
Units of equilibrium constant:

The unit of equilibrium constant depends on the equilibrium constant expression. We have two cases regarding the units of equilibrium constant:

Case-1:

It may have units if the number of moles of reactants and products are unequal in the balanced chemical equation.

Example:



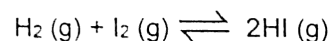
K_c for this reaction is:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}][\text{mol dm}^{-3}]^3}$$

$$= \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}]^4} = \frac{1}{[\text{mol dm}^{-3}]^2} = \frac{1}{[\text{mol}^2 \text{ dm}^{-6}]} \\ = \text{mol}^{-2} \text{ dm}^6$$

Case-2:

It may have no units if the number of moles of reactants and products are equal in the balanced chemical equation.

Example:

K_c for this reaction is:

$$K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} = \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}][\text{mol dm}^{-3}]} = \text{No units}$$

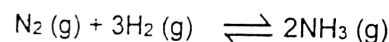
Therefore, it is concluded that equilibrium constant has different units for different chemical reactions.

Example 9.2:

Write an equilibrium constant expression for the reaction of nitrogen and hydrogen to form ammonia at 150-200 atm pressure and 400°C to 500°C while iron is used as catalyst.

Ans: Equilibrium Constant Expression (K_c):

First we write the chemical equation for the reaction of nitrogen with hydrogen to form ammonia:

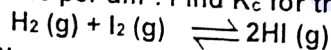


Now K_c for this reaction is:

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

Example 9.3:

In the equilibrium mixture, the concentration of hydrogen and iodine is 0.04 moles per dm^3 each while that of hydrogen iodide is 0.08 mole per dm^3 . Find K_c for the following reaction:

**Given:**

Chemical equation = $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
 Concentrations of hydrogen = 0.04 mol/ dm^3
 Concentrations of iodine = 0.04 mol/ dm^3
 Concentration of hydrogen iodide = 0.08 mol/ dm^3

Required:

Value of K_c

Solution:

Writing equilibrium constant expression for the above reaction:

$$K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$$

Putting the values we get:

$$K_c = \frac{[0.08 \text{ mol dm}^{-3}]^2}{[0.04 \text{ mol dm}^{-3}][0.04 \text{ mol dm}^{-3}]} = \frac{0.0064 \text{ mol}^2 \text{ dm}^{-6}}{0.0016 \text{ mol}^2 \text{ dm}^{-6}} = 4$$

Result:

Value of $K_c = 4$

Example 9.4:

For the above reaction at certain high temperature the concentration of CO is 0.0600 mol/ dm^3 , H_2O is 0.120 mol/ dm^3 , CO_2 is 0.150 mol/ dm^3 and H_2 is 0.300 mol/ dm^3 . Calculate the value of the equilibrium constant.

Given:

Chemical equation = $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$
 Concentrations of CO = 0.0600 mol/ dm^3
 Concentration of H_2O = 0.120 mol/ dm^3
 Concentration of CO_2 = 0.150 mol/ dm^3
 Concentration of H_2 = 0.300 mol/ dm^3

Required:

To calculate the value of K_c

Solution:

Writing equilibrium constant expression for the above reaction:

$$K_c = \frac{[\text{CO}_2][\text{H}_2]}{[\text{CO}][\text{H}_2\text{O}]}$$

Putting the values we get:

$$K_c = \frac{[0.150 \text{ mol dm}^{-3}][0.300 \text{ mol dm}^{-3}]}{[0.0600 \text{ mol dm}^{-3}][0.120 \text{ mol dm}^{-3}]}$$

$$K_c = \frac{[0.150 \text{ mol dm}^{-3}][0.300 \text{ mol dm}^{-3}]}{[0.0600 \text{ mol dm}^{-3}][0.120 \text{ mol dm}^{-3}]}$$

$$K_c = \frac{[0.150][0.300]}{[0.0600][0.120]}$$

$$K_c = \frac{0.045}{0.0072}$$

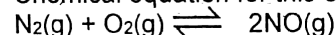
$$K_c = 6.25$$

Result:Value of $K_c = 6.25$ **Practice Problem 9.4:**

An equilibrium mixture of N_2 , O_2 and NO gases at $1500K$ is determined to consist of $6.4 \times 10^{-3} \text{ mol/dm}^3$ of N_2 , $1.7 \times 10^{-3} \text{ mol/dm}^3$ of O_2 and $1.1 \times 10^{-5} \text{ mol/dm}^3$ of NO . What is the equilibrium constant for the given system?

Given:Concentrations of $NO = 1.1 \times 10^{-5} \text{ mol/dm}^3$ Concentration of $N_2 = 6.4 \times 10^{-3} \text{ mol/dm}^3$ Concentration of $O_2 = 1.7 \times 10^{-3} \text{ mol/dm}^3$ **Required:**To calculate the value of K_c **Solution:**

Chemical equation for this equilibrium mixture is:



Writing equilibrium constant expression for the above reaction:

$$K_c = \frac{[NO]^2}{[N_2][O_2]}$$

Putting the values we get:

$$K_c = \frac{[1.1 \times 10^{-5} \text{ mol.dm}^{-3}]^2}{[6.4 \times 10^{-3} \text{ mol.dm}^{-3}][1.7 \times 10^{-3} \text{ mol.dm}^{-3}]}$$

$$K_c = \frac{[1.21 \times 10^{-10} \text{ mol}^2 \cdot \text{dm}^{-6}]}{[10.88 \times 10^{-6} \text{ mol}^2 \cdot \text{dm}^{-6}]}$$

$$K_c = \frac{[1.21 \times 10^{-10} \text{ mol}^2 \cdot \text{dm}^{-6}]}{[1.088 \times 10^{-5} \text{ mol}^2 \cdot \text{dm}^{-6}]}$$

$$K_c = \frac{1.21 \times 10^{-10} \times 10^5}{1.088}$$

$$K_c = 1.112 \times 10^{-5}$$

$$K_c = 6.25$$

Result:Value of $K_c = 1.112 \times 10^{-5}$

Q.7. What is the importance of equilibrium constant? OR
What are the applications of equilibrium constant?

Ans. Importance/applications of equilibrium constant:

The value of equilibrium constant is specific and remains constant at a particular temperature. The equilibrium constant can be used to predict:

- The direction of chemical reaction
- The extent of chemical reaction
- The effect of change in conditions upon a chemical reaction in equilibrium state.

The detail is given below:

1. Prediction of direction of reaction:

The direction of reaction can be predicted by comparing the value of reaction quotient (Q_c) with that of K_c .

(Q_c is the ratio of initial molar concentration of products to initial molar concentration of reactants i.e.

$$Q_c = \frac{[\text{Initial concentration of products}]}{[\text{Initial concentration reactants}]}$$

By comparing the value of Q_c with K_c we have three possibilities:

i. $Q_c < K_c$

If the value of Q_c is less than K_c then the reaction will proceed in forward direction to form products.

ii. $Q_c > K_c$

If the value of Q_c is greater than K_c then the reaction will go in the reverse direction to form reactants.

iii. $Q_c = K_c$

If the value of Q_c is equal to K_c then the reaction is at equilibrium i.e. rate of forward reaction is equal to the rate of reverse reaction.

2. Extent of chemical reaction:

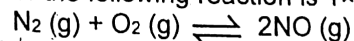
The value of K_c tells us about the extent of reaction from which quantities of reactants or products can also be predicted. There are three possibilities:

i. K_c value very small:

If K_c value is very small then the forward reaction will not occur to an appreciable extent and the reverse reaction (from right to left) will go nearly to completion. Thus, we have large amount of reactants as compared to products.

For example:

K_c value for the following reaction is 1×10^{-30} at 25°C which is very small



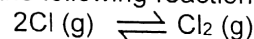
The equilibrium mixture of above reaction will contain large amounts of N_2 and O_2 and trace amount of NO .

ii. K_c value very large:

If K_c value is very large then the reverse reaction will not occur to an appreciable extent and the forward reaction (from left to right) will go nearly to completion. Thus, we have large amount of products as compared to reactants.

For example:

K_c value for the following reaction is 1×10^{38} at 25°C which is very large.



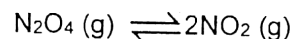
Thus, the equilibrium mixture of above reaction will consist of almost entirely all chlorine molecules. The chlorine atoms will be in negligible amount.

iii. K_c value neither very small nor very large (moderate):

If K_c value is neither very small nor very large then neither the forward nor the reverse reaction goes to completion. Thus, both reactants and products will be present in neither very large nor very small amounts.

For example:

The K_c value for the following reaction is 0.36 at 25°C which is moderate.



The equilibrium mixture of above reaction will contain both N_2O_4 and NO_2 in moderate amounts.

3. The effect of change in external conditions:

Once a system has attained the equilibrium then it is possible to change the ratio of products to reactants by changing the external conditions i.e. concentration, pressure, temperature. Changing these conditions will disturb the equilibrium. We can deduce the direction in which equilibrium will shift when one of these changes. This can be done by applying Le-Chatelier's principle stated by French chemist Henri Louis Le Chatelier in 1888.

Le-Chatelier's principle:

This principle states that if a system at equilibrium is disturbed by some change, the system will shift so as to counteract the effect of the change. (OR)

If the equilibrium of a system is disturbed through any body. It resists to change its position.

We can determine the extent of shift by working with the equilibrium constant K_c .

Q.8. Write down the conditions necessary for equilibrium.**Ans. Conditions necessary for equilibrium:**

If a system attains equilibrium, then it will remain at equilibrium until its conditions are changed. When the conditions are disturbed, the equilibrium will also be disturbed.

Followings are the conditions necessary for chemical equilibrium:

i. Closed container:

Equilibrium state can only be attained in closed container. It cannot be attained in open container because in open container the gaseous reactants and products will escape due to which there will be no possibility of equilibrium.

ii. Constant concentrations:

When equilibrium state is attained by a reaction in a closed container then the concentrations of various species in the reaction become constant. These concentrations are called equilibrium concentrations.

iii. No change in catalyst:

If the catalyst used at the equilibrium state is unchanged the system will remain at equilibrium.

iv. Constant Volume:

For equilibrium to remain, constant volumes are also necessary.

v. Constant Pressure:

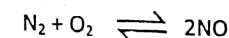
Constant pressure is also necessary for equilibrium state, to remain unchanged.

Society, technology and science

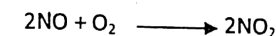
Nitrogen and oxygen are present in our atmosphere which are used in the industrial preparation of nitric acid by Birkland-Eyde process. This process has the following Steps:

Step-1:

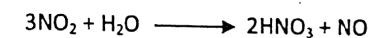
In this step air is passed through an electric arc to produce nitric oxide:

**Step-2:**

The nitric oxide is further oxidized to NO_2 in the presence of oxygen:

**Step-3:**

The NO_2 is dissolved in water in absorption tower to produce nitric acid:



EXERCISE

Multiple Choice Questions

Q.1: Choose the correct answers from the given options:

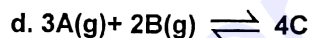
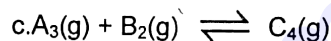
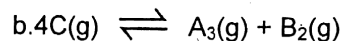
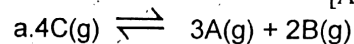
- i. At dynamic equilibrium
 - a. The reverse reaction stops
 - b. The forward reaction stops
 - c. Both forward and reverse reactions stop
 - d. Both forward and reverse reactions continue at the same rate.**
- ii. A reversible reaction has the following characteristics except:
 - a. They proceed in both directions
 - b. They never complete
 - c. Products do not form reactants again**
 - d. They are represented by $\rightleftharpoons$
- iii. The equilibrium constant expression for the given reaction is:

$$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$$
 - a. $\frac{[2\text{N}][2\text{O}]}{[2\text{NO}]}$
 - b. $\frac{[\text{N}]^2[\text{O}]^2}{[2\text{NO}]}$
 - c. $\frac{[\text{N}_2][\text{O}_2]}{[\text{NO}]^2}$
 - d. $\frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$**
- iv. The equilibrium constant K_c is:
 - a. The sum of the two reactants
 - b. The difference of two rate constants
 - c. The ratio of the two rate constants**
 - d. The product of the two rate constants
- v. When the value of K_c is very small it shows that:
 - a. Reaction will go in the forward direction**
 - b. Reaction will go in reverse direction
 - c. Reaction is a equilibrium
 - d. Equilibrium will never establish
- vi. For which of the following reaction, the K_c will have no unit:
 - a. $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$**
 - b. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$
 - c. $\text{CO}(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g})$
 - d. $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$
- vii. When the value of K_c is very large it shows that:
 - a. Reaction will go in the forward direction
 - b. Reaction will go in reverse direction**
 - c. Reaction is a equilibrium
 - d. Equilibrium will never establish

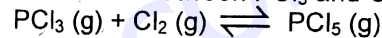
viii. Active mass means:

- a. The total mass of reactants
- b. The total mass of products
- c. The total mass of reactants and products
- d. Concentrations of reactants and products in mole per dm^3 in a dilute solution**

ix. For a reversible reaction: $\frac{[\text{C}]^4}{[\text{A}]^3 + [\text{B}]^2}$, The equation will be



x. The reaction between PCl_3 and Cl_2 will produce PCl_5



The units of K_c for this reaction are

- a. $\text{mol} \cdot \text{dm}^{-3}$
- b. $\text{mol}^{-1} \cdot \text{dm}^{-3}$
- c. $\text{mol}^{-1} \cdot \text{dm}^3$**
- d. $\text{mol} \cdot \text{dm}^3$

Solution:

$$K_c = \frac{[\text{PCl}_5]}{[\text{PCl}_3][\text{Cl}_2]} = \frac{[\text{mol} \cdot \text{dm}^{-3}]}{[\text{mol} \cdot \text{dm}^{-3}][\text{mol} \cdot \text{dm}^{-3}]}$$

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

Short Questions

Q 1. Define chemical equilibrium with two examples?

Ans. Chemical Equilibrium:

History:

Chemical equilibrium was first discovered by a French chemist Claude Louis Berthollet in 1803.

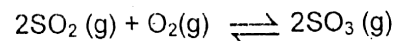
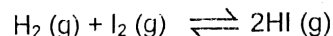
Definition:

"The state of a reversible chemical reaction in which the rate of forward reaction becomes equal to the rate of reverse reaction is called chemical equilibrium." (OR)

"The state of a reversible chemical reaction at which the reactants are continuously changing to products and the products are continuously changing to the reactants back but the concentrations of reactants and products remain constant is called chemical equilibrium."

Two Examples:

In the following two examples equilibrium state will be established in closed container.

i. Reaction of sulphur dioxide with oxygen:**ii. Reaction of hydrogen with iodine:**

Q 2. How would you identify that dynamic equilibrium has been established?

Ans. Identification Of Dynamic Equilibrium:

In order to identify the equilibrium state of a reversible chemical reaction, the following methods are used:

- Physical Methods such as refractometry, polarimetry, spectrophotometry.
- Chemical methods such as titration etc.

In both methods, the equilibrium state of a reversible chemical reaction is identified by knowing the concentration of reactants and products at regular interval of time.

When the concentration of the reactants and products become constant, then reaction is said to be in equilibrium.

Q 3. Compare the different macroscopic properties of forward and reverse reactions?

Ans. Comparison between the macroscopic properties of forward and reverse reactions:

It is given in the table below:

	Forward Reaction	Reverse Reaction
(i)	It is a reaction in which reactants react to form products.	It is a reaction in which products react to form reactants.
(ii)	It takes place from left to right.	It takes place from right to left.
(iii)	At initial stage, the rate of forward reaction is very fast.	At initial stage, the rate of reverse reaction is very negligible.
(iv)	It slows down gradually.	It speeds up gradually.
Example: $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \xrightleftharpoons[\text{Reverse reaction}]{\text{Forward reaction}} 2\text{HI}(\text{g})$		

Q 4. What is required to predict the direction of a chemical reaction?

Ans. Requirement for predicting direction of a chemical reaction:

The value of K_c and Q_c is required for predicting the direction of a chemical reaction. It is explained below:

Prediction of direction of reaction:

The direction of reaction can be predicted by comparing the value of reaction quotient (Q_c) with that of K_c .

Q_c is the ratio of initial molar concentration of products to initial molar concentration of reactants i.e.

$$Q_c = \frac{[\text{Initial concentration of products}]}{[\text{Initial concentration reactants}]}$$

By comparing the value of Q_c with K_c we have three possibilities:

i. $Q_c < K_c$:

If the value of Q_c is less than K_c then the reaction will proceed in forward direction to form products.

ii. $Q_c > K_c$:

If the value of Q_c is greater than K_c then the reaction will go in the reverse direction to form reactants.

iii. $Q_c = K_c$:

If the value of Q_c is equal to K_c then the reaction is at equilibrium i.e. rate of forward reaction is equal to the rate of reverse reaction.

Q 5. Relate the active mass with rate of a chemical equation?

Ans. Relation of active mass with rate of a chemical equation:

The active mass is related with rate of a chemical equation by law of mass action stated by two Norwegian Chemists, Guldberg and Peter Waage in 1864. According to law of mass action:

Statement:

The rate or speed of a chemical reaction is directly proportional to the products of active masses of reacting substances raised to a power the number moles of the reacting substances from the balanced chemical equation."

Active Masses:

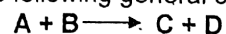
Active masses mean molar concentrations i.e. number of moles per dm^3 .

Rate Of Reaction:

Rate of reaction means change in concentrations of reacting substances per unit time.

Mathematical Relation:

Consider the following general chemical equation:



Then according to law of mass action;

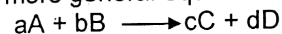
$$\begin{aligned} r &\propto [\text{A}][\text{B}] \\ \Rightarrow r &= k[\text{A}][\text{B}] \end{aligned}$$

Where,

r = rate of reaction

$[A]$ and $[B]$ = molar concentrations of reacting substances while
 k = rate constant of the reaction

For a more general equation law of mass action can be written as:



$$r \propto [A]^a [B]^b$$

$$r = k[A]^a [B]^b$$

where,

a and b = number of moles of reacting substances in the balanced chemical equation

Q 6. At equilibrium a mixture of N_2 , H_2 and NH_3 gas at $500^\circ C$ is determined to consist of 0.602 mol/dm^3 of N_2 , 0.420 mol/dm^3 of H_2 and 0.113 mol/dm^3 of NH_3 . What is equilibrium constant for the reaction at this temperature?

Ans. Given:

Concentration of $N_2 = 0.602 \text{ mol/dm}^3$

Concentration of $H_2 = 0.420 \text{ mol/dm}^3$

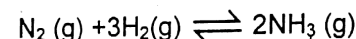
Concentration of $NH_3 = 0.113 \text{ mol/dm}^3$

Required:

To calculate the equilibrium constant (K_c).

Solution:

The chemical equation for the reaction is:



The equilibrium constant expression for this reaction is:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

Putting the values in the above equation we get:

$$K_c = \frac{[0.113 \text{ mol/dm}^3]^2}{[0.602 \text{ mol/dm}^3][0.420 \text{ mol/dm}^3]^3}$$

$$\Rightarrow K_c = \frac{0.01277 \text{ mol}^2 / \text{dm}^6}{0.04461 \text{ mol}^4 / \text{dm}^{12}}$$

$$\Rightarrow K_c = \frac{0.286 \text{ mol}^2 / \text{dm}^6}{\text{mol}^4 / \text{dm}^{12}}$$

$$\Rightarrow K_c = \frac{0.286 \text{ mol}^2 \cdot \text{dm}^{-6}}{\text{mol}^4 \cdot \text{dm}^{-12}}$$

$$\Rightarrow K_c = 0.286 \text{ mol}^2 \cdot \text{dm}^{-6} \cdot \text{mol}^{-4} \cdot \text{dm}^{12}$$

$$\Rightarrow K_c = 0.286 \text{ mol}^2 \cdot \text{dm}^6$$

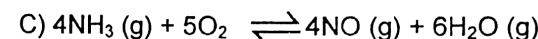
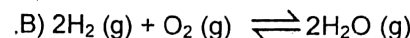
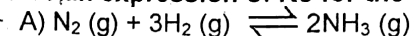
Result:

Equilibrium Constant (K_c) = $0.286 \text{ mol}^2 \cdot \text{dm}^6$

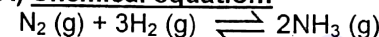
Q 7. State conditions necessary for chemical equilibrium.

Ans. For answer see Question no.8

1. Give an expression of K_c for the following reactions:



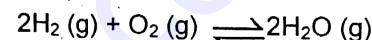
Ans. A) Chemical equation:



Equilibrium constant expression:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

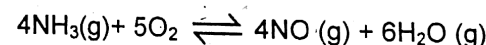
B) Chemical equation:



Equilibrium constant expression:

$$K_c = \frac{[H_2O]^2}{[H_2]^2 [O_2]}$$

C) Chemical equation:



Equilibrium constant expression:

$$K_c = \frac{[NO]^4 [H_2O]^6}{[NH_3]^4 [O_2]^5}$$

Q 9. A reaction between gaseous sulphur dioxide and oxygen gas to produce gaseous sulphur tri-oxide takes place at $600^\circ C$. At this temperature the concentration of SO_2 is found to be 1.50 mol/dm^3 , the concentration of O_2 is 1.25 mol/dm^3 and the concentration of SO_3 is 3.50 mol/dm^3 . Using balance chemical equation calculates the equilibrium constant for this system?

Ans. Given:

Concentration of $SO_2 = 1.50 \text{ mol/dm}^3$

Concentration of $O_2 = 1.25 \text{ mol/dm}^3$

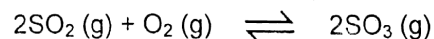
Concentration of $SO_3 = 3.50 \text{ mol/dm}^3$

Required:

To calculate the equilibrium constant (K_c)

Solution:

The chemical equation for the reaction is:



The equilibrium constant expression for this reaction is:

$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$$

Putting the values in the above equation we get:

$$K_c = \frac{[3.50 \text{ mol/dm}^3]^2}{[1.50 \text{ mol/dm}^3]^2 [1.25 \text{ mol/dm}^3]}$$

$$\Rightarrow K_c = \frac{12.25 \text{ mol}^2/\text{dm}^6}{2.25 \text{ mol}^2/\text{dm}^6 \times 1.25 \text{ mol/dm}^3}$$

$$\Rightarrow K_c = \frac{12.25}{2.8125 \text{ mol} \cdot \text{dm}^{-3}}$$

$$\Rightarrow K_c = 4.36 \text{ mol}^{-1} \cdot \text{dm}^3$$

Result:

Equilibrium Constant (K_c) = $4.36 \text{ mol}^{-1} \cdot \text{dm}^3$

Q 10. Describe the effect of temperature on equilibrium constant?

Ans. Effect Of Temperature On Equilibrium Constant:

Temperature affects the equilibrium constant of a system. It affects the equilibrium constant value in the following two ways:

Effect On Exothermic Reaction:

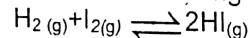
If we increase the temperature of an exothermic reaction, the value of equilibrium constant will decrease.

Effect On Endothermic Reaction:

If we increase the temperature of an endothermic reaction, the value of equilibrium constant will increase.

Example:

Consider the following chemical equation:



The K_c value for the above reaction at different temperatures is given below;

Temperature	K_c
500K	160
700K	54

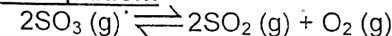
As the forward reaction is exothermic and backward is endothermic therefore when temperature is increased then according to Le-Chatelier's principle the backward reaction will proceed and more reactants will be formed thus the value of K_c is decreased.

Long Questions

Q.1. $\text{SO}_3(\text{g})$ decomposes to form $\text{SO}_2(\text{g})$ and $\text{O}_2(\text{g})$. For this reaction write,

- Chemical equation
- K_c expression
- Derive the units of K_c for this reaction

Ans(a) Chemical Equation:



Ans(b) K_c expression:

The equilibrium constant expression for this reaction is:

$$K_c = \frac{[\text{SO}_2]^2[\text{O}_2]}{[\text{SO}_3]^2}$$

Ans(c) Units Of K_c :

As we know that the equilibrium constant expression is:

$$K_c = \frac{[\text{SO}_2]^2[\text{O}_2]}{[\text{SO}_3]^2}$$

Putting the values we get:

$$K_c = \frac{[\text{mol/dm}^3]^2 [\text{mol/dm}^3]}{[\text{mol/dm}^3]^2}$$

$$K_c = \text{mol/dm}^3$$

Q.2 (a). Describe the equilibrium state with the help of a graph and an example.

Ans. For answer see Question no.2

(b). Define the law of mass action.

Ans. For answer see Question no.4

Q.3(a). Derive an expression for the equilibrium constant and explain its units.

Ans. For answer see Question no.6

(b). How can you predict the direction of reaction for the K_c value?

Ans. For answer see Question no.7

Q.4(a). K_c has different units in different reactions. Prove it with suitable examples.

Ans. For answer see Question no.6

(b). How can you predict the extent of reaction from the K_c value?

Ans. For answer see Question no.7

Q.5 (a) K_c expression for a reaction is given below,

$$K_c = \frac{[\text{Cl}_2]^2[\text{H}_2\text{O}]^2}{[\text{HCl}]^4[\text{O}_2]}$$

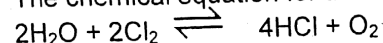
For this reaction write,

i. Reactants and products

ii. Derive the units of K_c

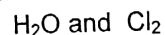
Ans(i). Chemical Equation:

The chemical equation for this expression is:



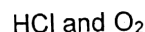
Reactants:

Reactants for this reaction are:



Products:

Products for this reaction are:



Ans(ii) Units Of K_c : As

$$K_c = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]}$$

Putting the values in the above equation we get:

$$K_c = \frac{[\text{mol/dm}^3]^2 [\text{mol/dm}^3]^2}{[\text{mol/dm}^3]^4 [\text{mol/dm}^3]}$$

$$\Rightarrow K_c = \frac{[\text{mol/dm}^3]^4}{[\text{mol/dm}^3]^4 [\text{mol/dm}^3]}$$

$$\Rightarrow K_c = \frac{[\text{mol/dm}^3]^4}{[\text{mol/dm}^3]^4 [\text{mol/dm}^3]}$$

$$\Rightarrow K_c = \frac{1}{[\text{mol/dm}^3]}$$

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

b. Explain the importance of equilibrium constant, support your answer with examples and reasons.

Ans: For answer see Question no.7

Additional Multiple Choice Questions

1. A reversible reaction proceeds in the:
 - (a) Reverse direction.
 - (b) Forward direction.
 - (c) Forward and reverse direction.
 - (d) More backward less forward.

2. For the reaction $A + B \rightleftharpoons C + D$, K_c is equal to:

- (a) $\frac{[A]+[B]}{[C]+[D]}$ (b) $\frac{[A]+[D]}{[B]+[C]}$ (c) $\frac{[A][B]}{[C][D]}$ (d) $\frac{[C][D]}{[A][B]}$

3. Molecules of chlorine do not decompose into atomic chlorine i.e: $\text{Cl}_2 \rightleftharpoons 2\text{Cl}$. This is because K_c of this reaction is:

- (a) Very large (b) very small (c) zero (d) 1.

4. How much reaction is complete when $K_c=1$:

- (a) 10% (b) 25% (c) 50% (d) 100%.

5. The escape of molecules from the surface of a liquid is called-----

- (a) Evaporation (b) condensation.
(c) Sublimation (d) calcinations.

6. The conversion of a solid into vapours and vapours into solid without passing it through liquid state is called.

- (a) Evaporation (b) condensation.
(c) sublimation (d) calcinations

7. Reactions which proceed in both directions are called----reactions.

- (a) Reversible (b) irreversible
(c) physical (d) both a&b.

8. Nitric acid (HNO_3) is prepared through-----process.

- (a) Solvay (b) Haber
(c) Birkland Eyde (d) down's process.

9. Law of mass action was presented by----in 1864.

- (a) Guldberg & Waage (b) Boyle
(c) Charles (d) Dalton.

10. Law of mass action is related to the----- of products & reactants.

- (a) Types (b) concentration
(c) Alkalinity (d) acidity

11. A reversible reaction proceeds in the -----.

- (a) Forward direction (b) Reverse direction
(c) Both A & B (d) No change.

12. The unit of K_c in following system is $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$.

- (a) mol^2/L^2 (b) L/mole
(c) mol/L^2 (d) mol/L .

Chapter No.10

Acids, Bases And Salts

Q.1. What is the origin of Acid? Give examples of acids, bases and salts substances in our daily life?

Ans. Origin of Acid:

The term acid is derived from Latin word "Acidus" which means sour. So acids are those substances having sour taste.

Some important acids in our daily life:

Many important acidic substances which we use in our daily life are as under:

i. **Acetic Acid:**

It is found in vinegar.

ii. **Lactic Acid:**

It is found in fermented milk.

iii. **Malic Acid:**

It is found in apple.

iv. **Citric Acid:**

It is found in citrus fruits like lemon, orange, grapes etc.

v. **Hydrochloric Acid:**

It is found in our stomach which helps in the digestion of food.

vi. **Formic Acid:**

It is in sting of ants and bees.

Some important bases and salts in our daily life:

There are many bases and salts which we use in our daily life.

For example:

i. **Washing Soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$):**

It is a salt and is used for washing purposes.

ii. **Baking Soda (NaHCO_3):**

It is also a salt and is used for baking of cakes and other confectionaries.

iii. **Sodium Hydroxide (NaOH):**

It is also called caustic soda which is used for the preparation of soap.

iv. **Magnesium Hydroxide ($\text{Mg}(\text{OH})_2$):**

It is used as antacid.

Q.2. Compare the physical properties of acids and bases?

Ans. Comparison between physical properties of acids and bases:

It is given in the table given below:

	Acid	Base
(i)	Acid solution has bitter taste.	Base solution has sour taste.
(ii)	Acid solution turns blue litmus paper to red.	Base solution turns red litmus paper to blue.
(iii)	Strong acids are very corrosive and damage skin and other organic substances.	Strong bases are also very corrosive but less corrosive as compared to strong acids.
(iv)	Acid solutions do not have soapy touch.	Base solutions have soapy touch.
(v)	Acids solutions conduct electric current.	Base solutions can also conduct electric current.

Q.3: Describe the different concepts of acids and bases?

Ans. Different concepts about acids and bases:

The different concepts about acids and bases are described below:

1. The Arrhenius concept (The classical concept):

Introduction:

The first concept about acids and bases was presented by a Swedish chemist, Arrhenius in 1884.

Definitions of acids and bases:

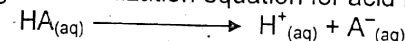
According to this concept acids and bases are defined as follows:

Acid:

"The compound which gives H^+ ions in water is called acid."

General Ionization Equation:

The general ionization equation for acid is given below:

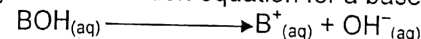


Base:

"The compound which gives OH^- ions in water is called base."

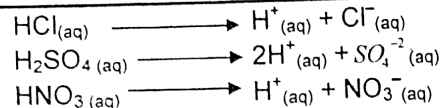
General Ionization Equation:

The general ionization equation for a base is given below:

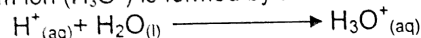


Examples of Arrhenius acids:

HCl , H_2SO_4 , HNO_3 , HBr , HI , CH_3COOH etc. are some of the examples of Arrhenius acids because when these are added to water, they ionize to give H^+ ions which react with water to form hydronium ions H_3O^+ . The chemical equations for the ionization of some acids are as follows:

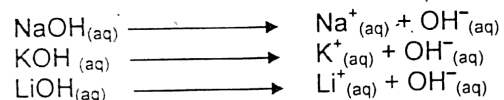


Note: That hydronium ion (H_3O^+) is formed by the reaction of H^+ with H_2O i.e.



Examples of Arrhenius bases:

NaOH , KOH , LiOH , $\text{Ba}(\text{OH})_2$, NH_4OH , $\text{Al}(\text{OH})_3$ etc. are the examples of Arrhenius bases because they give OH^- ions in water. The chemical equations for the ionization of some of the bases are given below:



Summary:

Acid gives H^+ ion while base gives OH^- ions in water.

Advantage:

- ❖ It shows the strength of Acids and bases.

Limitations Of Arrhenius Concept:

The limitations of Arrhenius concept are given below:

i. Restriction To Aqueous Medium:

This concept is only limited to aqueous medium and it does not explain the acidity and basicity of substances in non-aqueous medium.

ii. Restriction To H^+ and OH^- Ions:

In this concept acids are limited to H^+ while bases to OH^- ions only and it cannot explain the acidic nature of CO_2 and basic nature of NH_3 .

2. The Bronsted-Lowry concept (The protonic concept):

Introduction:

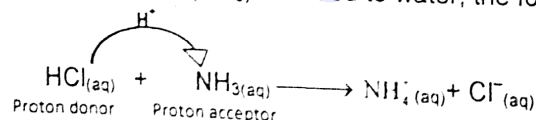
This concept was presented by Danish chemist J.N Bronsted and English chemist T.M Lowry in 1923.

Definitions of acids and bases:

According to Bronsted-Lowry concept, **acids** are defined as the substances which donate protons (H^+ ions), while **bases** are defined as the substances which accept protons.

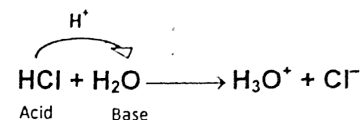
Examples:

i. When ammonia (NH_3) is added to water, the following reaction occurs:

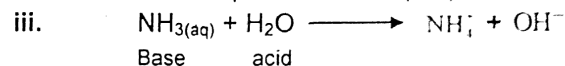


In the above example the ammonia accepts a proton from HCl , therefore, it acts as a base while HCl donates a proton and therefore it acts as an acid.

ii.



In the above example water accepts proton, therefore it acts as a base.



In the above example water donates proton, therefore here water acts as an acid. Thus water is amphoteric.

Summary:

Acid is proton (H^+) donor while base is proton acceptor.

Limitations Of Bronsted-Lowry Concept:

Some bases like NaOH , KOH etc. cannot be explained on the basis of this concept because these cannot accept protons.

3. The Lewis concept:

Introduction:

G.N Lewis presented his own concept of acids and bases in 1923.

Definitions of acids and bases:

According to this concept an **acid** is a species that can accept or tends to accept a pair of electrons while a **base** is a species which can donate or tends to donate a pair of electrons.

An acid is electrophile (electron loving) while a base is a nucleophile (nucleus loving).

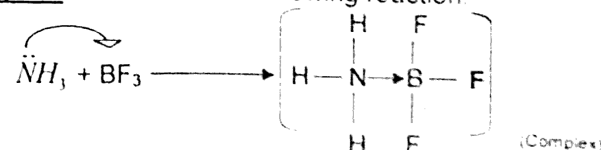
Species which acts as Lewis acids:

- ❖ Those compounds in which central atom has less than eight electrons in valance shell and positive ions act as Lewis acids i.e. they accept electron pair e.g. BF_3 , AlCl_3 , etc.
- ❖ All cations are act as lewis acids e.g. H^+ , Ag^+

Species which acts as Lewis Bases:

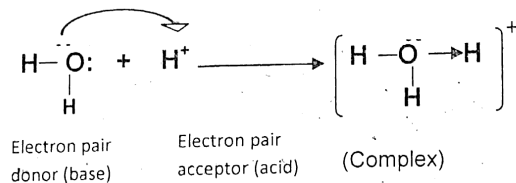
- ❖ Those compounds which have lone pair of electrons in valance shell and negative ions, act as Lewis bases i.e. they donate electron pair e.g. NH_3 , H_2O , etc.
- ❖ All anions act as lewis bases. e.g. CN^- , Cl^- etc

Examples: i. Consider the following reaction:

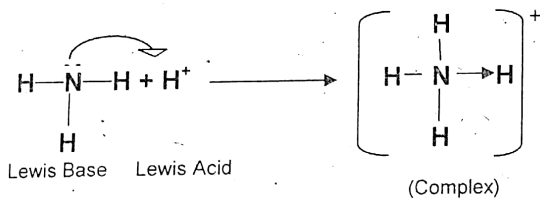


In the above example NH_3 acts as a base (electron pair donor) while BF_3 acts as an Lewis acid (electron pair acceptor).

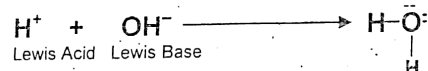
i.



ii.



iii.



Q.4. Compare the definitions of acids-bases.

Ans. Comparison between acids-bases definitions:

It is given in the table given below:

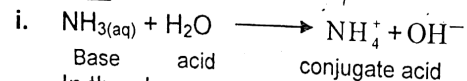
Type Of Concept	Acid	Base
Arrhenius	H^+ producer in water.	OH^- producer in water.
Bronsted-Lowry	Proton(H^+) donor	Proton(H^+) acceptor
Lewis	Electron pair acceptor	Electron pair donor

Q. What is meant by conjugate acid and base? Explain with examples.

Ans. Conjugate acids:

"The positively charged species formed by a base after taking a proton is called conjugate acid of the corresponding base because it can give a proton."

Examples:



In the above example NH_4^+ is the conjugate acid of NH_3 .

It may be noted that a base and its conjugate acid differ from each other by one proton (H^+) e.g. NH_3 and NH_4^+ , H_2O and H_3O^+ etc.

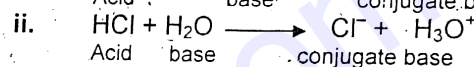


Conjugate bases:

"The negatively charged species left after an acid donates a proton is called conjugate base of that acid because it can accept a proton."

Examples:

i. When acetic acid gives a proton it forms acetate ion (CH_3COO^-). Acetate ion is the conjugate base of acetic acid because it can accept a proton.



It may be noted that acid and its conjugate base differ by one proton e.g. HCl and Cl^- , HBr and Br^- etc.

Q.5. Describe the types of Acids?

Ans. Types Of Acids:

On the basis of number of protons that can be given by an acid per molecule in water, there are the following types of acids:

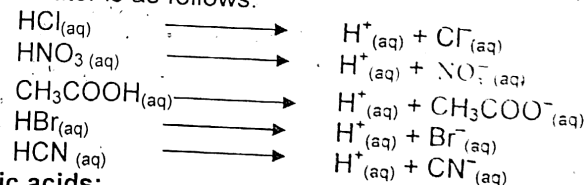
- Mono-protic acids
- Poly-protic acids

i. Mono-protic acids:

"Those acids which give one proton per molecule are called mono-protic acids or mono-basic acids."

Examples:

HCl , HNO_3 , CH_3COOH , HBr , HCN etc are some of the examples of mono-protic acids because they give only one proton per molecule. Their dissociation in water is as follows:



ii. Poly-protic acids:

"Those acids which give more than one protons per molecule are called poly-protic acids or poly-basic acids."

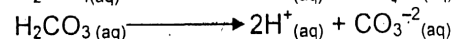
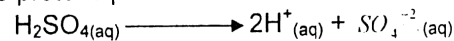
These are further divided into the following sub-groups:

i. Di-protic acids:

"Those acids which give two protons per molecule are called di-protic acids or di-basic acids."

Examples:

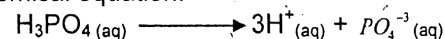
H_2SO_4 , H_2CO_3 etc. are the examples of di-protic acids because they give two protons per molecule:

**ii. Tri-protic acids:**

"Those acids that give three protons per molecule are called tri-protic acids or tri-basic acids."

Example:

Phosphoric acid is an example of tri-protic acid as clear from the following chemical equation:

**Q.6. Describe the types of Bases?****Ans. Types Of Bases:**

On the basis of number of OH^- ions that can be given by an acid per molecule in water, there are the following types of bases:

i. Mono-acid bases

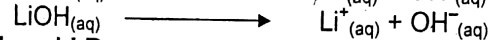
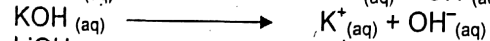
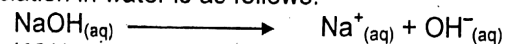
ii. Poly-acid bases

i. Mono-acid bases:

"Those bases which give one OH^- ion per molecule are called mono-acid bases."

Examples:

NaOH , KOH , LiOH , CsOH etc are some of the examples of mono-acid bases because they give only one OH^- ion per molecule. Their dissociation in water is as follows:

**ii. Poly-acid Bases:**

"Those bases which give more than one OH^- ions per molecule are called poly-acid bases".

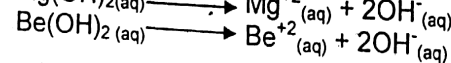
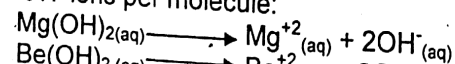
These are further divided into the following sub-groups:

iii. Di-acid Bases:

"Those Bases which give two OH^- ions per molecule are called di-acid bases"

Examples:

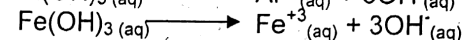
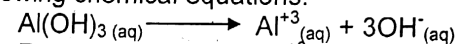
$\text{Mg}(\text{OH})_2$, $\text{Be}(\text{OH})_2$ etc. are the examples of di-acid bases because they give two OH^- ions per molecule:

**iv. Tri-acid bases:**

"Those bases that give three OH^- ions per molecule are called tri-acid bases."

Example:

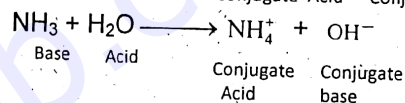
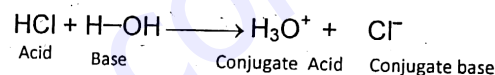
$\text{Al}(\text{OH})_3$, $\text{Fe}(\text{OH})_3$ etc are the examples of tri-acid bases as clear from the following chemical equations:

***Q. What are amphoteric substances?****Ans. Amphoteric substances:**

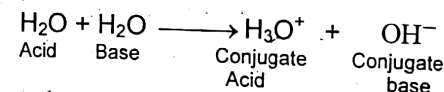
"Those substances which can act both as an acids and a base are called amphoteric substances."

Examples:

i. Water is amphoteric because it acts as a base with an acid while it acts as an acid with a base



ii. During self-ionization of water some water molecules acts as an acid while some acts as a base:

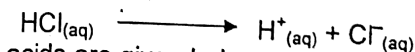
**Q.7. What are strong and weak acids? OR Describe the strength of Acids?****Ans. Strong acids:**

"Those acids which almost completely ionize in aqueous solutions and give higher concentration of H^+ ions are called **strong acids**."

The solutions of strong acids contain ions and almost no unionized molecules are left.

Examples:

Hydrochloric acid is a strong acid because it almost completely ionize in water.



Some other strong acids are given below:

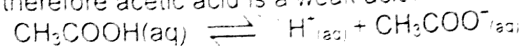
	Strong Acid	Chemical Formula
(i)	Perchloric acid	HClO_4
(ii)	Nitric Acid	HNO_3
(iii)	Sulphuric Acid	H_2SO_4
(iv)	Hydroiodic acid	HI

Weak acids:

"Those acids which partially ionize in water are called weak acids." The solutions of weak acids, in addition to ions, also contain unionized molecules.

Examples:

When acetic acid is added to water, very few molecules are ionized, therefore acetic acid is a weak acid.



Some other weak acids are given below:

Weak Acid	Chemical Formula
(i) Phosphoric acid	H_3PO_4
(ii) Nitrous Acid	HNO_2
(iii) Sulphurous Acid	H_2SO_3
(iv) Carbonic acid	H_2CO_3
(v) Propanoic acid	$\text{C}_2\text{H}_5\text{COOH}$

Q.8. What are strong and weak bases? OR

Describe the strength of bases?

Ans. Strong bases:

"Those bases which dissociate almost completely in water are called strong bases."

Strong bases completely ionize in water and almost no unionized molecule is left behind.

Examples:

Examples of some of the strong bases are given below:

Strong Base	Chemical Formula
(i) Sodium Hydroxide	NaOH
(ii) Potassium Hydroxide	KOH
(iii) Lithium Hydroxide	LiOH
(iv) Cesium Hydroxide	CsOH

Weak bases:

"Those bases which do not dissociate completely in water are called weak bases."

Weak bases partially ionize in water and their solutions in addition to ions also contain unionized molecules.

Examples:

Some bases weak bases are given below:

Weak Base	Chemical Formula
(i) Ammonium Hydroxide	NH_4OH
(ii) Aluminium Hydroxide	Al(OH)_3
(iii) Ferric Hydroxide	Fe(OH)_3
(iv) Zinc hydroxide	Zn(OH)_2

Q.9. Explain self-ionization of water.

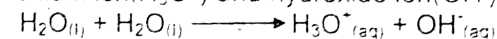
Ans. Self-ionization of water:

"The reaction in which two water molecules produce ions is called self-ionization or auto-ionization of water"

Explanation:

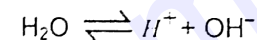
It is experimentally proved that water ionizes into hydronium ion (H_3O^+) and hydroxide ions (OH^-) to a very small extent.

During self-ionization of water two molecules of water react to produce hydronium ion (H_3O^+) and hydroxide ion (OH^-)



In order to understand the concept of ionization of water, we take one molecule of water and its ionization at 25°C .

The equation for ionization of water is:



Equilibrium constant expression for this reaction is:

$$K_c = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$$

$$\Rightarrow K [\text{H}_2\text{O}] = [\text{H}^+][\text{OH}^-]$$

Since the dissociation of water into ions is very small, the concentration of H_2O remains constant and the above equation can be written as:

$$K_w = [\text{H}^+][\text{OH}^-] \text{ where } K_w = K [\text{H}_2\text{O}]$$

Dissociation constant of water (K_w):

K_w is called dissociation constant or ionization constant of water. It is defined as "the product of molar concentration of H^+ (H_3O^+) and OH^- ions is called dissociation constant of water." The value of K_w of water at 25°C is $1.0 \times 10^{-14} \text{M}^2$ i.e.

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14} \text{M}^2 \text{----- eq.1}$$

$$\text{As } [\text{H}^+] = [\text{OH}^-]$$

Putting $[\text{OH}^-] = [\text{H}^+]$ in eq.1 we get

$$[\text{H}^+][\text{H}^+] = 1.0 \times 10^{-14} \text{M}^2$$

$$[\text{H}^+]^2 = 1.0 \times 10^{-14} \text{M}^2$$

$$\sqrt{[\text{H}^+]} = \sqrt{1.0 \times 10^{-14} \text{M}^2}$$

Therefore $[\text{H}^+] = 1.0 \times 10^{-7} \text{M}$

and $[\text{OH}^-] = 1.0 \times 10^{-7} \text{M}$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$\Rightarrow K_w = [1.0 \times 10^{-7} \text{M}][1.0 \times 10^{-7} \text{M}] = 1.0 \times 10^{-14} \text{M}^2$$

Q.10: What is meant by P^H ? Explain.

P^H :

The acidity or basicity of a solution is expressed in term of P^H .

Introduction:

Soren Peter Lauritz Sorenson in 1909 suggested a simple number scale based on H^+ ion concentration to express the acidic or basic nature of the solution which is called P^H scale. The values on this scale range from 0 to 14.

Definition:

"The logarithm of reciprocal of molar concentration of H^+ ions is called P^H ."

Mathematically:

$$P^H = \log \frac{1}{[H^+]}$$

$$\Rightarrow P^H = \log 1 - \log[H^+] \quad Q \log \frac{m}{n} = \log m - \log n$$

$$\Rightarrow P^H = 0 - \log[H^+] \quad Q \log 1 = 0$$

$$\Rightarrow P^H = -\log[H^+]$$

Therefore P^H can also be defined as:

"The negative logarithm of molar concentration of H^+ ions is called P^H ."

Meaning of p in P^H :

p stands for potenz (potential to be). Thus, P^H means potential of H^+ ions while it denotes negative log i.e. $P = -\log$.

Comparison of P^H values:

A solution having P^H value of 7 is neutral, less than 7 is acidic while a solution having P^H value more than 7 is basic.

Whole number value of P^H below 7 is ten times more acidic than the next higher value.

For example:

A P^H of 2 is ten times more acidic than P^H of 3 and 100 times more acidic than a P^H value of 4.

Experimental determination of P^H :

Experimentally P^H is determined by two methods:

i. By P^H paper:

A rough value of P^H is determined by using P^H paper.

ii. By P^H meter:

P^H meter is an instrument which determines accurate value of P^H .

Q.11. Differentiate between P^H and P^{OH} scales.

Ans. Difference between P^H and P^{OH} :

	P^H	P^{OH}
1	"The logarithm of reciprocal of molar concentration of H^+ ions is called P^H ."	"The logarithm of reciprocal of molar concentration of OH^- ions is called P^{OH} ."
2	$P^H = \log \frac{1}{[H^+]}$ $\Rightarrow P^H = \log 1 - \log[H^+]$ $Q \log \frac{m}{n} = \log m - \log n$ $\Rightarrow P^H = 0 - \log[H^+]$ $Q \log 1 = 0$ $\therefore P^H = -\log[H^+]$	$P^{OH} = \log \frac{1}{[OH^-]}$ $\Rightarrow P^{OH} = \log 1 - \log[OH^-]$ $Q \log \frac{m}{n} = \log m - \log n$ $\Rightarrow P^{OH} = 0 - \log[OH^-]$ $Q \log 1 = 0$ $\Rightarrow P^{OH} = -\log[OH^-]$
3	P^H can also be defined as: "The negative logarithm of molar concentration of H^+ ions is called P^H ."	P^{OH} can also be defined as: "The negative logarithm of molar concentration of OH^- ions is called P^{OH} ."

Q.12. Prove that $P^H + P^{OH} = 14$

Ans. As we know that:

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ or } 10^{-14}$$

$$\text{Or } [H^+][OH^-] = 10^{-14}$$

Taking $-\log$ on both sides:

$$-\log[H^+][OH^-] = -\log 10^{-14}$$

$$\Rightarrow [-\log[H^+]] + [-\log[OH^-]] = -\log 10^{-14} \quad Q -\log[H^+] = P^H \text{ and } -\log[OH^-] = P^{OH}$$

$$\text{Therefore } P^H + P^{OH} = -\log 10^{-14}$$

$$\Rightarrow P^H + P^{OH} = -(-14)\log 10 \quad Q \log m^n = n \log m$$

$$\Rightarrow P^H + P^{OH} = 14 \log 10 \quad Q \log 10 = 1$$

$$\Rightarrow P^H + P^{OH} = 14 \times 1 = 14$$

Hence proved that,

$$P^H + P^{OH} = 14$$

Table. P^H and P^{OH} values

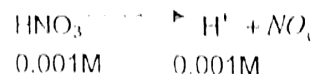
Concentration of H^+ ions	P^H	P^{OH}	
1 or 10^0	0	14	Strong acids
10^{-1}	1	13	
10^{-2}	2	12	
10^{-3}	3	11	
10^{-4}	4	10	Weak acids
10^{-5}	5	9	
10^{-6}	6	8	
10^{-7}	7	7	Neutral
10^{-8}	8	6	Weak bases
10^{-9}	9	5	
10^{-10}	10	4	
10^{-11}	11	3	Strong bases
10^{-12}	12	2	
10^{-13}	13	1	
10^{-14}	14	0	

Example 10.2:Calculate the P^H and P^{OH} of 0.001M solution of nitric acid?**Given:**

Molarity of nitric acid solution = 0.001M

Required:To calculate the P^H and P^{OH} **Solution:**

Chemical equation for ionization of nitric acid is:

Hydrogen ion concentration $[H^+] = \frac{0.001\text{M}}{1000} = 10^{-3}\text{M}$ **Determination of P^{OH} :**

$$P^H = -\log[H^+]$$

Putting the value of $[H^+]$ we get:

$$P^H = -\log 10^{-3}$$

$$P^H = -(-3) \log 10 \quad Q \log m^n = n \log m$$

$$P^H = 3 \log 10$$

$$P^H = 3 \times 1 \quad Q \log 10 = 1$$

$$P^H = 3$$

Determination of P^{OH} :

We know that:

$$P^H + P^{OH} = 14$$

$$P^{OH} = 14 - P^H$$

Putting the value of P^H we get:

$$P^{OH} = 14 - 3$$

$$\Rightarrow P^{OH} = 11$$

Result:

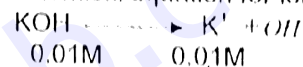
$$P^H = 3, P^{OH} = 11$$

Example 10.3:Calculate the P^H and P^{OH} of 0.01M potassium hydroxide (KOH) solution?**Given:**

Concentration of KOH solution = 0.01M

Required:To calculate the P^H and P^{OH} **Solution:**

Chemical equation for ionization of potassium hydroxide is:

Hydroxide ion concentration $[OH^-] = 0.01\text{M} = 10^{-2}\text{M}$ **Determination of P^{OH} :**

$$P^{OH} = -\log[OH^-]$$

Putting the value of $[OH^-]$ we get:

$$P^{OH} = -\log 10^{-2}$$

$$\Rightarrow P^{OH} = -(-2) \log 10 \quad Q \log m^n = n \log m$$

$$\Rightarrow P^{OH} = 2 \log 10$$

$$\Rightarrow P^{OH} = 2 \times 1$$

$$Q \log 10 = 1$$

$$\Rightarrow P^{OH} = 2$$

Determination of P^H :

We know that:

$$P^H + P^{OH} = 14$$

$$\Rightarrow P^H = 14 - P^{OH}$$

Putting the value of P^{OH} we get:

$$P^H = 14 - 2$$

$$\Rightarrow P^H = 12$$

Result:

$$P^{OH} = 2 \quad \text{and} \quad P^H = 12$$

Q.13. Explain acidic, basic and neutral solutions?

Ans. Neutral Solution:

A solution having P^H value of 7 is neutral solution. Neutral solution has equal concentration of H^+ ions and OH^- ions which is $1 \times 10^{-7} M$ at $25^\circ C$.

Acidic Solution:

A solution having P^H value less than 7 is acidic solution. Acids increase the concentration of H^+ ions thus its P^H is decreased. Thus, in acidic solution the concentration of H^+ ions will be more than $1 \times 10^{-7} M$.

Example:

A solution having concentration of H^+ ions $1 \times 10^{-4} M$ is acidic because this concentration is greater than the concentration of H^+ ions in a neutral solution.

Basic Solution:

The solution having P^H value greater than 7 is basic solution. Bases increase the concentration of OH^- ions in aqueous solutions. Thus, its pH is increased.

Example:

A solution containing concentration of OH^- ions $1 \times 10^{-4} M$ is basic because this concentration is greater than the concentration of H^+ ions in a neutral solution.

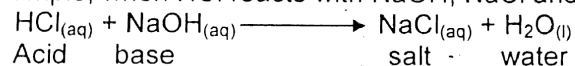
Q.14. Explain the process of neutralization?

Ans. Neutralization:

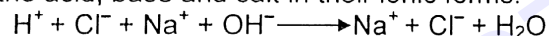
"The reaction of an acid with a base to form salt and water is called neutralization reaction."

Explanation with example:

For example, when HCl reacts with $NaOH$, $NaCl$ and water are formed.

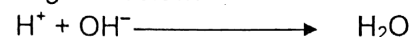


In order to understand the process of neutralization, we need to write the acid, base and salt in their ionic forms.



In solution HCl exists as H^+ and Cl^- , and $NaOH$ exists as Na^+ and OH^- . In neutralization H^+ reacts with OH^- to form water, leaving Na^+ and Cl^- ions in the solution.

In the above equation Na^+ and Cl^- ions are present on both sides of the equation and they have not reacted. They are called **spectator ions**. So the net reaction of neutralization is the reaction of H^+ with OH^- to form water as given below:



There are equal number of H^+ and OH^- ions in equal molar solutions of HCl and $NaOH$ both of which are fully converted to H_2O .

Q.15. What are salts explain with examples?

Ans. Salt:

"The substance obtained (in addition to water) as a result of acid base reaction is called **salt**." **OR**

"A class of solid crystalline ionic substances consisting of positive and negative ions, generally good conductors in aqueous solution or in molten states are called salts."

Composition of salt:

A salt consists of positive ions combined with negative ions. Positive ions come from a base while negative ions come from an acid i.e. In $NaCl$ Na^+ is from $NaOH$ while Cl^- is from HCl . The detail of combination of positive and negative ions is given below:

Monoatomic positive ion + monoatomic negative ions:

Examples of such salts are given $NaCl$, $AgCl$, and KCl , LiF , NaF etc.

Polyatomic positive ions + polyatomic negative ions:

Examples of such salts are $(NH_4)_2CO_3$, NH_4NO_3 , NH_4HCO_3 etc.

Monoatomic positive ions + polyatomic negative ions:

Examples of such salts are Na_2SO_4 , $CaSO_4$, $MgCO_3$ etc.

Polyatomic positive ions + monoatomic negative ions:

Examples of such salts are NH_4Cl , NH_4F , NH_4Br , $(NH_4)_2S$ etc.

Examples of some salts:

Some examples of salts are given below:

- Sodium chloride ($NaCl$)
- Sodium bicarbonate ($NaHCO_3$)
- Calcium oxide (CaO)
- Ammonium nitrate (NH_4NO_3) etc.

Q.16. How salts can be prepared?

Ans. Preparation of salts:

There are two types of salts

- Soluble salts
- Insoluble salts

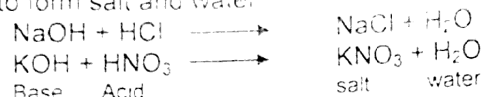
Their preparations are given below:

1. Preparation of soluble salts:

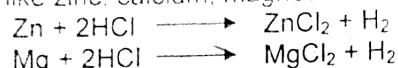
They are prepared by the following methods:

i. By neutralization reaction:

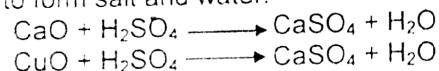
One of the most important and common method of preparation, soluble salts is neutralization reaction, in which an acid reacted with base to form salt and water

**ii. By the reaction of metal and acid (Direct displacement method):**

In this method hydrogen ion of an acid is replaced by an active metal like zinc, calcium, magnesium etc to produce salt and hydrogen gas

**iii. By The Reaction Of Acid And Metal Oxide:**

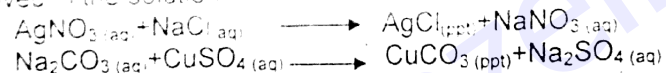
Metallic oxide like calcium oxide, copper oxide etc react with dilute acids to form salt and water.

**iv. By the reaction of acids with carbonates and bicarbonates:**

When an acid reacts with carbonate or bicarbonate it produces salts e.g.

**2. Preparation Of Insoluble Salts:**

Insoluble salts are prepared by mixing the solutions of two soluble salts. In this reaction the two salts exchange their ions and form two new salts. One is the insoluble salt which is precipitated while the other salt remains dissolved in the solution.

**Q.17. Describe the different types of salts in detail.****Ans. Types of salts:**

There are three types of salts i.e. normal, acidic and basic salts. Their detail is given below:

i. Normal salts or neutral salts:

"The salts formed when hydrogen atom of an acid is completely replaced by a metal ion or group of atoms behaving like metal ion are called normal salts." OR

The salt which is formed by strong acid and strong bases is called neutral salt.

Examples:

Some other examples of normal salts are given below

- i. Potassium sulphate (K_2SO_4)
- ii. Sodium phosphate (Na_3PO_4)
- iii. Ammonium sulphate ($(\text{NH}_4)_2\text{SO}_4$)
- iv. Sodium carbonate (Na_2CO_3)

ii. Acidic salts:

"The salts formed when hydrogen atom of a polyprotic acid is partially replaced by a metal ion or group of atoms behaving like metal ion are called acidic salts." OR

"The salt which is formed by strong acid and weak base is called acidic salt."

Acids which form acidic salts:

Acidic salts are formed by polyprotic or polybasic acids only e.g. H_2SO_4 , H_2CO_3 , H_3PO_4 etc.

Examples:

Polyprotic acid base acidic salt

Some other examples of acidic salts are given below

- i. Ammonium bi phosphate ($(\text{NH}_4)_2\text{H}_2\text{P}_2\text{O}_7$)
- ii. Potassium bicarbonate (KHCO_3)
- iii. Lithium bisulphate (LiHSO_4)
- iv. Calcium bicarbonate ($(\text{Ca}(\text{HCO}_3)_2)$ etc)

iii. Basic salts:

"The salts formed when hydroxide ion of a poly acid base is partially replaced by negative ions of acids are called basic salts." OR

"The salt which is formed by weak acid and strong base is called basic salt."

Bases which form basic salts:

Basic salts are formed by poly acid bases only e.g. $\text{Ca}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$, $\text{Al}(\text{OH})_3$ etc.

Examples:

Some other examples of basic salts are

- i. Lead monohydroxy chloride ($\text{Pb}(\text{OH})\text{Cl}$)
- ii. Copper monohydroxy chloride ($\text{Cu}(\text{OH})\text{Cl}$)
- iii. Aluminum dihydroxy fluoride ($\text{Al}(\text{OH})_2\text{F}$)
- iv. Barium monohydroxy fluoride ($\text{Ba}(\text{OH})\text{F}$)

Q.18. Describe the uses of salts?

Ans. Uses of salts:

Salts have many different uses, ranging from household to big industries. Some important uses of different salts are given below:

1. Sodium chloride (NaCl):

- It is daily used in our food to give it taste.
- In industry it is used as raw material for the preparation of caustic soda, washing soda etc.
- It is also used in de-icing of road ways.
- It is also used for preserving food.

2. Calcium sulphate dehydrate (CaSO₄·2H₂O):

- It is also called gypsum and is used in the manufacture of plaster of paris and cement.
- It is also used as fertilizer.

3. Sodium Sulphate (Na₂SO₄):

It is used in the manufacture paper, glass and detergents etc.

4. Sodium carbonate (Na₂CO₃):

- Anhydrous sodium carbonate (Na₂CO₃) is called soda ash while hydrated sodium carbonate (Na₂CO₃·10H₂O) is called washing soda.
- It is used as cleaning agent in laundries and as water softener.
- It is also used as raw material in the manufacture of glass.
- It is also used in paper industry, leather industry and petroleum refining industry.

5. Sodium bicarbonate (NaHCO₃):

- It is also called as baking soda because it is used in baking of cakes and other confectionaries.
- It is also used as antacids in medicines and in toothpastes.

6. Copper sulphate (CuSO₄·5H₂O) (Blue vitriol):

- It is used as electrolyte in copper electroplating process.
- It is also used to kill algae in water reservoirs and in agriculture spray.

7. Magnesium sulphate (MgSO₄·7H₂O) (Epsom salt):

- It is used as antacid and laxative in medicines.
- It is also used in dye industries.

8. Potash alum (K₂SO₄·Al₂(SO₄)₃·24H₂O):

- It is used for water purification to remove suspended impurities by a process called flocculation or coagulation.
- It is also used in textile industry since it causes dyes to adhere to the fabric.
- It is also used as blood coagulant in small injuries.

9. Calcium Carbonate (CaCO₃):

It is used in preparation of cement and ceramics industry.

10. Potassium Nitrate (KNO₃):

It is used as a fertilizer and in the manufacture of flint glass.

EXERCISE

Multiple Choice Questions

Q.1: Select the suitable option:

i. According to Arrhenius concept, which of the following is not an acid:

- A) HCl B) H₂SO₄ C) CO₂ D) HNO₃

ii. AlCl₃ is an acid according to _____

- A) Arrhenius B) Lowry and Bronsted C) Lewis D) All

iii. Which one of the following is a Lewis base?

- A) HCl B) AlCl₃ C) BF₃ D) F⁻

iv. Neutral solution has a pH value of _____

- A) 3 B) 5 C) 7 D) 14

v. The pOH of 0.001M solution of nitric acid is _____

- A) 0.001 B) 10.0 C) 11 D) 14

vi. When a strong base and weak acid reacts, the only products are:

- A) Neutral salt and water B) Basic salt and water
C) Acidic salt and water D) Acidic, Basic salt and water

vii. NH₃ is a base according to _____

- A) Arrhenius B) Lowry and Bronsted
C) Lewis D) Both B & C

viii. Which one of the following is a basic salt?

- A) KCl B) NaCl C) Pb(OH)Cl D) KHSO₄

ix. The bases which are soluble in water are called

- A) Acids B) Alkalis C) Salts D) Amphoteric

x. The example of weak acid is _____

- A) HNO₃ B) CH₃COOH C) HCl D) H₂SO₄

Short Questions

Q.1. When a clear liquid is placed in a beaker. How can you identify it as an acid, base or neutral (water)?

Ans. Identification of a liquid to be acid, base or neutral:

A clear liquid in a beaker can be determined to be an acid, base or neutral by finding its P^H value. P^H value is found by the following ways;

i. By Using P^H paper:

A strip of pH paper will be dipped in the liquid. Its colour will change. This colour will be matched with colour bands having pH values from 0 to 14.

ii. By Using P^H meter:

It is a digital instrument which is dipped in the liquid. pH value is directly read from its LCD screen.

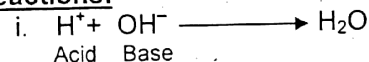
Q.2. Justify H^+ ion as a Lewis acid?

Ans. H^+ ion As Lewis Acid:

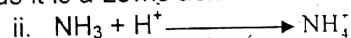
According to Lewis concept;

Acid is a species which accept a pair of electrons. Since H^+ has shortage of two electrons. Therefore, it accepts a pair of electron when reacts with a species having lone pair of electrons or a species having negative charge like OH^- .

Reactions:



In the above reaction H^+ ion accept a pair of electron from OH^- ion, thus it is a Lewis acid.



In the above reaction H^+ ion accept a pair of electron from NH_3 , thus it is a Lewis acid

Q.3. Distinguish strong acids from weak acids? Give two examples of each

Ans. Differences between strong and weak acids:

Some differences between strong and weak acids are given in the table below:

	Strong Acid	Weak Acid
(i)	"Those acids which almost completely ionize in aqueous solutions and give higher concentration of H^+ ions are called strong acids ."	"Those acids which partially ionize in water are called weak acids ."
(ii)	The solutions of strong	The solutions of weak acids

	acids contain ions and almost no unionized molecules are left.	in addition to ions also contain unionized molecules.
(iii)	Strong acids are strong electrolytes.	Weak acids are weak electrolytes.
(iv)	Examples: a. Hydrochloric acid(HCl) b. Nitric acid(HNO_3)	Examples: a. Carbonic acid(H_2CO_3) b. Acetic acid(CH_3COOH)

Q.4. Compare the physical properties of acids and bases.

Ans. For answer see Question no.2

Q.5. A carbonated drink has $[H^+] = 3.2 \times 10^{-3} M$, classify the drink as neutral, acidic or basic with reason?

Ans. Classification of a substance as acidic, basic or neutral:

The acidic, basic or neutral nature of a substance depends upon its pH value.

- If the pH value is 7 it is neutral.
- If the pH value is more than 7 it is basic.
- If the pH value is less than 7 it is acidic.

So first we will find the pH value of given substance.

As we know that;

$$\text{Hydrogen ion concentration } [H^+] = 3.2 \times 10^{-3} M$$

Determination of pH:

$$P^H = -\log[H^+]$$

Putting the value of $[H^+]$ we get:

$$P^H = -\log 3.2 \times 10^{-3}$$

$$\Rightarrow P^H = -(\log 3.2 + \log 10^{-3}) \quad Q \log m \times n = \log m + \log n$$

$$\Rightarrow P^H = -(\log 3.2 + (-3 \log 10)) \quad Q \log m^n = n \log m$$

$$\Rightarrow P^H = -(0.5051 + (-3 \times 1)) \quad Q \log 10 = 1$$

$$\Rightarrow P^H = -(0.5051 - 3)$$

$$\Rightarrow P^H = -(-2.4949)$$

$$P^H = 2.4949$$

Conclusion:

As the pH value is less than 7, therefore the given carbonated drink is acidic due to higher concentration of H^+ ions.

Q.6: Write the chemical name of an acid present in the following:

(a) Apple (b) Grape Juice (c) Lemon Juice (d) Sour milk

	Substance Name	Acid Present
(a)	Apple	Malic Acid
(b)	Grape Juice	Tartaric Acid
(c)	Lemon Juice	Citric Acid
(d)	Sour Milk	Lactic Acid

Q.7. What determines the strength of a base? Give one example of each solution that are strongly and weakly basic.

Ans. Determination of strength of a base:

The extent to which a base ionizes in aqueous solution determines the strength of a base. If the base ionize completely then it is called strong base and if the base ionizes partially it is called weak base.

One example of strongly basic solution"

The solution of sodium hydroxide (NaOH) is strongly basic.

One example of weakly basic solution"

The solution of ammonium hydroxide (NH₄OH) is weakly basic.

Q.8: Calculate the P^H and P^{OH} of 0.5M solution of HCl. (P^H= 0.301, P^{OH}= 13.69)

Given:

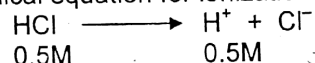
Molarity of hydrochloric acid (HCl) solution = 0.5M

Required:

To calculate the P^H and P^{OH}

Solution:

Chemical equation for ionization of nitric acid is:



Hydrogen ion concentration [H⁺] = 0.5M = 5 × 10⁻¹ M

Determination of P^H:

$$\text{P}^{\text{H}} = -\log[\text{H}^+]$$

Putting the value of [H⁺] we get:

$$\begin{aligned} \text{P}^{\text{H}} &= -\log[5 \times 10^{-1}] \\ \Rightarrow \text{P}^{\text{H}} &= -(\log 5 + \log 10^{-1}) \\ \Rightarrow \text{P}^{\text{H}} &= -\log 5 - \log 10^{-1} \\ \Rightarrow \text{P}^{\text{H}} &= -(0.6989) - (-1) \log 10 \\ \Rightarrow \text{P}^{\text{H}} &= -0.6989 + 1 \log 10 \\ \Rightarrow \text{P}^{\text{H}} &= -0.6989 + 1 \times 1 \\ \Rightarrow \text{P}^{\text{H}} &= -0.6989 + 1 \\ \text{P}^{\text{H}} &= 0.3011 \end{aligned}$$

$$\text{Q } \log mn = \log m + \log n$$

$$\text{Q } \log m^n = n \log m$$

$$\text{Q } \log 10 = 1$$

Determination of pOH:

We know that:

$$\begin{aligned} \text{P}^{\text{H}} + \text{P}^{\text{OH}} &= 14 \\ \Rightarrow \text{P}^{\text{OH}} &= 14 - \text{P}^{\text{H}} \end{aligned}$$

Putting the value of P^H we get:

$$\begin{aligned} \Rightarrow \text{P}^{\text{OH}} &= 14 - 0.3011 \\ \text{P}^{\text{OH}} &= 13.6989 \end{aligned}$$

Result:

$$\text{P}^{\text{OH}} = 13.6989 \text{ and } \text{P}^{\text{H}} = 0.3011$$

Q.9: Calculate the P^{OH} of 0.005M H₂SO₄. (P^{OH} = 11.699)

Given:

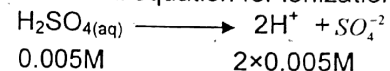
Molarity of sulphuric acid (H₂SO₄) solution = 0.005M

Required:

To calculate the P^{OH}

Solution:

Chemical equation for ionization of sulphuric acid is:



$$\begin{aligned} \text{Hydrogen ion concentration } [\text{H}^+] &= 2 \times 0.005\text{M} \\ &= 0.010\text{M} \\ &= 1 \times 10^{-2} \text{ M or } 10^{-2} \text{ M} \end{aligned}$$

For finding P^{OH} first we will find P^H as we are given the concentration of H⁺ ions.

Determination of P^H:

$$\text{P}^{\text{H}} = -\log[\text{H}^+]$$

Putting the value of [H⁺] we get:

$$\begin{aligned} \text{P}^{\text{H}} &= -\log[10^{-2}] \\ \Rightarrow \text{P}^{\text{H}} &= -(-2 \log 10) \\ \Rightarrow \text{P}^{\text{H}} &= -(-2)(1) \\ \text{P}^{\text{H}} &= 2 \end{aligned}$$

$$\text{Q } \log mn = \log m + \log n$$

$$\text{Q } \log 10 = 1$$

Determination of pOH:

We know that:

$$\begin{aligned} \text{P}^{\text{H}} + \text{P}^{\text{OH}} &= 14 \\ \Rightarrow \text{P}^{\text{OH}} &= 14 - \text{P}^{\text{H}} \end{aligned}$$

Putting the value of P^H we get:

$$\begin{aligned} \Rightarrow \text{P}^{\text{OH}} &= 14 - 2 \\ \text{P}^{\text{OH}} &= 12 \end{aligned}$$

Result:

$$\text{P}^{\text{OH}} = 12$$

Q.10: Calculate the P^H of 0.2M solution of NaOH. (P^H=13.30)

Given:

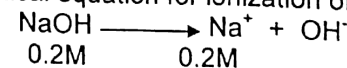
Molarity of NaOH solution = 0.2M

Required:

To calculate the P^H

Solution:

Chemical equation for ionization of NaOH is:



$$\begin{aligned} \text{Hydroxyl ion concentration } [\text{OH}^-] &= 0.2\text{M} \\ &= 2 \times 10^{-1} \text{ M} \end{aligned}$$

For finding P^H first we will find P^{OH} as we are given concentration of

OH^- ions.

Determination of P^{OH} :

$$P^{OH} = -\log[OH^-]$$

Putting the value of $[OH^-]$ we get.

$$P^{OH} = -\log[2 \times 10^{-1}]$$

$$= P^{OH} = -(\log 2 - \log 10^{-1}) \quad Q \log nm = \log m - \log n$$

$$= P^{OH} = -(\log 2 - (-1)\log 10) \quad Q \log m^r = r \log m$$

$$= P^{OH} = -(\log 2 - (-1)(1)) \quad Q \log 10 = 1$$

$$= P^{OH} = -(0.3010 - 1)$$

$$= P^{OH} = -(-0.699)$$

$$P^{OH} = 0.699$$

Determination of P^H :

We know that.

$$P^H + P^{OH} = 14$$

$$\Rightarrow P^H = 14 - P^{OH}$$

Putting the value of P^{OH} we get:

$$\Rightarrow P^H = 14 - 0.699$$

$$P^H = 13.301$$

Result:

$$P^H = 13.301$$

Long Questions

Q 1. (a). What is salt?

Ans: For answer see Question no.15

(b). Write down the different types of salts with examples?

Ans: For answer see Question no.17

Q 2. (a) Define the auto-ionization of water. How can you find the P^H of water?

Ans: For auto-ionization see Question no.9

Finding the P^H of water:

The P^H value of water can be found by two ways:

i. Mathematically

ii. Experimentally

i. Mathematically:

Mathematically the P^H of water can be found by the following formula

$$P^H = -\log[H^+]$$

For example the concentration of H^+ ions in pure water is $10^{-7}M$ therefore its P^H value will be:

$$P^H = -\log 10^{-7}$$

$$\Rightarrow P^H = -(-7)\log 10$$

$$\Rightarrow P^H = 7(1)$$

$$P^H = 7$$

ii. Experimentally:

Experimentally P^H is determined by two methods

a. By P^H paper:

A rough value of P^H is determined by using P^H paper

b. By P^H meter:

P^H meter is an instrument which determines accurate value of P^H

(b). Why some acids are called monoprotic, diprotic and polyprotic acids. Explain your answer with suitable examples.

Ans: For answer see Question no 5

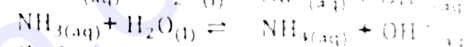
Q 3. (a) Discuss the concept of Lewis acids and bases with examples.

Ans: For answer see Question no 3

(b) Give the Bronsted-Lowry definition of acids and bases. Write equations that explain the definition.

Ans: For answer see Question no 3

Q 4. Below are two equations showing how two alkalis react with water



(a). Name both the alkalis.

Ans(a)

Alkali Formula	Name
NaOH	Sodium Hydroxide
NH ₃	Ammonia

(b). Which is classified as weak alkali and why?

Ans. **Weak Alkali In The Given Examples:**

NH_3 is a weak alkali.

Reason:

Weak alkali is that alkali which partially ionizes in water. Since NH_3 partially ionize in water. Therefore, it is a weak alkali.

(c). What is the likely P^H of each alkali?

Ans. **P^H Of The Given Alkalis:**

The P^H of NaOH is almost 14 while that of NH_3 is about 9

Q 5. (a) Write the balanced neutralization reaction of

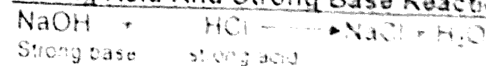
(i) Strong acid and strong base

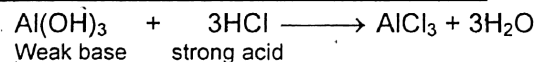
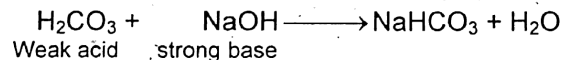
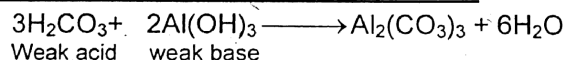
(ii) Strong acid and weak base

(iii) Weak acid and strong base

(iv) Weak acid and weak base

Ans: i. **Strong Acid And Strong Base Reaction:**



ii. Strong Acid And Weak Base Reaction:**iii. Weak Acid And Strong Base Reaction:****iv. Weak Acid And Weak Base Reaction:****(b). Define P^H and P^{OH} ?****Ans:** See answer of Q No. 11.**Q 6. (a) According to your understanding which one of the three acid definitions is the broadest? Explain.****Ans: Three Definitions Of Acid:**

	Type Of Concept	Acid
1	Arrhenius	H^+ ion producer in water.
2	Bronsted-Lowry	Proton(H^+) donor
3	Lewis	Electron pair acceptor

Broadest definition of acid:

Among the three definitions of acid, the broadest is the Lewis concept.

Explanation:

The Arrhenius concept limits the acids to aqueous medium which cannot explain the acidic behavior of acids in non-aqueous medium.

Similarly, the Bronsted-Lowry concept restricts acids to protons which cannot explain the behavior of acids having no protons like AlCl_3 , BF_3 etc.

The Lewis concept is a broadest of all the above mentioned concepts because it completely explains the acids definitions of Arrhenius and Bronsted-Lowry concepts. But they don't explain the Acid definition of Lewis concept.

Example:

For example BF_3 is a Lewis acid; it cannot be explained to be an acid on the basis of Arrhenius concept because it does not produce hydrogen ion in aqueous solution. Similarly, BF_3 cannot be explained, to be an acid, on the basis of Bronsted-Lowry concept because it does not donate proton. However, it can be explained, to be an acid, on the basis of Lewis concept, to be an acid as it accepts electron pair.

(b). Write the uses of any three salts.**Ans:** For answer see Question no. 18**Additional Multiple Choice Questions**

1. According to Bronsted, acids are:

- (a) Proton donor (b) Proton acceptor.
(c) Electron donor. (d) Electron acceptor.

2. NH_3 is-----

- (a) Acid (b) Base. (c) Salt. (d) Buffer solution.

3. Neutral solution has a P^H value:

- (a) 3. (b) 5 (c) 7 (d) 14.

4. Lower the P^H value -----will be an acid.

- (a) Weaker (b) Stronger (c) Neutral (d) Alkaline

5. Salts are-----compounds.

- (a) Acidic. (b) Basic. (c) Amphoteric. (d) Neutral.

6. KHSO_4 is a -----salt.

- (a) Basic. (b) Acidic (c) Neutral. (d) Amphoteric

7. Citrus fruits contain-----acid.

- (a) HCl . (b) H_2SO_4 . (c) HNO_3 . (d) CH_3COOH .

8. HCl is present in-----.

- (a) Stomach (b) Liver (c) Mouth. (d) Large intestine.

9. For washing purposes -----base is used.

- (a) $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$. (b) NaHCO_3 . (c) Ca(OH)_2 . (d) Mg(OH)_2 .

10. According to Lewis concept acids are-----.

- (a) Electron pair acceptors. (b) Electron pair donors.
(c) H^+ producers. (d) OH^- producers.

11. In Lewis concept acid, base form-----bond.

- (a) Covalent. (b) Coordinate covalent.
(c) Ionic (d) Hydrogen bonding.

12. Compounds having less than eight electrons in valence shell of central atom and positive ions act as-----.

- (a) Lewis acids (b) Lewis base
(c) Arrhenius acid (d) Arrhenius base.

13. Compounds having lone pair of electrons in the valence shell or negatively charged ions can donate electron pair and behave as ----.

- (a) Lewis bases (b) Lewis acid
(c) Bronsted acid (d) Bronsted base.

14. In soda water-----acid is present
(a) H_2SO_4 (b) H_2CO_3 (c) HNO_3 (d) HCl
15. For soap making and for drain opening-----is used
(a) NaOH (b) Na_2CO_3 (c) NaHCO_3 (d) Na_2SO_4
16. -----is used as antacid to neutralize excess of stomach acid
(a) $\text{Mg}(\text{OH})_2$ (b) NaOH (c) $\text{Ca}(\text{OH})_2$ (d) KOH
17. In water the concentration of H_3O^+ and OH^- is always 1×10^{-14} at temperature-----
(a) 30°C (b) 40°C (c) 25°C (d) 20°C
18. Acid in stomach plays a role in the digestion of -----
(a) Protein (b) carbohydrates (c) fats (d) vitamins
19. P^{H} and P^{OH} scales were introduced by ----- in 1909
(a) Sorenson (b) Priestly (c) Dalton (d) Lewis
20. The -----measures acidity and basicity of a solution
(a) indicator (b) P^{H} (c) litmus (d) Baeyer's reagent
21. The term acid is derived from-----word
(a) English (b) Greek (c) Latin (d) Arabic
22. The sum of P^{H} and P^{OH} is equal to ----
(a) 7 (b) 10 (c) 12 (d) 14
23. Salts are-----types
(a) two (b) three (c) four (d) five
24. NH_3 is-----
(a) Acid (b) base (c) salt (d) buffer
25. The conjugate acid of water is-----
(a) H_3O^+ (b) OH^- (c) HOH (d) none of these
26. Which one of the following is a Lewis base?
(a) NH_4OH (b) NH_3 (c) CaO (d) NaOH
27. Which one of the following is an acidic salt----
(a) NaCl (b) Na_2SO_4 (c) NaHSO_4 (d) NH_4Cl
28. Which one of the following is not a strong acid.
(a) CH_3COOH (b) H_2SO_4 (c) HNO_3 (d) HCl
29. Which one of these acids is monoprotic?
(a) H_2SO_4 (b) H_3PO_4 (c) CH_3COOH (d) None of these.
30. The chemical formula of baking soda is:
(a) Na_2CO_3 (b) NaHCO_3 (c) NaOH (d) Na_2SO_4
31. Which one of the following is poly-protic acid?
(a) HCl (b) CH_3COOH (c) HNO_3 (d) none of these.

Chapter No.11 Organic Chemistry

Q.1. What is vital force theory?

Ans. Vital force theory:

This theory was presented by a Swedish Chemist, Berzelius in 1815. According to this theory organic compounds cannot be prepared in laboratory. They are only prepared in the bodies of living organisms under the influence of a supernatural force called vital force.

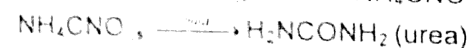
For example:

Urea (from urine), tartaric acid (from grapes), citric acid (from lemon) and sucrose (from cane sugar) are organic compounds.

Rejection of vital force theory:

In 1828 a German chemist Friedrich Wohler prepared an organic compound (urea) in the laboratory by heating ammonium cyanate and rejected the vital force theory.

Ammonium cyanate is obtained by heating solid ammonium chloride with solid potassium cyanate.



Q.2. Why organic compounds are placed in a separate branch of chemistry?

Ans. Reason of placing organic compounds in separate branch of chemistry:

The organic compounds have common properties and they are very large in number. Thus, to make their study easier they are placed in a separate branch of chemistry called organic chemistry.

Q.3. Which compounds of carbon are not organic?

Ans. The following compounds of carbon are not included in organic compounds because they do not possess the properties of organic compounds;

i. Carbonates like sodium carbonate, potassium carbonate calcium carbonate etc.

- ii. **Bicarbonates:** like sodium bicarbonate, magnesium bicarbonate, calcium bicarbonate etc.
- iii. **Cyanides:** like potassium cyanide, sodium cyanide, magnesium cyanide etc.
- iv. **Carbides** like calcium carbide, aluminum carbide etc.
- v. **Carbon monoxide:** (CO)
- vi. **Carbon dioxide:** CO₂
- vii. **Sulphide:** like carbon disulphide

Q.4. Define organic compounds and organic chemistry?

Ans. Organic compounds:

"The compounds of carbon and hydrogen called hydrocarbons. Hydrocarbons and their derivatives are called organic compounds."

Composition of organic compounds:

All organic compounds contain carbon and hydrogen as an essential ingredient beside these elements they may also contain halogens, sulphur, oxygen, nitrogen.

Derivatives of hydrocarbon:

When hydrogen atom of hydrocarbon is replaced by an atom or group of atoms then the resulting compound will be the derivative of that hydrocarbon.

For example:

If we remove one H from ethane C₂H₆ then ethyl group (C₂H₅) is obtained thus ethyl alcohol (C₂H₅OH), ethyl chloride (C₂H₅Cl), ethyl bromide (C₂H₅Br) are the examples of derivatives of ethane.

Organic chemistry:

"The branch of chemistry which deals with the study of hydrocarbons and their derivatives is called organic chemistry." For example, in this branch we study about alkanes like methane, alcohols like ethyl alcohol etc.

Q.5: How organic compounds are represented by

1. Molecular formula
2. Structural formula
3. Condensed formula
4. Dot and cross formula

Ans. 1. Molecular Formula:

"Molecular formula shows the actual number of atoms in a molecule of organic compound."

Examples:

Compound Name	Molecular Formula
Methane	CH ₄
Benzene	C ₆ H ₆
Propane	C ₃ H ₈
Butane	C ₄ H ₁₀

2. Structural Formula:

"This formula represents the arrangement of different atoms of various elements around the carbon atoms present in a molecule of a compound."

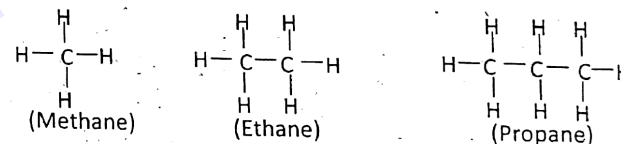
Explanation:

Structural formula shows the nature and type of atoms present in a molecule of a compound. It also shows the bonding arrangement of atoms.

In structural formula, single bonds are shown by single dash (—), double bond by double dashes (=) and triple bond by triple dashes (≡) between the bonded atoms.

Examples:

Structural formulas of some compounds are given below:



3. Condensed Formula:

In this formula group of atoms are shown in an order with no bonds or dashes.

Examples:

- For example hexane (C₆H₁₄) has the condensed formula of CH₃(CH₂)₄CH₃.
- The condensed formula of heptane (C₇H₁₆) is CH₃(CH₂)₅CH₃

4. Dot and Cross Formula / Electronic formula:

The type of formula in which electrons are represented in the form of dots and cross of an organic compound is called Dot and cross formula. e.g.

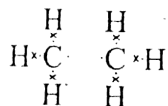
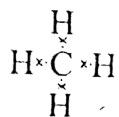


Table: Name, molecular formula, condensed formula and structural formula of first ten Hydrocarbons.

S. No	Name	General Formula C _n H _{2n+2}	Molecular Formula	Condensed Formula	Structural Formula
1	Methane	C ₁ H _{2×1+2}	CH ₄	CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
2	Ethane	C ₂ H _{2×2+2}	C ₂ H ₆	H ₃ CCH ₃	$\begin{array}{cc} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$
3	Propane	C ₃ H _{2×3+2}	C ₃ H ₈	H ₃ CCH ₂ CH ₃	$\begin{array}{ccc} \text{H} & \text{H} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & \\ \text{H} & \text{H} & \text{H} \end{array}$
4	Butane	C ₄ H _{2×4+2}	C ₄ H ₁₀	H ₃ C(CH ₂) ₂ CH ₃	$\begin{array}{cccc} \text{H} & \text{H} & \text{H} & \text{H} \\ & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
5	Pentane	C ₅ H _{2×5+2}	C ₅ H ₁₂	H ₃ C(CH ₂) ₃ CH ₃	$\begin{array}{ccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
6	Hexane	C ₆ H _{2×6+2}	C ₆ H ₁₄	H ₃ C(CH ₂) ₄ CH ₃	$\begin{array}{cccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
7	Heptane	C ₇ H _{2×7+2}	C ₇ H ₁₆	H ₃ C(CH ₂) ₅ CH ₃	$\begin{array}{ccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
8	Octane	C ₈ H _{2×8+2}	C ₈ H ₁₈	H ₃ C(CH ₂) ₆ CH ₃	$\begin{array}{cccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
9	Nonane	C ₉ H _{2×9+2}	C ₉ H ₂₀	H ₃ C(CH ₂) ₇ CH ₃	$\begin{array}{ccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
10	Decane	C ₁₀ H _{2×10+2}	C ₁₀ H ₂₂	H ₃ C(CH ₂) ₈ CH ₃	$\begin{array}{cccccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & & & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & & & & & & \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$

Q.6: Describe the classification of organic compounds.

Ans. Classification Of Organic Compounds:

The classification of organic compounds is given below:

1. On the basis of carbon skeleton
2. On the basis of bonds

The detail is given below:

1. On the basis of carbon skeleton:

On the basis of carbon skeleton, organic compounds have the following two types:

- i. Open chain organic compounds
- ii. Close chain or cyclic organic compounds

i. Open chain organic compounds:

"The type of organic compounds which consist of open chain of carbon atoms are called open chain organic compounds or aliphatic organic compounds."

Open chain organic compounds are further classified into two types which are given below:

a. Straight chain organic compounds:

"The type of open chain organic compounds which contain straight chain of carbon in their molecules are called straight chain organic compounds."

A carbon atom in straight chain organic compounds is not directly bonded to more than two carbon atoms. The prefix n is put before their names which means "normal."

Examples:

Some examples of straight chain organic compounds are given below:

- i. CH₃—CH₂—CH₂—CH₃ (n-butane)
- ii. CH₃—CH₂—CH₂—CH₂—CH₃ (n-pentane)
- iii. CH₃—CH₂—CH₂—CH₂—CH₂—CH₃ (n-hexane)

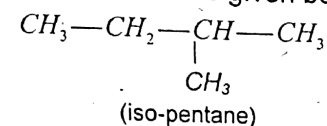
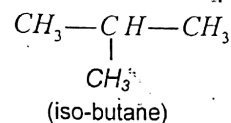
b. Branched chain organic compounds:

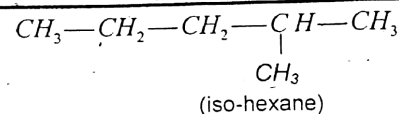
"The type of open chain organic compounds which contains branches of carbon atoms is called branched chain organic compounds."

At least one carbon atom in their molecules is directly bonded to more than two carbon atoms. Their common names have prefix iso- with corresponding organic compound.

Examples:

Some examples of branched chain alkanes are given below:



**ii. Close chain or cyclic organic compounds:**

"The type of organic compound in which the carbon atoms are linked in cyclic form or ring form is called cyclic organic compound."

For cyclic form at least three carbon must be present.

These are further classified into two types:

- Homocyclic or carbocyclic organic compounds
- Heterocyclic organic compounds

a. Homocyclic or carbocyclic organic compounds:

The type of cyclic organic compounds in which the ring is composed of carbon atoms only are called homocyclic or carbocyclic organic compounds.

These have further two types:

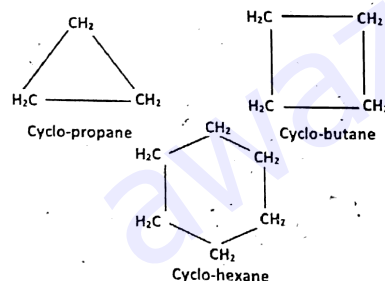
- Ali-cyclic organic compounds
- Aromatic organic compounds

i. Ali-cyclic organic compounds:

These are the type of homocyclic organic compounds in which the carbon ring do not have alternate double and single bonds (aromatic character). They resemble the open chain organic compounds in their properties but differ from them in their formula. They differ from their corresponding open chain member by H_2 group.

Examples:

Examples of Ali-cyclic organic compounds are given below:

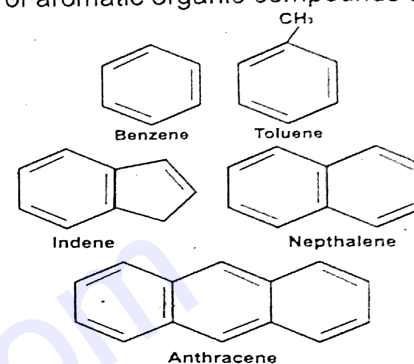
**ii. Aromatic organic compounds:**

These are the type of homocyclic organic compounds in which the carbon rings have alternate double and single bonds. The important

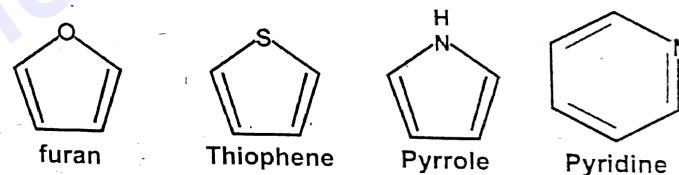
member of this class is benzene and the compounds derived from benzene.

Examples:

Some examples of aromatic organic compounds are given below:

**b. Heterocyclic organic compounds:**

The type of cyclic organic compounds in which the ring contain other atoms like nitrogen, sulphur etc. along with carbon are called heterocyclic organic compounds.

Examples:**2. On the basis of bonds:**

On the basis of bonds there are two types of organic compounds:

- Saturated organic compounds
- Unsaturated organic compounds

Their detail is given below:

i. Saturated organic compounds:

"The organic compounds which contain all carbon-carbon single bonds are called saturated organic compounds."

In case of hydrocarbons saturated hydro-carbons are called alkanes.

Examples:

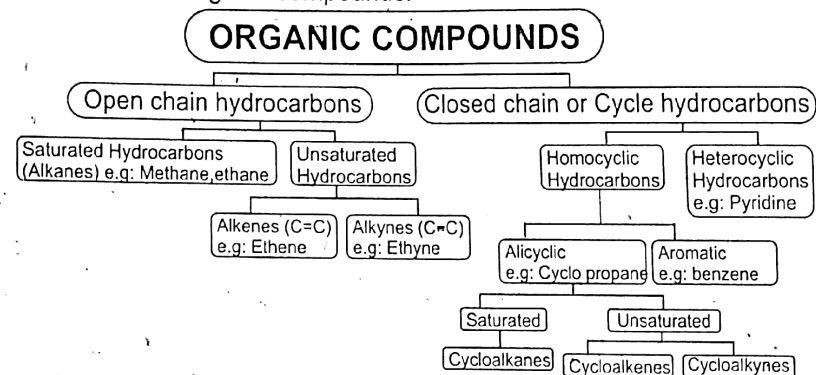
Methane (CH_4), Ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) etc. are the examples of saturated organic compounds.

ii. Unsaturated organic compounds:

"The organic compounds containing at least one carbon-carbon double or triple bond are called unsaturated organic compounds."

Examples:

Ethene(C_2H_4), propene(C_3H_6), butene(C_4H_8) etc. are the examples of unsaturated organic compounds.

**Q.7. Explain diversity and magnitude of organic compounds?****Ans. Diversity and magnitude of organic compounds:**

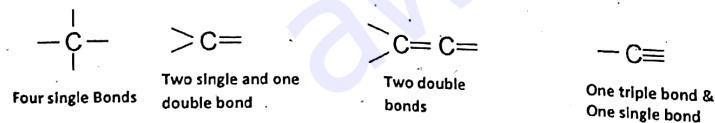
The diversity and magnitude of organic compounds is due to the unique structure and bonding of carbon. Due to unique bonding, carbon forms a variety of structures including chains and rings of many shapes and sizes. Some of the main reasons of diversity and magnitude of organic compounds is given below:

1. Tetra-valent:

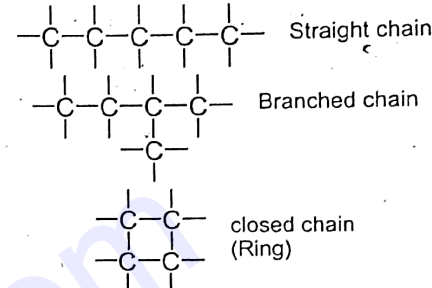
Carbon is tetra-valent in nature because it has four electrons in its valance shell and require four more electrons to complete its octet

2. Mode of bonding:

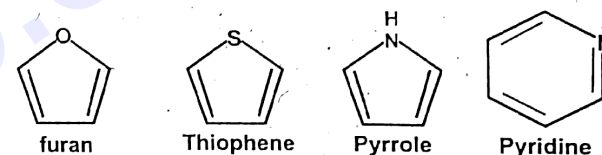
Carbon can form single, double or triple bonds in organic compound in different ways given below:

**3. Carbon-carbon bonding (Catenation):**

Carbon atom form bonds with other carbon atoms in different ways to form straight chain, branched chain and rings. This ability of carbon, to bond with other carbon atoms in different ways, is called catenation.

**4. Carbon bonding with other elements:**

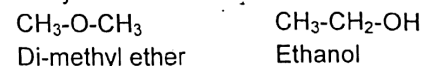
Carbon atom can also bond with other elements like oxygen, nitrogen, sulphur to form different organic compounds. Example;

**5. Different arrangement of same atoms (isomerism):**

Due different arrangements of same atoms there are a large number of organic compounds. These compounds which have same atoms but different arrangement have different properties.

Example:

For example the molecular formula C_2H_6O represents both ethanol and di-methyl ether.

**6. Strength of covalent bonds of C-atoms:**

A large number of organic compounds are also available due strong covalent bonding of carbon between themselves and other elements like sulphur, nitrogen, oxygen etc.

Q.8. Give characteristic properties of organic compounds.

Ans. Characteristic properties of organic compounds:

Organic compounds have the following general properties:

i. Origin:

The main source of organic compounds is plants and animals.

ii. Composition:

Carbon is an essential component of all organic compounds. However beside carbon they also contain hydrogen as essential part. They may also contain some other elements like sulphur, nitrogen, oxygen and halogen.

iii. Thermal Unstability:

Many organic compounds are thermally unstable and decompose to simple substances on heating.

iv. Low melting points and boiling points:

Organic compounds have generally low melting points and boiling points and they are generally volatile due to weak intermolecular force.

v. Bonding:

Organic compounds are generally covalent in nature in which most are non-polar.

vi. Solubility:

As most of the organic compounds are non-polar therefore, they are soluble in non-polar solvent like benzene, acetone, ether and less soluble or insoluble in polar solvents like water.

vii. Electrical conductivity:

Most of the covalent compounds are non-polar therefore, poor conductors of electricity in molten or solution form.

viii. Inflammability:

Most of the organic compounds are inflammable. They burn out to give carbon dioxide, water vapours and energy.

ix. Reactivity:

The reactions of organic compounds are much slower than the inorganic compounds.

x. Isomerism:

The compounds having same molecular formula but different structures are called isomers and this phenomenon is called isomerism. Isomerism is common in most organic compounds. For example butane has two isomers n-butane and iso-butane both have the molecular formula C_4H_{10} but they have different structures.

xi. Similarity in behaviour:

Different organic compounds show similar behavior due to the presence of same functional group.

Q.9. Describe the sources of organic compounds.

Ans. Sources of organic compounds:

Sources of organic compounds may be natural or they may be prepared synthetically.

Natural sources of organic compounds:

Natural organic compounds formed by plants and animals are Coal, petroleum and natural gas. These are the main sources of large variety of organic compounds and are called fossil fuels.

Formation of fossil fuels:

Coal, petroleum and natural gas are called fossil fuels because they are formed from the decay of plants and animals buried under ground. After a long period of time the plants and animals were changed to fossil fuels.

The detail of natural sources is given below:

i. Coal:

"A combustible organic rock composed primarily of carbon, hydrogen, and oxygen is called coal."

Composition of coal:

Coal consists mainly of hydrocarbons. In addition to hydrocarbons coal also contains organic compounds containing nitrogen, oxygen and Sulphur. Coal also contains inorganic components, known as ash.

Destructive distillation of coal:

When coal is heated in the absence of air, this process is called destructive distillation or carbonization of coal.

Products obtained by destructive distillation of coal:

Coal yields coke, ammoniacal liquor, coal gas and coal tar at high temperature in the absence of air. More than 200 organic compounds have been isolated from coal tar.

Uses:

Coal is a major source of organic compounds. It is used as a solid fuel.

ii. Petroleum (petra = rock, oleum = oil):

Petroleum is also an important source of organic compounds. It may be defined as follows:

"A dark brown coloured and unpleasing smelling liquid that consists of mixture of various hydrocarbons, found in sedimentary rock of earth is called petroleum."

It is also called rock oil, crude oil, liquid gold and mineral oil.

Composition of petroleum:

Petroleum consists of hydrocarbons majority of which are open and cyclic alkanes.

Fractional distillation of petroleum:

By fractional distillation of petroleum many useful products are obtained. These are petroleum gases, petrol and naphtha, kerosene, diesel oil, lubricating oil and bitumen.

Uses:

After refining, petroleum is used as a fuel in the form of petrol, diesel, kerosene etc. It is also used for the production of useful products like synthetic rubber, plastics and explosives etc.

iii. Natural gas:

It is also a natural source of organic compounds. It may be defined as:

"A flammable gaseous mixture consisting of hydrocarbons found naturally inside earth is known as natural gas."

It is usually found together with petroleum.

Composition:

Natural gas consists of 85% methane and 15% ethane, propane and butane. It may also contain small amounts of hydrogen sulphide (H_2S), nitrogen (N_2) and (CO_2) which are often removed during refining process.

Uses:

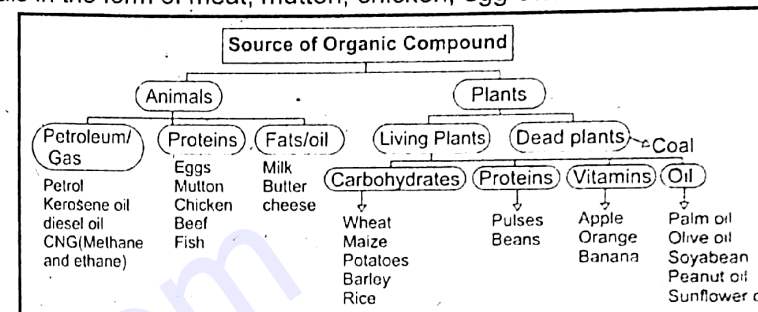
Natural gas is used as fuel for domestic as well as industrial purposes. It is also used for the production of many organic compounds like methyl alcohol etc. It is a chief source of power generation in Pakistan.

iv. Plants:

Plants are also source of organic compounds. They produce carbohydrates, proteins, vitamins, oils etc. Most of the organic compounds are obtained directly from plants. e.g sugar while some other are indirectly obtained from their decay and death.

v. Animals:

A variety of organic compounds like protein are obtained from animals in the form of meat, mutton, chicken, egg etc.

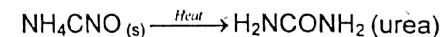
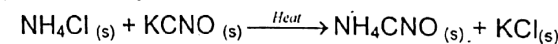


Q 10. Explain the synthesis of organic compounds in the laboratory?

Ans. Synthetic of organic compounds in laboratory:

Organic compounds are also prepared in laboratory and industries. In earlier times it was thought that organic compounds cannot be prepared in laboratory (Vital force theory) but after the synthesis of urea (H_2NCONH_2) this theory was rejected and a large number of organic compounds were prepared in the laboratory and industries.

In 1828, a German chemist Friedrich Wohler prepared an organic compound (urea) in the laboratory by heating ammonium cyanate. Ammonium cyanate is obtained by heating solid ammonium chloride with solid potassium cyanate.



Q.11. Describe the uses of organic compounds.

Ans. Uses of organic compounds:

The uses of organic compounds are given below:

i. In medicines:

Many organic compounds are used in medicines.

ii. In food:

The foods we eat contain many organic compounds like carbohydrates, proteins and vitamins etc.

iii. In power generation:

Mixture of organic compounds like natural gas, petrol and diesel are used in power generation.

iv. As fuels:

Mixtures of organic compounds like natural gas, petrol, kerosene and diesel etc are used as fuels. They are the main sources of energy for human beings.

vi. In industries:

Organic compounds are also used in industries.

vii. As life molecules:

The four main groups of organic compounds combine to form cells and their parts. These four groups are carbohydrates, proteins, lipids and nucleic acids. These are called life molecules.

viii. As clothing:

Cloths are made of fibres. These fibres may be natural or synthetic and these are organic compounds.

Q.12. What are alkanes?**Ans. Alkanes:**

"The saturated hydrocarbons containing all carbon-carbon single bonds are called alkanes or paraffins."

Reason of calling paraffines:

Paraffin is a Latin word meaning "little affinity". Since alkanes contain C-C and C-H single bonds, therefore they have little affinity towards chemical reactions that is why they are called paraffins.

Reason of calling saturated hydrocarbons:

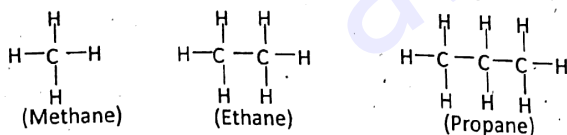
Since in alkanes each carbon atom is bonded with four other atoms therefore no further atom can be added to alkanes. Hence, they are called saturated hydrocarbons.

General formula:

The general formula of alkanes is C_nH_{2n+2} where n is the number of carbon atoms e.g. if $n=1$ then the formula will be CH_4 , which is called methane. Similarly if $n=2$ then the formula will be C_2H_6 called ethane etc.

Structures of some alkanes:

The structures of first three members are given below:

**Examples:**

S. no	Name of alkane	Chemical formula(C_nH_{2n+2})
1	Methane	CH_4
2	Ethane	C_2H_6
3	Propane	C_3H_8
4	Butane	C_4H_{10}
5	Pentane	C_5H_{12}
6	Hexane	C_6H_{14}
7	Heptane	C_7H_{16}
8	Octane	C_8H_{18}
9	Nonane	C_9H_{20}
10	Decane	$C_{10}H_{22}$

Q.13. How alkanes are named? Or describe the rules of naming alkanes.

Ans. Naming of alkanes(nomenclature):

"The naming of alkanes under certain rules is called nomenclature."

Rules for naming alkanes(straight chain):

Simple straight chain alkanes can be named by the following rules:

- Count the number of carbon atoms in the formula of alkanes.
- Give prefixes meth for 1, eth for 2, prop for 3, but for 4 carbon atoms respectively etc.
- Add suffix -ane to the corresponding prefix. Thus the full name of simple straight chain alkane is obtained.

Examples:

Chemical formula (C_nH_{2n+2})	Number of C-atoms	Greek numerals (Prefixes)	Full name
CH_4	1	Meth-	Methane
C_2H_6	2	Eth-	Ethane
C_3H_8	3	Prop-	Propane
C_4H_{10}	4	But-	Butane
C_5H_{12}	5	Pent-	Pentane
C_6H_{14}	6	Hex-	Hexane
C_7H_{16}	7	Hept-	Heptane
C_8H_{18}	8	Oct-	Octane
C_9H_{20}	9	Non-	Nonane
$C_{10}H_{22}$	10	Dec-	Decane

Q.14. What is homologous series? Give the names of alkane homologous series up to ten C-atoms.

Ans. Homologous series: (Homo = same, logous = properties)

"A series of organic compounds having same chemical properties but each member differ from the adjacent member by methylene group (-CH₂-) is called homologous series while each member of homologous series is called homologue." OR

"A series of organic compounds having same elements with same general formula and same chemical properties but each member differ from adjacent member by methylene group (-CH₂-) is called homologous series while each member of homologous series is called homologue."

Properties of homologous series:

- They have the same general formula.
- They have the same functional group.
- They have the same chemical properties.
- They have different physical properties.
- Each member of homologous series differs from adjacent member by -CH₂- group.
- They have the same general methods of preparations.

Examples:

There are seven homologous series of the organic compounds they are hydrocarbons, alcohols, carboxylic acids, carbonyl compounds (aldehydes and ketones), ethers, amines and alkyl halides.

Homologous series of alkanes:

Alkanes are saturated hydrocarbons having general formula of C_nH_{2n+2} where n is the number of carbon atoms. Names and formulas of first ten alkanes are given in the table below:

C-atoms	Name of alkane	Chemical formula (C _n H _{2n+2})
1	Methane	CH ₄
2	Ethane	C ₂ H ₆
3	Propane	C ₃ H ₈
4	Butane	C ₄ H ₁₀
5	Pentane	C ₅ H ₁₂
6	Hexane	C ₆ H ₁₄
7	Heptane	C ₇ H ₁₆
8	Octane	C ₈ H ₁₈
9	Nonane	C ₉ H ₂₀
10	Decane	C ₁₀ H ₂₂

Activity:

What is the next homologue of each the following compounds?

- i. C₃H₈ ii. CH₃OH iii. CH₃COOH
iv. C₂H₅Br v. C₃H₇NH₂

Ans:

- i. Given compound: C₃H₈ (Propane)
Ans: Next homologue: C₄H₁₀ (Butane)
ii. Given compound: CH₃OH (Methyl alcohol)
Ans: Next homologue: C₂H₅OH (Ethyl alcohol)
iii. Given compound: CH₃COOH (Ethanoic acid)
Ans: Next homologue: C₂H₅COOH (Propanoic acid)
iv. Given compound: C₂H₅Br (Ethyl bromide)
Ans: Next homologue: C₃H₇Br (Propyl bromide)
v. Given compound: C₃H₇NH₂ (Propyl amine)
Ans: Next homologue: C₄H₉NH₂ (Butyl amine)

Q.15. Write a note on cycloalkanes?

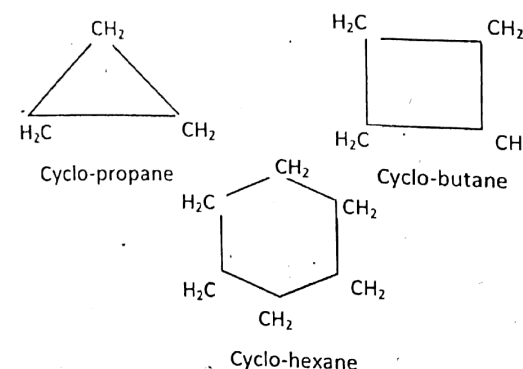
Ans. Cycloalkanes:

"Cycloalkanes are the alkanes in which carbons atoms are arranged in a ring or cyclic structure with no alternate double and single bonds."

Characteristics:

- They have no free carbon atom end. (primary carbon)
- They have two hydrogen less than the corresponding straight chain alkanes.
- They have the general formula of C_nH_{2n}.

Example:



Q.16. What are alkyl radicals? Explain with examples.

Ans. Alkyl radical/group:

"A radical or group of atoms obtained by removing one hydrogen atom from an alkane is called alkyl group."

General formula:

The general formula of alkyl radical is C_nH_{2n+1} , where n is the number of carbon atoms i.e. 1,2,3,4 etc.

General Symbol:

Alkyl radicals are denoted by a general symbol -R.

Naming an alkyl radical:

Alkyl radicals are named by replacing -ane of corresponding alkane by -yl.

Examples:

Number of C-atoms	Name of alkane	Formula C_nH_{2n+2}	Name of Alkyl radical	Formula C_nH_{2n+1}
1	Methane	CH_4	Methyl	CH_3
2	Ethane	C_2H_6	Ethyl	C_2H_5
3	Propane	C_3H_8	Propyl	C_3H_7
4	Butane	C_4H_{10}	Butyl	C_4H_9
5	Pentane	C_5H_{12}	Pentyl	C_5H_{11}
6	Hexane	C_6H_{14}	Hexyl	C_6H_{13}
7	Heptane	C_7H_{16}	Heptyl	C_7H_{15}
8	Octane	C_8H_{18}	Octyl	C_8H_{17}
9	Nonane	C_9H_{20}	Nonyl	C_9H_{19}
10	Decane	$C_{10}H_{22}$	Decyl	$C_{10}H_{21}$

Activity 11.1:

Name the following alkyl groups

- i. $CH_3CH_2CH_2-$ ii. CH_3CH_2- iii. CH_3
 iv. $CH_3(CH_2)_2CH_2-$ v. $CH_3(CH_2)_4CH_2-$

Ans:

No.	Given Structural formula	Name of Alkyl radical
i)	$CH_3CH_2CH_2-$ or C_3H_7	Propyl
ii)	CH_3CH_2- or C_2H_5	Ethyl
iii)	CH_3	Methyl
iv)	$CH_3(CH_2)_2CH_2-$ or C_4H_9	Butyl
v)	$CH_3(CH_2)_4CH_2-$ or C_6H_{13}	Hexyl

Q.17. What is functional group? Explain with examples.

Ans. Functional group:

"An atom or group of atoms which replace the hydrogen atom in an alkane and give characteristic chemical properties to it is called functional group." OR

"An atom or group of atoms which specify the chemical properties of an organic compound is called functional group." OR

The active part of an organic compound is called functional group.

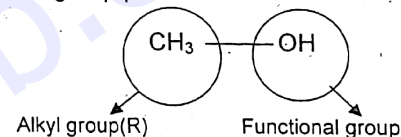
Explanation:

A functional group is the active part of an organic compound. Most of the organic compounds consist of two parts i.e.

- The hydrocarbon part which is an alkyl group.
- The functional group part.

For example:

In methanol (CH_3-OH), $-CH_3$ is the alkyl group (R) while $-OH$ is the functional group part.



Examples:

The most common functional groups are given in the table below:

Functional group	Name of the class	Example	Name of compound
-OH	Alcohols	CH_3-OH	Methyl alcohol
-CHO	Aldehydes	CH_3-CHO	Ethanal
-CO-	Ketones	$CH_3-CO-CH_3$	Propanone
-COOH	Carboxylic acids	CH_3-COOH	Ethanoic acid
-NH ₂	Amines	CH_3-NH_2	Methyl amine
-X	Alkyl halides	CH_3-Cl	Methyl chloride
-O-	Ether	CH_3-O-CH_3	Di methyl ether

Q.18. Explain the classification of functional groups?

Ans. Classification Of Functional Groups:

Functional groups can be classified into the following types:

i. Functional Groups Containing C, H and N:

Amines belongs to functional groups containing carbon, hydrogen and nitrogen. The functional group of amines is -NH_2 while the general formula for amines is R-NH_2 .

Example:

For example methyl-amine ($\text{CH}_3\text{-NH}_2$)

ii. Functional Groups Containing C, H and O:

Alcohols, carbonyl compounds (Aldehydes and ketones), carboxylic acids and their derivatives such as esters, acid halides and acid amides comes in this category. The detail is given below:

a. Alcoholic Functional Group:

The functional group of alcohols is -OH and general formula is R-OH where R stands for alkyl radical.

Examples:

- Methyl alcohol ($\text{CH}_3\text{-OH}$)
- Ethyl alcohol ($\text{C}_2\text{H}_5\text{-OH}$)

b. Ethers Functional Group:

The functional group of ethers is -O- and their general formula is R-O-R .

Examples:

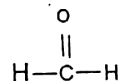
- Di-methyl ether ($\text{CH}_3\text{-O-CH}_3$)
- Ethyl methyl ether ($\text{C}_2\text{H}_5\text{-O-CH}_3$)

c. Carbonyl Functional Group:

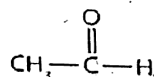
A carbon atom doubly bonded to oxygen atom is called carbonyl group (-C=O). The compounds containing carbonyl group are called carbonyl compounds. These compounds are further classified to aldehydes and ketones.

Aldehydes:

These compounds have carbonyl carbon (-C=O). The carbonyl group on one side is attached to H and on other side to alkyl group or hydrogen. Their general formula is R-C(=O)-H .

Example:

Formaldehyde

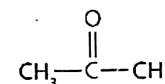


Acetaldehyde

Ketones:

These compounds have carbonyl carbon (-C=O). The carbonyl group on which both side alkyl group is attached:

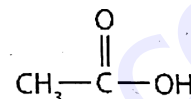
Their general formula R-C(=O)-R

Examples:

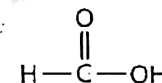
Acetone

d. Carboxylic Acid Functional Group:

The functional group for carboxylic acids is -COOH . Their general formula is R-COOH .

Examples:

Acetic acid



Formic acid

iii. Functional Groups Containing C, H and Halogens:

Alkyl halides are the examples of this category. Their general formula is R-X .

Examples:

- Methyl fluoride ($\text{CH}_3\text{-F}$)
- Ethyl chloride ($\text{C}_2\text{H}_5\text{-Cl}$) etc.

Activity 11.2:

Name the class of the compounds to which each of the following belongs:

- | | | |
|--|---------------------------------------|-------------------------------|
| i. $\text{CH}_3\text{CH}_2\text{CH}_3$ | ii. $\text{CH}_3\text{CH}_2\text{Br}$ | iii. CH_3COOH |
| iv. $\text{C}_2\text{H}_5\text{CHO}$ | v. $\text{CH}_3\text{CH}_2\text{OH}$ | |

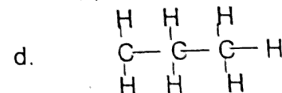
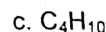
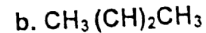
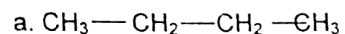
Ans:

- Name of the class = Alkane
- Name of the class = Alkyl halide
- Name of the class = Carboxylic acid
- Name of the class = Aldehyde
- Name of the class = Alcohol

EXERCISE

A. Choose the Correct Option.

1. The condensed structural formula of butane is,

2. The compounds C_6H_{12} must have

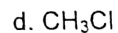
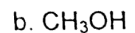
a. All single bonds

b. At least one double bond

c. At least one triple bond

d. All double bonds

3. Which of the following is an inorganic compound?



4. Alkyl halide is composed of carbon, hydrogen and

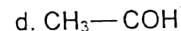
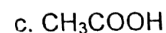
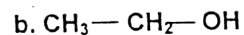
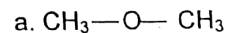
a. Oxygen

b. Nitrogen

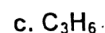
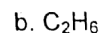
c. Halogen

d. Sulphur

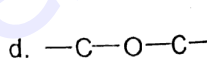
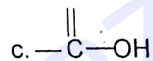
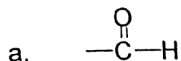
5. Which of the following is an alcohol



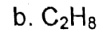
6. Unsaturated hydrocarbon is



7. The functional group of ketone is



8. Natural gas is mainly composed of



9. Catenation is the linkage of carbon with other

a. Oxygen atoms

b. Carbon atoms

c. Nitrogen atom

d. Halogens

10. Oxygen is attached on both sides to carbon atom in

a. Alcohol

b. Ketone

c. Aldehyde

d. Ether

Short Questions

Q.1. Define the functional group? Give some example of functional groups containing oxygen.

Ans. For answer see Question no.18

Q.2. How can we obtain the organic compounds from natural sources?

Ans. For answer see Question no.9

Q.3. What are Cycloalkanes?

Ans. For answer see question no.15

Q.4. Write down examples of three unsaturated hydrocarbons with structural and condensed formulas?

Ans. Three unsaturated hydrocarbons with structural and condensed formulas:

(Structural Formula)	(Condensed Formula)
i. $\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{C} = \text{CH} - & \text{C} & - \text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$ (Propene)	$(\text{CH}_2\text{CHCH}_3)$ (Propene)
ii. $\begin{array}{c} \text{H} & & \text{H} & \text{H} \\ & & & \\ \text{C} = \text{CH} - & \text{C} & - & \text{C} & - \text{H} \\ & & & \\ \text{H} & & \text{H} & \text{H} \end{array}$ (Butene)	$(\text{CH}_2\text{CHCH}_2\text{CH}_3)$ (Butene)
iii. $\begin{array}{c} \text{H} & & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{C} = \text{CH} - & \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\ & & & & \\ \text{H} & & \text{H} & \text{H} & \text{H} \end{array}$ (Pentene)	$(\text{CH}_2\text{CH}(\text{CH}_2)_2\text{CH}_3)$ (Pentene)

Q.5. Define hydrocarbons, and briefly discuss their importance?

Hydrocarbons:

"The compounds of carbon and hydrogen are called hydrocarbons."

Examples:i. Methane(CH_4)ii. Acetylene(C_2H_2)iii. Benzene(C_6H_6)iv. Pentane(C_5H_{12}) etc.Importance of hydrocarbons:

Hydrocarbons are very important in our daily life. They are used in almost all aspects of life. Some of them are given below:

i. In medicines:

Many hydrocarbons are used in medicines.

iii. In power generation:

Mixture of hydrocarbon like natural gas, petrol and diesel are used in power generation.

iv. As fuels:

Mixtures of hydrocarbons compounds like natural gas, petrol, kerosene and diesel etc are used as fuels.

v. In industries:

Hydrocarbons are also used in industries.

Q.6. How alkyl radicals are formed? Discuss it with examples.

Ans. Formation Of Alkyl Radicals:

Alkyl radicals are formed by removing one hydrogen atom from an alkane.

General formula:

The general formula of alkyl radical is C_nH_{2n+1} , where n is the number of carbon atoms i.e. 1,2,3,4 etc.

General Symbol:

Alkyl radicals are denoted by a general symbol -R.

Naming an alkyl radical:

Alkyl radicals are named by replacing -ane of corresponding alkane by -yl.

Examples:

Number of C-atoms	Name of alkane	Formula C_nH_{2n+2}	Name of Alkyl radical	Formula C_nH_{2n+1}
1	Methane	CH_4	Methyl	CH_3
2	Ethane	C_2H_6	Ethyl	C_2H_5
3	Propane	C_3H_8	Propyl	C_3H_7
4	Butane	C_4H_{10}	Butyl	C_4H_9
5	Pentane	C_5H_{12}	Pentyl	C_5H_{11}
6	Hexane	C_6H_{14}	Hexyl	C_6H_{13}
7	Heptane	C_7H_{16}	Heptyl	C_7H_{15}
8	Octane	C_8H_{18}	Octyl	C_8H_{17}
9	Nonane	C_9H_{20}	Nonyl	C_9H_{19}
10	Decane	$C_{10}H_{22}$	Decyl	$C_{10}H_{21}$

Q.7. List some uses of organic compounds?

Ans. For answer see Question no.10

Q.8. Give the general molecular formulae of the following homologous series:

(a) Alkanes (b) alkenes (c) alkynes

Ans. (a) General Formula Of Alkanes:

The general formula of alkanes is C_nH_{2n+2} .

Examples:

- Methane(CH_4)
- Ethane(C_2H_6) etc.

b. General Formula Of Alkenes:

The general formula of alkenes is C_nH_{2n} .

Examples:

- Ethene(C_2H_4)
- Propene(C_3H_6) etc.

c. General Formula Of Alkynes:

The general formula of alkynes is C_nH_{2n-2} .

Examples:

- Ethyne(C_2H_2)
- Propyne(C_3H_4) etc.

Q.9. Why organic compounds are volatile in nature?

Ans. Reason For Organic Compounds Being Volatile:

Volatile are those substances which easily evaporate and change into gaseous state at relatively low temperature. The volatility of a substance depends upon the strength of intermolecular attractive forces. Weaker the intermolecular attractive forces more volatile will be the substance and vice versa.

Since organic compounds have generally weak inter molecular forces due to their non-polar nature that is why organic compounds are volatile in nature.

Q.10. Why are the chemical properties of a homologous series always same?

Ans. Reason For Homologous Series Having Same Chemical Properties:

The chemical properties of a homologous series depend on the functional group because it is the functional group which takes an active part in a chemical reaction.

As all the members (homologues) of a homologous series have the same functional group that is why chemical properties of a homologous series are always the same.

Long Questions

Q1. (a) List the different characteristics of organic compounds.

Ans. For answer see question no 8

(b) Which of these is not an unsaturated molecule?

- (i) C_4H_6 (ii) C_6H_6 (iii) C_6H_{10} (iv) C_3H_6

Ans. Way to find saturated molecule (not unsaturated):

Saturated hydrocarbon molecule can easily be found by comparing the molecule with the general formula

General Formula:

The general formula of saturated hydrocarbon molecule is C_nH_{2n+2}

Molecule which is not unsaturated:

Molecule no. iii C_6H_{10} is not an unsaturated molecule because it is a saturated molecule and it fully satisfies the general formula of saturated hydrocarbons i.e. alkanes

In C_6H_{10} , $n=8$ therefore putting the value in general formula we get,

$$C_8H_{2(8)+2} = C_8H_{18}$$

Other molecules given, do not fit with the general formula of saturated hydrocarbons therefore, they are unsaturated molecules

(c) Define destructive distillation of coal. Name the different types of products obtained by the destructive distillation of coal.

Ans. For answer see question no 9

Q 2. (a) What is catenation?

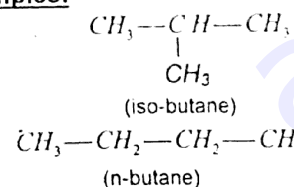
Ans. For answer see question no 7

(b) How does catenation contribute to the diversity of organic compounds?

Ans. Contribution of catenation in diversity of organic compounds:

Due to catenation carbon atoms can arrange themselves in different ways due to which different compounds are formed. Thus we have large varieties of organic compounds. The same no. of carbon can arrange themselves to form different compounds.

Examples:



Q 3. (a) What information about a compound is provided by a structural formula?

Ans. Structural Formula:

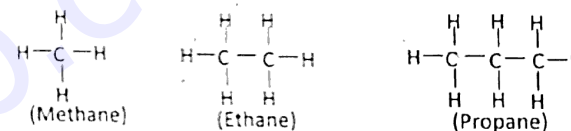
"This formula represents the arrangement of different atoms of various elements around the carbon atoms present in a molecule of a compound."

Information provide by structural formula:

- Structural formula shows the nature and type of atoms present in a molecule of a compound.
- It shows the bonding arrangement of atoms.
- It shows us the total no. of bonds formed by an atom.
- It also shows the total no. of atoms in a molecule.
- It gives idea about the shape of molecule.

Examples:

Structural formulas of some compounds are given below:



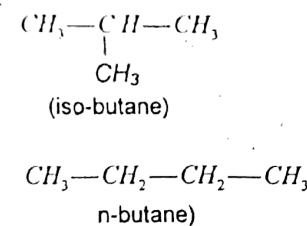
(b). How are structural formulae used in organic chemistry?

Ans. Use of structural formula in organic chemistry:

Structural formula is widely used in organic chemistry in order to know the real arrangement of atoms. Due to this formula properties of the compounds can also be predicted.

There are a large number of organic compounds having same chemical formula but different structural formulas. These compounds can only be differentiated from one another by the use of structural formula.

Examples:



Q 4. (a) What do the terms saturated and unsaturated mean when applied to hydrocarbons?

Ans. Meaning of the term saturated and unsaturated in hydrocarbons:

The term saturated in hydrocarbons means those hydrocarbons in which the carbon atoms form four single bonds i.e., carbon atom is directly attached with four other atoms while unsaturated hydrocarbons means that in these hydrocarbons carbon atom forms at least one double or triple bond.

Saturated hydrocarbons are also called alkanes while unsaturated hydrocarbons have two types alkenes and alkynes.

i. Saturated hydrocarbons examples:

- a. $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$ (n-butane)
 b. $\text{CH}_3-\text{CH}_2-\text{CH}_3$ (n-propane)

ii. Unsaturated hydrocarbons examples:

- a. $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ (β -butene or 2-butene)
 b. $\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_3$ (β -butyne or 2-butyne)

(b). What other meanings do these terms have in chemistry?

Ans. Other meanings of saturated and unsaturated:

In addition to hydrocarbons saturated and unsaturated terms are applied to types of solutions also they are discussed below:

Saturated solution:

"The type of solution which cannot dissolve more solute at a given temperature is called saturated solution."

Unsaturated solution:

"The type of solution which can dissolve more solute at a given temperature is called unsaturated solution."

(c). Classify alkenes, alkanes, alkynes, and aromatic hydrocarbons as either saturated or unsaturated.

Ans. Classification of the given classes as saturated or unsaturated:

Saturated hydrocarbons are those in which carbon atoms have single bonds only while in unsaturated hydrocarbons carbon atoms may have double or triple bonds.

Alkanes as saturated hydrocarbons:

Alkanes are saturated hydrocarbons because in these carbon atoms have single bonds only.

Examples

- a. $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_3$ (n-butane)
 b. $\text{CH}_3-\text{CH}_2-\text{CH}_3$ (n-propane) etc.

Alkenes, alkynes and aromatic hydrocarbons as unsaturated hydrocarbons:

Alkenes, alkynes and aromatic hydrocarbons are unsaturated hydrocarbons because alkenes contain carbon-carbon double bonds, alkynes contain carbon-carbon triple bonds while aromatic compounds contain alternate double and single bonds between the carbon atoms.

Examples:

- a. Alkene $\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3$ (β -butene or 2-butene)
 b. Alkyne $\text{CH}_3-\text{C}\equiv\text{C}-\text{CH}_3$ (β -butyne or 2-butyne)

c. Aromatic compound



benzene

Q5. (a) Can you explain the term homologous series?

Ans. For answer see Question no.14

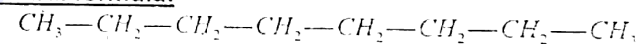
(b) How the straight-chain hydrocarbons are named?

Ans. For answer see Question no.13

(c) Name the straight-chain alkane with the molecular formula C_8H_{18} .

Ans:

Structural formula:



Name of the compound:

The name of the compound, having straight chain, with molecular formula C_8H_{18} is n-octane where n stands for normal.

Additional Questions

Q. Briefly discuss how organic and inorganic compounds differ?

Ans. Difference between organic and inorganic compounds :

The difference between organic and inorganic compounds is given in the table below:

	Organic compounds	Inorganic compounds
1)	"Hydrocarbons and their derivatives are called organic compounds."	"The compounds of all elements except hydrocarbons and their derivatives are called inorganic compounds."
2)	They are mostly found in the bodies of living organisms.	They are mostly found in earth crust.

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Organic Chemistry

3)	Most of the organic compounds are combustible.	Most of the inorganic compounds are non-combustible.
4)	Most of the organic compounds are non-polar.	Most of the inorganic compounds are polar.
5)	All the organic compounds have covalent bonds in them.	Inorganic compounds have covalent as well as ionic bond in them.
6)	Most of them are thermally unstable.	Most of them are thermally stable.
7)	Most of them dissolve in non-polar solvents like benzene, acetone etc.	Most of them dissolve in polar solvents like water.
8)	Their reactions are slower than inorganic compounds.	Their reactions are faster as compared to organic compounds.
9)	Most of the organic compounds are volatile.	Most of the inorganic compounds are non-volatile.
10)	Examples: i. Alkanes like methane, ethane etc. ii. Alkenes like ethene, propene etc. iii. Alkynes like ethyne, propyne etc. iv. Alcohols like methyl alcohol, ethyl alcohols etc.	Examples: i. Acids like hydrochloric acid, nitric acid etc. ii. Salts like sodium chloride, potassium chloride etc. iii. Bases like sodium hydroxide, aluminium hydroxide etc. iv. Carbon monoxide Carbon dioxide etc.

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Organic Chemistry

Additional Multiple Choice Questions

- Which of the following is organic compound?
(a) CO. (b) CO₂ (c) NaHCO₃ (d) C₂H₂.
- Which one of the following is the general formula of alkanes?
(a) C_nH_{2n+2}. (b) C_nH_{2n+1}. (c) C_nH_{2n-1} (d) C_nH_{2n-2}
- The homologous have the same:
(a) state. (b) colour. (c) density (d) **Chemical properties.**
- Carbon atom usually:
(a) **Forms for covalent bonds.** (b) gains four electrons.
(c) Loses four electrons. (d) Ionizes.
- Organic radical with general formula C_nH_{2n+1} is:
(a) Phenyl (b) benzyl. (c) **Alkyl.** (d) Allyl.
- The next homologue of C₈H₁₈ is:
(a) C₈H₁₆ (b) **C₉H₂₀** (c) C₉H₁₈ (d) C₇H₁₄.
- Methane is the first member of:
(a) **Alkane series** (b) alkenes series
(c) alcohol series (d) carboxylic acids series.
- The compound C₃H₈ must have:
(a) **All single bonds** (b) at least one double bond
(c) at least one triple bond (d) an ionic bond.
- Organic compounds are originated from:
(a) Air (b) rock (c) sun (d) **living organism.**
- The name of C₆H₁₄ is:
(a) propane (b) heptanes (c) **hexane** (d) decane.
- Which one of the following organic compounds has different chemical properties?
(a) CH₃OH (b) **C₂H₅COOH** (c) C₂H₅OH (d) C₅H₁₁OH.
- Which of the following is inorganic?
(a) CH₄ (b) CH₃OH (c) **NaCN** (d) CH₃Cl.
- In 1828 A.D vital force theory was rejected by:
(a) **Friedrich Wohler** (b) Mosley
(c) John Dalton (d) J.J. Thomson.
- Organic compound -----was among the first that was synthesized in laboratory.
(a) **Urea** (b) chloroform (c) penicillin (d) C₂H₅OH.

15. Wohler synthesized urea from:
 (a) NH_4CNO (b) NH_4Cl (c) KCN (d) NaCN .
16. Natural gas contains----- % methane.
 (a) 85% (b) 90% (c) 70% (d) 60%
17. In n-alkane carbon atom are held to -----other carbon atoms:
 (a) Three (b) two (c) one (d) four.
18. -----gives characteristics chemical properties to a molecule.
 (a) Functional group (b) homologue
 (c) alkyl groups (d) no any group.
19. Organic compounds are generally -----in nature.
 (a) Ionic (b) covalent (c) coordinate (d) free radical.
20. The homologous have the same-----.
 (a) State (b) colour (c) density (d) chemical properties.
21. -----is a major source of organic compounds.
 (a) coal (b) rock (c) minerals (d) sand.
22. Organic compounds are originated from:
 (a) Air (b) rock (c) sun (d) living organisms.
23. Which one is organic compound?
 (a) CO (b) CO_2 (c) Na_2CO_3 (d) C_2H_2 .
24. The general formula of alkyl radical is-----.
 (a) $\text{C}_n\text{H}_{2n-1}$ (b) $\text{C}_n\text{H}_{2n-2}$ (c) $\text{C}_n\text{H}_{2n-2}$ (d) $\text{C}_n\text{H}_{2n-2}$.
25. The functional group of alkyl halide is-----.
 (a) R-OH (b) HX (c) $-\text{COH}$ (d) R-X .
26. The functional group of carboxylic acid is:
 (a) $-\text{OH}$ (b) $-\text{CO}-$ (c) $-\text{COOH}$ (d) $-\text{COH}$.
27. The general formula of alkynes is.
 (a) $\text{C}_n\text{H}_{2n-2}$ (b) $\text{C}_n\text{H}_{2n-1}$ (c) C_nH_{2n} (d) $\text{C}_n\text{H}_{2n-2}$.
28. Which one of the following organic compounds is an alcohol?
 (a) CH_3COCH_3 (b) $\text{C}_2\text{H}_5\text{CHO}$
 (c) $\text{C}_3\text{H}_7\text{OH}$ (d) CH_3COOH .

Chapter No.12 Hydrocarbons

Q.1. What are hydrocarbons? Explain with examples.

Ans. Hydrocarbons:

"The compounds of carbon and hydrogen are called hydrocarbons."

Classification of hydrocarbons:

Hydrocarbons are classified into two main groups:

- Saturated hydrocarbons (alkanes)
- Unsaturated hydrocarbons (alkenes and alkynes)

i. Saturated hydrocarbons:

"The hydrocarbons which contain all carbon-carbon single bonds are called saturated hydrocarbons or alkanes."

General formula:

They have the general formula of $\text{C}_n\text{H}_{2n+2}$, where n is the number of carbon atoms.

Examples:

Methane (CH_4), Ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) etc. are the examples of saturated hydrocarbons.

ii. Unsaturated hydrocarbons:

"The hydrocarbons containing at least one carbon-carbon double or triple bond are called unsaturated hydrocarbons."

They are further classified to:

a. Alkenes:

"The hydrocarbons which contain at least one carbon-carbon double bond are called alkenes."

General formula:

They have the general formula of C_nH_{2n} , where n is the number of carbon atoms.

Examples:

Ethene (C_2H_4), propene (C_3H_6), butene (C_4H_8) and pentene (C_5H_{10}) are the examples of alkenes.

b. Alkynes:

"The hydrocarbons which contain at least one carbon-carbon triple bonds are called alkynes."

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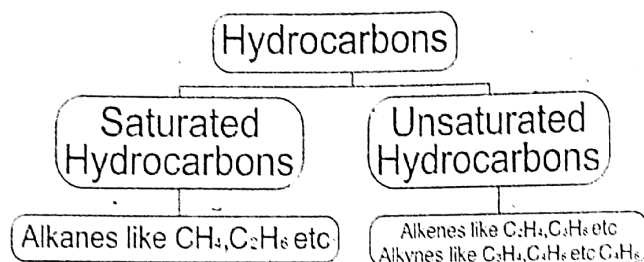
Hydrocarbons

General formula:

They have the general formula of C_nH_{2n+2} , where n is the number of carbon atoms.

Examples:

Ethyne (C_2H_2), propyne (C_3H_4), butyne (C_4H_6) and pentyne (C_5H_8) etc. are the examples of alkynes.

**Q.2. Write a short note on alkanes?****Ans. Alkanes:**

"The saturated hydrocarbons containing all carbon-carbon or carbon to hydrogen single bonds are called alkanes or paraffins."

Reason of calling paraffins:

Paraffin is a Latin word meaning "little affinity". Since alkanes contain C-C and C-H single bonds, therefore they have little affinity towards chemical reactions that is why they are called paraffins.

Reason of calling saturated hydrocarbons:

Since in alkanes each carbon atom is bonded with four other atoms therefore no further atom can be added to alkanes. Hence, they are called saturated hydrocarbons.

General formula:

The general formula of alkanes is C_nH_{2n+2} where n is the number of carbon atoms e.g. if $n=1$ then the formula will be CH_4 , which is called methane. Similarly if $n=2$ then the formula will be C_2H_6 called ethane etc.

Examples:

The name of first ten alkanes along with their physical states, melting point and boiling points are given in the table below:

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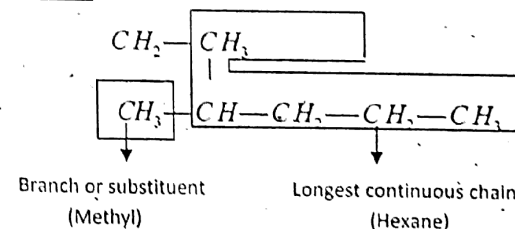
C- atoms	Name of alkane	Formula C_nH_{2n+2}	Physical state	M.P($^{\circ}C$)	B.P($^{\circ}C$)
1	Methane	CH_4	Gas	-183	-162
2	Ethane	C_2H_6	Gas	-172	-89
3	Propane	C_3H_8	Gas	-188	-42
4	Butane	C_4H_{10}	Gas	-138	-0.5
5	Pentane	C_5H_{12}	Liquid	-130	36
6	Hexane	C_6H_{14}	Liquid	-95	69
7	Heptane	C_7H_{16}	Liquid	-91	98
8	Octane	C_8H_{18}	Liquid	-57	126
9	Nonane	C_9H_{20}	Liquid	-51	151
10	Decane	$C_{10}H_{22}$	Liquid	-30	174

Q.3. Describe the rules for naming alkanes?**Ans. Rules for naming alkanes/nomenclature of alkanes:**

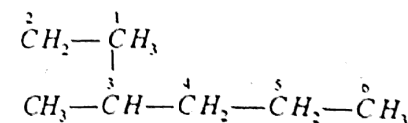
The general rules for naming alkanes are given below:

Rules for naming branched chain alkanes:**i. Selection of longest continuous chain:**

Select the longest continuous chain having maximum number of branches (substituent). This chain is called parent chain.

Example:**ii. Numbering the carbon atoms:**

Start numbering the carbon atoms so that the branch gets the lowest number.

Example:

iii. Naming the longest chain:

Name the longest chain e.g propane for 3, butane for 4 carbon atoms etc.

It is called the base name or parent name of the compound

Example:

For example, the parent name of above example is hexane

iv. Naming the branch:

Name each branch (substituent) attached to the longest chain and give its location by the number of carbon atom to which it is attached. A hyphen is used between the number and name of branch, and comma (,) is used between number and number

Example:

For example, in the above example 3-methyl is the position of branch.

v. Writing the full name:

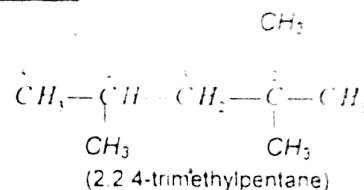
The parent name is written at the end, after mentioning the position of substituent

Example:

For example, the name of above compound is 3-methyl hexane

vi. Naming two or more identical branches:

When two or more identical branches are present then use prefixes di, tri, tetra etc. A comma is used to separate the position numbers

Example:**vii. Numbering the branches on same carbon:**

When two branches are present on the same carbon use the number of that carbon twice.

Example:

For example, in the above example two methyl groups are present on same carbon therefore their position is mentioned as 2,2.

viii. Arranging two or more non-identical branches:

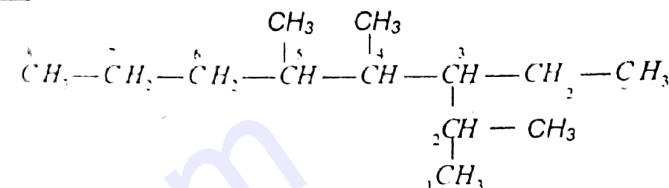
When two or more non-identical branches are present then they are arranged alphabetically.

Example:

For example, ethyl is placed before methyl.

ix. Selecting longest chain from equal no. of C:

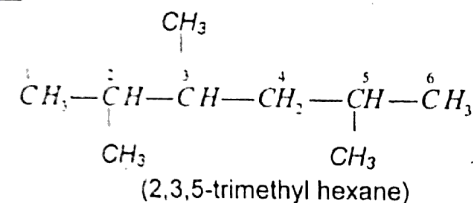
When there are two or more chains having equal no. of carbons, then choose the one with greater no. of branches.

Example:

3-Ethyl-2,4,5-trimethyl octane

x. Numbering branches occurring at same position from either end:

When first branch occurs at an equal distance from either end of longest chain, start numbering from that end which gives lowest number to next branch.

Example:

Q.4. Differentiate between alkanes and alkenes. Give methods of preparation of alkanes.

Ans. Difference between alkanes and alkenes:

The difference between alkanes and alkenes is given in the table below:

	Alkanes	Alkenes
1	"The saturated hydrocarbons containing all C-C single bonds are called alkanes."	"The unsaturated hydrocarbons containing at least one C-C double bond are called alkenes."
2	They have the general formula of $\text{C}_n\text{H}_{2n+2}$	They have the general formula of C_nH_{2n}

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3	In alkanes all the carbon atoms are bonded with 4 other atoms.	In alkenes all the carbon atoms are not bonded with 4 other atoms i.e. at least two carbon atoms are bonded with 3 other atoms.
4	Addition reactions cannot occur in alkanes i.e. only substitution reactions occur in alkanes.	Addition reactions occur in alkenes.
5	Examples: i. Methane (CH ₄) ii. Ethane (C ₂ H ₆) iii. Propane (C ₃ H ₈) iv. Butane (C ₄ H ₁₀)	Examples: i. Ethene (C ₂ H ₄) ii. Propene (C ₃ H ₆) iii. Butene (C ₄ H ₈) iv. Pentene (C ₅ H ₁₀)

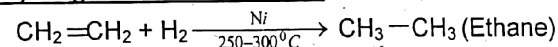
Preparation of alkanes:

Alkanes can be prepared by the following methods:

i. From hydrogenation of alkenes or alkynes:

Unsaturated hydrocarbons like alkenes and alkynes can be changed to alkanes by reacting them with hydrogen in the presence of nickel as catalyst at 250-300 °C or in the presence of platinum as catalyst at room temperature.

a. Hydrogenation Of Alkenes:

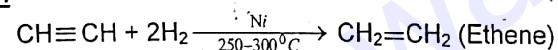


By hydrogenation of alkene the oil is converted to ghee

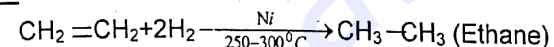
b. Hydrogenation of alkynes:

It occurs in two steps. In first step alkyne is converted to alkene while in second step alkene is converted to alkane.

Step-i



Step-ii



ii. From reduction of alkyl halides:

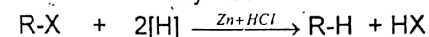
Reduction of alkyl halides mean addition of hydrogen to alkyl halides. In this reaction nascent hydrogen is added to alkyl halides to form

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the corresponding alkanes i.e. methyl halide will form methane, ethyl halide will form ethane etc.

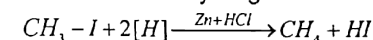
This reaction occurs in the presence of zinc dust and HCl.

General reaction of alkyl halide and nascent hydrogen to form alkane is:

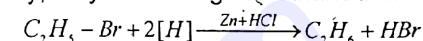


Alkyl halide Nascent H alkane halogen acid

For example, methyl iodide forms methane and hydrogen iodide, on reaction with nascent hydrogen.



Similarly, ethyl bromide gives ethane and hydrogen bromide.



Q.5. Give the properties of alkanes?

Ans. Properties of alkanes:

The properties of alkanes are described below:

Physical properties:

i. Physical state:

The first four members (methane, ethane, propane, butane) of alkane series are gases. Next thirteen members (from C₅H₁₂ to C₁₇H₃₆) are colourless liquids while higher alkane (above C₁₇H₃₆) are solids.

ii. Solubility:

Since alkanes are non-polar therefore, they are soluble in non-polar solvents like benzene, acetone, ether etc. However, they are insoluble on polar solvents like water.

iii. Melting points and boiling points:

The melting points and boiling points of alkanes increase with the increase in molecular masses because generally higher molecular masses alkanes have stronger intermolecular forces.

iv. Density:

Their densities increase regularly with increase in molecular mass.

v. Viscosity:

They become more viscous as their molecular size increase.

vi. Flammability:

They are flammable; with increase in size and no. of carbons they become less flammable.

Chemical properties:

As carbon atoms of alkanes are directly bonded with 4 other atoms therefore, only substitution reactions can occur in alkanes.

Alkanes are chemically inert at room temperature due to all C-C and C-H single bonds present in them. However, at higher temperature, absorption of light etc. the following reactions take place in them:

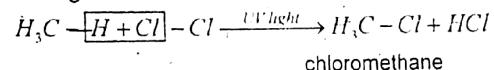
i. Halogenation:

The substitution of hydrogen of an alkane by halogen is called halogenation.

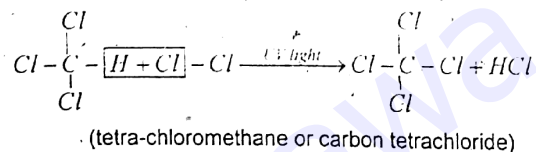
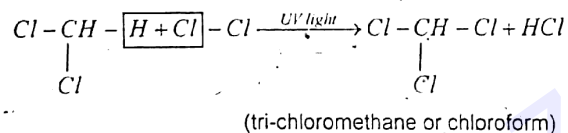
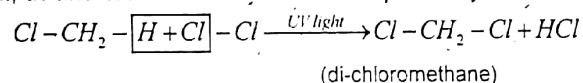
Alkanes react with halogens in presence of ultra violet light and produce alkyl halides and hydrogen halide.

Example:

For example, chlorine reacts with methane in the presence of diffused sunlight to form chloro-methane:



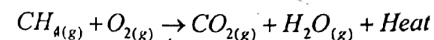
In excess of chlorine, this reaction does not stop here. The remaining three hydrogen atoms are also replaced by chlorine atoms to form di, tri and tetra chloro-methane respectively:

**ii. Combustion:**

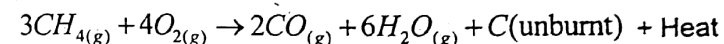
It is also called burning. It may be complete or incomplete.

Complete Combustion:

Alkanes burn completely in excess of oxygen or air to form carbon dioxide, water vapours with evolution of large amount of heat. That's why alkanes are used as fuels.

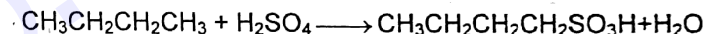
Example:**Incomplete combustion:**

In limited supply of air, incomplete combustion occurs. During incomplete combustion water, unburnt carbon and a poisonous gas, carbon monoxide is produced which creates suffocation and cause death.

Example:***iii. Sulphonation:**

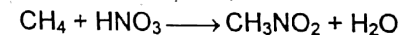
"The substitution of hydrogen of an alkane by sulphonate group ($-\text{SO}_3\text{H}$) is called sulphonation."

Alkanes can be converted to alkyl sulphonic acids with fuming sulphuric acid at $50-60^\circ\text{C}$.

Example:**iv. Nitration:**

"The substitution of hydrogen atom of an alkane by nitro group ($-\text{NO}_2$) is called nitration."

Alkanes can be converted to nitro-alkanes by reacting them with concentrated HNO_3 .

***Example:**

Q.6. What is alkene? Give examples.

Ans. Alkenes:

"The unsaturated hydrocarbons containing at least one carbon-carbon double bond are called alkenes or olefins."

Reason of calling olefins:

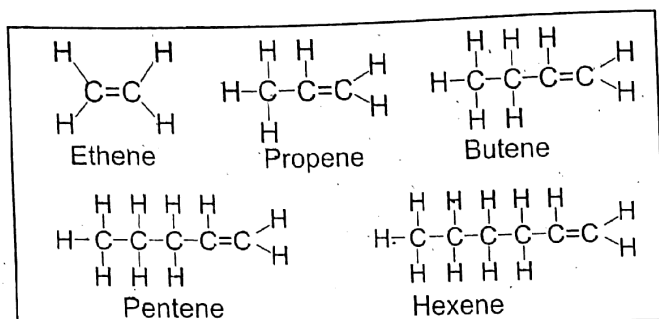
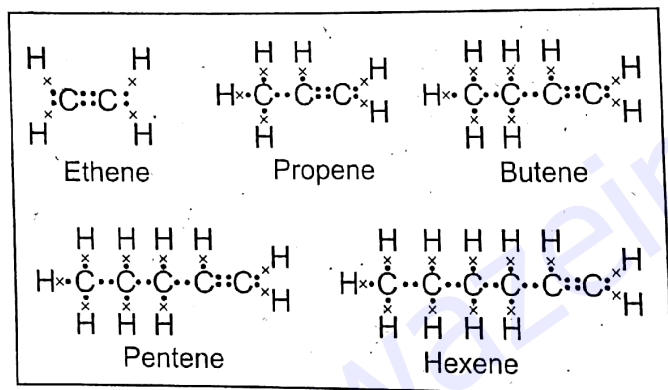
Olefin is a Latin word meaning "oil forming". Since alkenes react with halogens to form oily liquids therefore they are called olefins.

General formula:

The general formula of alkenes is C_nH_{2n} , where n is the number of carbon atoms. It is clear from the general formula of alkenes that they have two hydrogen atoms less than the corresponding alkane.

Examples:

- $\text{CH}_2=\text{CH}_2$ (Ethene or ethylene)
- $\text{CH}_3-\text{CH}=\text{CH}_2$ (Propene or propylene)
- $\text{CH}_3-\text{CH}_2-\text{CH}=\text{CH}_2$ (Butene or butylene)
- $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}=\text{CH}_2$ (Pentene or 1-pentene)
- $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}=\text{CH}_2$ (Hexene)

Structural formula of first five Alkenes:**Electron cross and dot formula of first five alkenes:**

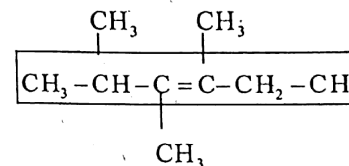
Q.7. How alkenes are named? OR write the rules for naming alkenes?

Ans. Rules for naming Alkenes (Nomenclature):

General rules for naming alkenes are given below:

i. Selection of longest continuous chain:

Select the longest continuous chain containing double bond. This is called the parent chain.

Example:**ii. Naming the parent chain:**

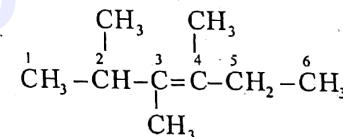
The name of the parent chain is derived from corresponding alkane in which the last -ane of alkane is replaced by -ene.

Example:

For example, the parent name of the above example is hexene.

iii. Numbering the carbon atoms:

Number the longest continuous chain containing double bonds. Start numbering from that end which gives lower number to double bond. If double bond get same number from either end with same branches, it can be numbered from either end.

Example:**iv. Showing the position of double bond:**

The position of double bond is shown by putting number of first carbon atom of double bond as prefix.

Example:

The position of double bond of above example is shown as 3-Hexene

v. Indicating the position of branches:

Indicate the position of branches by number of carbon atom to which they are attached. Use prefix di, tri etc. if the same branch occurs more than one time.

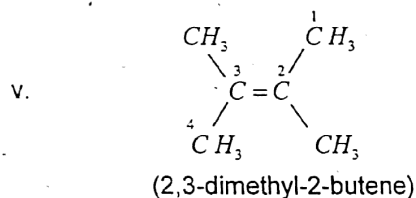
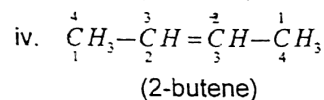
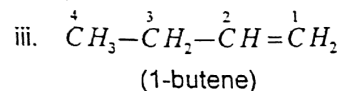
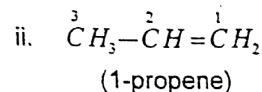
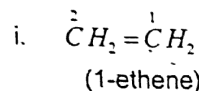
If different branches are present then alphabetical order will be used e.g. ethyl before methyl.

Example:

In the above example the branches are shown as: 2,3,4-Trimethyl-3-hexene.

Some more examples:

Some more examples explaining the above rules are given below:

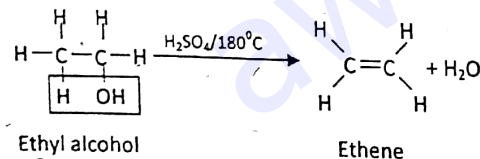
**Q.8. Write down the methods for the preparation of alkenes.****Ans. Preparation of alkenes:**

Most methods of preparation of alkenes involve elimination of two atoms or group of atoms from the adjacent carbon atoms of saturated organic compounds. Some methods are given below:

i. Dehydration of alcohols:

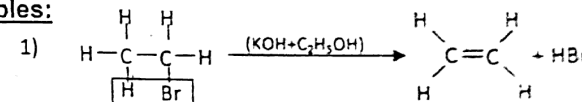
"Removal of water molecule from an alcohol is called dehydration of alcohol".

When an alcohol is heated up to 180°C in the presence of concentrated sulphuric acid as catalyst, a molecule of water is eliminated from the alcohol forming an alkene.

Example:**ii. Dehydrohalogenation of alkyl halides:**

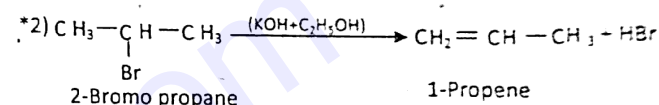
"The removal of hydrogen along with halogen from adjacent atoms of alkyl halide is called dehydrohalogenation of alkyl halides."

In this process an alkyl halide is heated with an alcoholic solution of potassium hydroxide. As a result, a molecule of hydrogen halide is removed to form an alkene. In this elimination, a hydrogen atom along with the adjacent halogen, are removed from the alkyl halide molecule.

Examples:

Bromoethane or
Ethyl bromide

Ethene



2-Bromo propane

1-Propene

Q.9. Give the physical properties of alkenes?**Ans. Physical properties of alkenes:**

Some physical properties of alkenes are given below:

i. Physical state:

The first three members of alkenes i.e. ethene, propene and butene are gases. Linear members from five to sixteen are liquids while higher alkenes are solids.

ii. Solubility:

As they are non-polar therefore, they are soluble in non-polar solvents like benzene. They are insoluble in water.

iii. Melting points and boiling points:

Their melting points and boiling points increase with increase in molecular mass.

iv. Density:

The first member has less density than air. While, others are denser than air. Their densities increase with increase in molecular mass.

Q.10: Give important reactions of alkenes?**Ans: Reactions of alkenes:**

Alkenes are reactive compounds as the electrons of double bonds are easily available for reaction.

As alkenes contain double bonds, therefore, this bond can be broken down to add other atoms to alkene molecules. That is, addition reactions occur in alkenes by the breaking of double bonds and they are

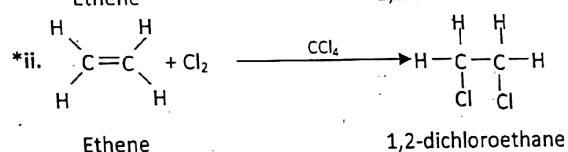
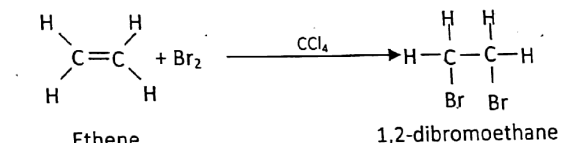
changed into saturated organic compounds. Some important reactions of alkenes are given below:

1. Addition Of Halogens:

Chlorine and bromine are quickly added to the alkenes, with breaking of double bonds of alkenes, in the presence of an inert solvent like carbon tetrachloride to form dihalo compounds. This reaction does not need high energy or sunlight.

Examples:

i. For example, bromine (a red liquid) is reacted with ethene. It adds to ethene to form 1,2-dibromoethane. During this reaction the red colour of bromine disappears. Thus, bromine is used to detect the double bonds of alkenes.



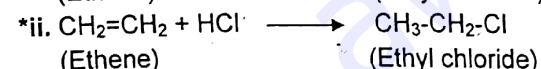
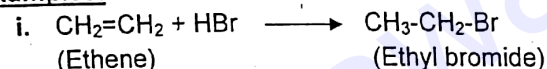
2. Addition Of Hydrogen Halides:

Addition of hydrogen halides mean the addition of hydrogen along with halogen like HCl, HBr, HI to alkenes.

When a hydrogen halide is reacted with alkene its molecule is added with alkene to form alkyl halides.

The order of reacting alkene with hydrogen halides is $\text{HI} > \text{HBr} > \text{HCl}$.

Examples:

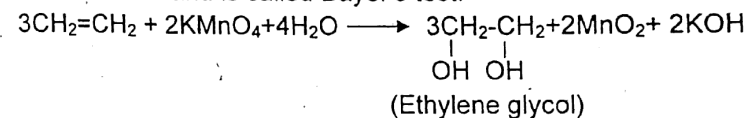


3. Oxidation Of Alkenes by KMnO_4 (Baeyer's test):

Alkenes react with cold dilute potassium permanganate solution (acidified) to form glycol. Glycols are the alcohols containing two hydroxyl groups (-OH) on two adjacent carbon atoms.

Example:

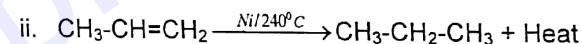
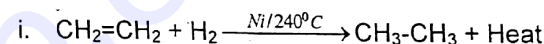
For example ethene reacts with acidified solution of potassium permanganate to produce ethylene glycol, manganese dioxide and potassium hydroxide due to which the purple colour of potassium permanganate solutions disappears. This is a very useful test for the detection of alkenes and is called Bayer's test.



4. Hydrogenation:

"Addition of hydrogen to alkenes is called hydrogenation". Hydrogen is added to alkenes in presence of nickel as catalyst and 240°C to form the corresponding alkane. Hydrogenation of alkene is an exothermic process.

Example:



Hydrogenation of alkenes is also used industrially to convert vegetable oil to ghee.

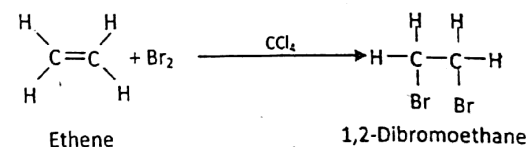
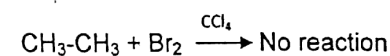
Activity 1:

You have bromine solution and two gases ethane and ethene. Distinguish between these hydrocarbons.

Procedure:

- i. Pass ethane gas through bromine solution in the presence of CCl_4 .
- ii. No change in the red colour of bromine occurs which shows that ethane does not react with bromine solution due to the presence of C-C single bond.
- iii. Now, pass ethene gas through bromine solution in the presence of CCl_4 .
- iv. The red colour of bromine solution will disappear showing that ethene reacts with bromine solution due to the presence of C-C double bond.

Chemical equations:



Conclusion:

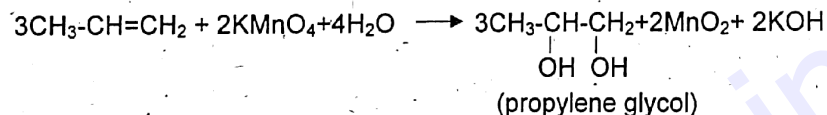
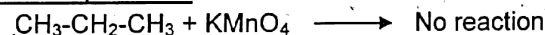
It is concluded from the above activity that ethane has C-C single bond while ethene has C-C double bond.

Activity 2:

Distinguish between propane and propene using Baeyer's test.

Procedure:

- Pass propane gas through cold and dilute solution of potassium permanganate.
- No change in the colour of potassium permanganate occurs showing that propane does not react with potassium permanganate due to the presence of C-C single bonds.
- Now pass propene gas through cold and dilute solution of potassium permanganate.
- The purple colour of potassium permanganate will disappear showing that propene has reacted with potassium permanganate due to the presence of C-C double bond.

Chemical equations:

Q.11. What are alkynes? Give examples.

Ans. Alkynes:

"The unsaturated hydrocarbons containing at least one carbon-carbon triple bond are called alkynes."

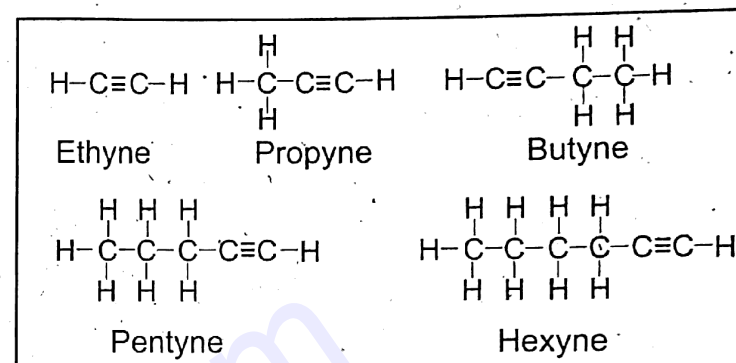
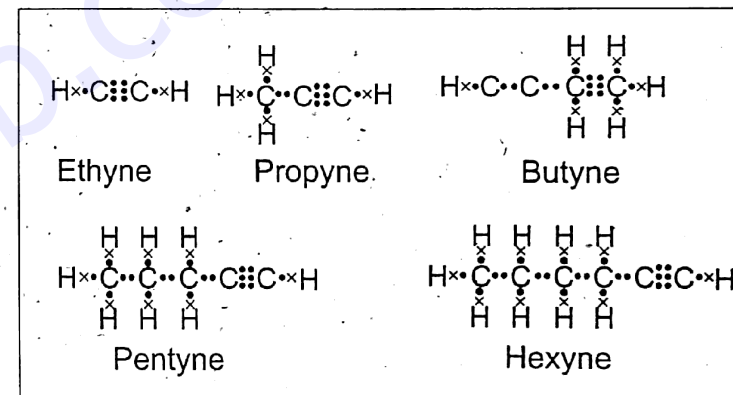
General formula:

The general formula of alkynes is $\text{C}_n\text{H}_{2n-2}$, where n is the number of carbon atoms.

Examples:

A few examples are given below:

- $\text{CH}\equiv\text{CH}$ (Acetylene or ethyne)
- $\text{CH}_3\text{-C}\equiv\text{CH}$ (1-Propyne)
- $\text{CH}_3\text{-CH}_2\text{-C}\equiv\text{CH}$ (1-Butyne)
- $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-C}\equiv\text{CH}$ (1-Pentyne)

Structural formula of first alkynes:**Electron cross and dot formula of first five alkynes:**

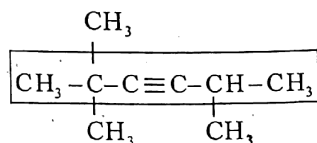
Q.12. How alkynes are named? OR write the rules for naming alkynes?

Ans. Rules For Naming Alkynes (Nomenclature):

General rules for naming alkynes are given below:

i. Selection Of Longest Continuous Chain:

Select the longest continuous chain containing triple bond. This is called the parent chain.

Example:**ii. Naming The Parent Chain:**

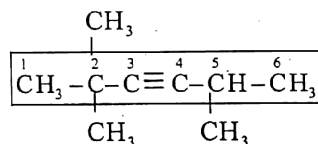
The name of the parent chain is derived from corresponding alkane in which the last -ane of alkane is replaced by -yne.

Example:

For example, the parent name of the above example is hexyne.

iii. Numbering The Carbon Atoms:

Number the longest continuous chain containing triple bonds. Start numbering from that end which gives lower number to triple bond. If triple bond gets same number from either end and branches are at different places then start numbering from that end which gives lowest number to branch.

Example:**iv. Showing The Position Of Triple Bond:**

The position of triple bond is shown by putting number of first carbon atom of triple bond as prefix.

Example:

The position of triple bond of above example is shown as 3-Hexyne

v. Indicating The Position Of Branches:

Indicate the position of branches by number of carbon atom to which they are attached. Use prefix di, tri etc. if the same branch occurs more than one time.

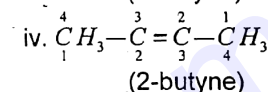
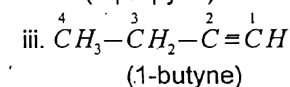
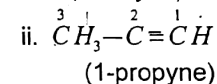
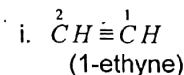
If different branches are present then alphabetical order will be used e.g. ethyl before methyl.

Example:

In the above example the branches are shown as: 2,2,5-Trimethyl-3-hexyne.

Some More Examples:

Some more examples explaining the above rules are given below:

**Q.13. Write a note on the preparation of alkynes?****Ans. Preparation Of Alkynes:**

Alkynes can be prepared by the following methods:

1. Dehydrohalogenation of vicinal dihalides:

"Compounds that contain two halogen atoms first and second carbon atoms are called vicinal dihalides or 1,2-dihalides."

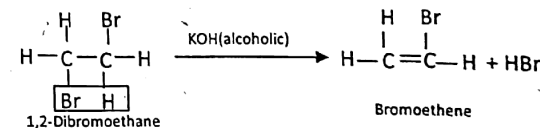
Alkynes are obtained by reacting vicinal dihalides with alcoholic solution of potassium hydroxide. In this reaction two molecules of hydrogen halides are eliminated to form alkynes.

Example:

Acetylene can be prepared by reacting alcoholic solution of potassium hydroxide with vicinal dibromoethane. This reaction is completed in the following two steps:

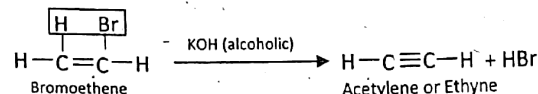
Step-i:

In the first step one molecule of hydrogen bromide is eliminated and single bond between C-C atoms is converted into double bond to form bromoethene and HBr.



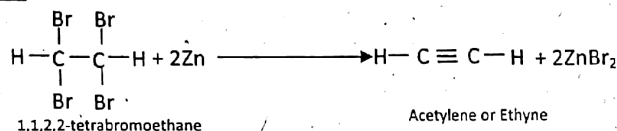
Step-ii:

In the second step another molecule of hydrogen bromide is eliminated and the double bond is converted into triple bond to form acetylene and HBr.

**2. Dehalogenation Of Tetrahalides:**

"Compounds that contain four halogen atoms at two adjacent carbon atoms are called tetrahalides."

When alkyl tetrahalides like 1,1,2,2-tetrabromoethane is reacted with an active metal like zinc dust, bromine atoms are removed and acetylene is formed.

Example:**Q.14. Give the physical properties of alkynes?****Ans. Physical Properties Of Alkynes:**

Some physical properties of alkynes are given below:

i. Physical State:

The first three members of alkynes i.e. ethyne, propyne and butyne are gases while members from five to thirteen are liquids while higher alkynes are solids.

ii. Solubility:

As they are non-polar therefore, they are soluble in non-polar solvents like benzene. They are insoluble in water.

iii. Melting Points And Boiling Points:

Their melting points and boiling points increase with increase in molecular mass.

iv. Density:

Their densities increase with increase in molecular mass.

Q.15. Give important reactions of alkynes?**Ans. Important reactions of alkynes:**

As alkynes are unsaturated therefore, they easily undergo addition reactions. And thus, they are converted to saturated organic compounds.

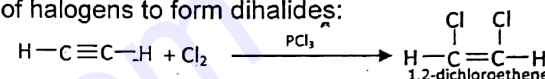
Some important reactions of alkynes are given below:

1. Halogenation:

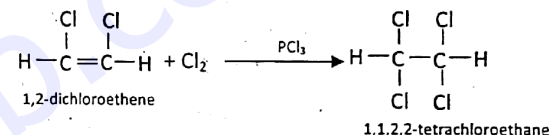
"Addition of halogens to alkyne is called halogenation." Chlorine and bromine react readily while iodine reacts slowly with alkynes. Phosphorus trichloride is used as a catalyst. This reaction occurs in two steps:

Step-i:

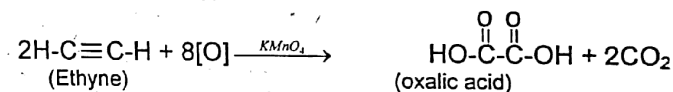
In first step triple bond is converted into double bond by the addition of two atoms of halogens to form dihalides:

**Step-ii:**

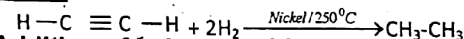
In this step double bond is converted to single bond by the addition of two atoms of halogens to form tetrahalides.

**2. Oxidation with KMnO_4 :**

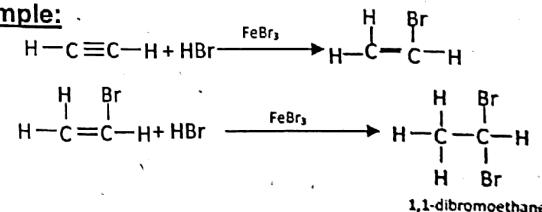
When alkynes are oxidized with solution of potassium permanganate, the triple bond of alkynes are broken to form carboxylic acid and carbon dioxide.

***3. Hydrogenation:**

Hydrogen can be added to alkynes in presence of nickel as catalyst and suitable temperature to form alkanes.

Example:***4. Addition of halogen acids:**

Halogen acids are added to alkynes in the presence of FeX_3 as catalyst to form 1,1-dihaloalkanes. The reaction completes in two steps.

Example:

EXERCISE

A. Choose the Correct Option.

- Which one of the following is a substitution reaction?
 - Halogenation of alkynes
 - Halogenation of alkanes**
 - Halogenation of alkenes
 - Oxidation of alkene
- When ethene reacts with HBr, the compound formed is
 - $\text{CH}_3-\text{CH}_2-\text{Br}$**
 - $\text{Br}-\text{CH}_2-\text{CH}_2-\text{Br}$
 - $\text{CH}_3-\text{CH}_2-\text{CH}_3$
 - $\text{CH}\equiv\text{CH}$
- Halogenations of methane in the presence of diffused sunlight occurs
 - Quickly, only in one step
 - Slowly, only in one step
 - In a series of four steps**
 - Quickly, in two step
- Dehydrohalogenation of alkyl halide is
 - Removal of hydrogen
 - Removal of halogen
 - Removal of hydrogen and halogen**
 - Addition of hydrogen and halogen
- Which one of the following decolourises Br_2 water
 - Ethane
 - Ethene**
 - Propane
 - Methane
- The general formula of alkane
 - C_nH_{2n}
 - $\text{C}_n\text{H}_{2n+2}$
 - $\text{C}_n\text{H}_{2n+2}$
 - $\text{C}_n\text{H}_{2n-2}$
- Dehydration of ethyl alcohol with conc. H_2SO_4 results in the formation of
 - Ethane
 - Methane
 - Ethyne
 - Ethene**
- Substitution reaction is the characteristic of
 - Alkynes
 - Alkenes
 - Alkanes**
 - None of these
- Which one is the least reactive?
 - Ethyne
 - Propane
 - Ethene
 - Ethane**
- The order of reactivity of hydrogen halides with alkenes is
 - $\text{HI} > \text{HCl} > \text{HBr}$
 - $\text{HI} < \text{HBr} < \text{HCl}$
 - $\text{HCl} > \text{HBr} > \text{HI}$
 - $\text{HI} > \text{HBr} > \text{HCl}$**

SHORT QUESTIONS

Q.1. How would you test that alkenes undergo an addition reaction.

Ans. Test for detection of addition reaction by alkene:

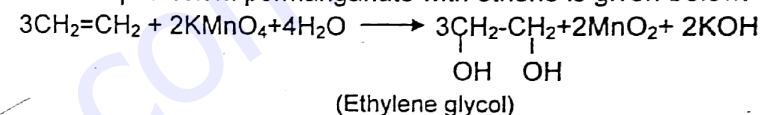
Alkene are unsaturated hydrocarbons therefore, they undergo addition reactions during which their double bond is converted into single bond. It can be tested by two ways:

i. Baeyer's test:

Alkenes react with cold dilute potassium permanganate solution (acidified) to form glycol. Glycols are the alcohols containing two hydroxyl groups (-OH) on two adjacent carbon atoms.

Example:

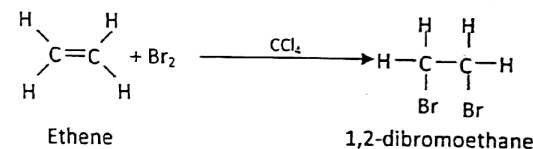
The reaction of potassium permanganate with ethene is given below:



During this reaction potassium permanganate is changed to manganese dioxide and potassium hydroxide due to which its purple colour disappears. Thus, the change in colour proves that addition reaction has taken place.

ii. By The Reaction Of Bromine:

Bromine (a red liquid) is reacted with ethene to form 1,2-dibromoethane. During this reaction the red colour of bromine disappears. Thus, it is proved that addition reaction has taken place.



Q.2. Which one is more reactive between alkane and alkene? Explain.

Ans. More Reactive Between Alkane And Alkene:

Alkenes contain C-C double bonds and double bonds are weaker and can easily be broken. The electrons of double bonds are easily available for reaction. Therefore, alkenes are more reactive.

On the other hand alkanes contain all C-C single bonds which are stronger and cannot be easily broken. That's why alkenes are more reactive than alkanes.

Conclusion:

Alkenes are more reactive than the corresponding alkanes.

Example:

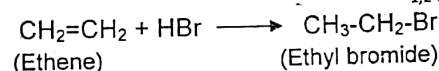
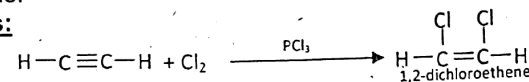
For example ethane does not react with bromine solution while ethene reacts easily with bromine solution, decolourizing its red colour.

Q.3. Justify alkenes and alkynes as unsaturated hydrocarbons.

Ans: Reason for alkenes and alkynes being unsaturated hydrocarbons:

Alkenes and alkynes are unsaturated hydrocarbons because addition reactions occur in alkenes and alkynes.

The reason for addition reaction is that two carbon atoms of alkenes and alkynes are directly bonded with less than 4 other atoms. Therefore, more atoms can be added to them by the breaking of double or triple bonds.

Examples:**Q.4. Why alkanes are inert in nature?**

Ans. Reason for inertness of alkanes:

Alkanes contain C-C and C-H single bonds and these bonds are strong. The electrons of these are not easily available for reaction. That is why alkanes are inert in nature due to which they are called paraffins.

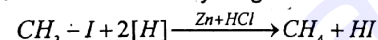
Q.5. What happens when alkyl halide is reduced?

Ans. Reduction of alkyl halides:

When alkyl halides are reduced, alkanes are produced. Reduction of alkyl halides mean addition of hydrogen to alkyl halides. In this reaction nascent hydrogen is added to alkyl halides to form the corresponding alkanes i.e. methyl halide will form methane, ethyl halide will form ethane etc. This reaction occurs in the presence of zinc dust and HCl.

Example:

For example, methyl iodide forms methane and hydrogen iodide, on reaction with nascent hydrogen.

**Q.6. Can you predict the product if KMnO_4 solution reacts with alkene?**

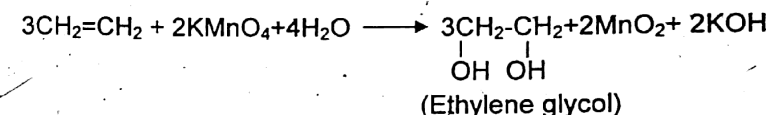
Ans. Yes, the detail is given below:

Reaction of alkene with KMnO_4 solution:

Alkenes react with cold dilute potassium permanganate solution (acidified) to form glycol. Glycols are the alcohols containing two hydroxyl groups (-OH) on two adjacent carbon atoms.

Example:

For example ethene reacts with acidified solution of potassium permanganate to produce ethylene glycol, manganese dioxide and potassium hydroxide due to which the purple colour of potassium permanganate solutions disappears. This is a very useful test for the detection of alkenes and is called Bayer's test.

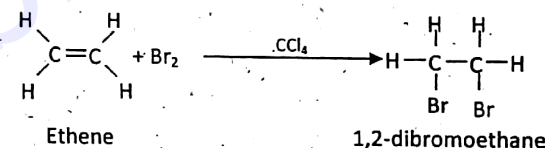
**Q.7. Why the colour of bromine water discharges on addition to ethene?**

Ans. reason for discharge of colour of bromine:

The colour of bromine water discharges on addition to ethene because it chemically reacts with ethene.

The detail is given below:

Bromine (a red liquid) is reacted with ethene it adds to ethene to form 1,2-dibromoethane. During this reaction the red colour of bromine disappears due to its addition to ethene.

**Q.8. Compare the reactivity of alkane and alkene.**

Ans. Comparison between the reactivity of alkane and alkene:

The comparison between the reactivity of alkanes and alkenes is given below:

	Alkanes	Alkenes
1	Alkanes are saturated hydrocarbons having carbon-carbon single bonds. These single bonds are strong, therefore they are less reactive than alkenes.	Alkenes are un-saturated hydrocarbons having carbon-carbon double bonds. The double bonds are weak, therefore they are more reactive than alkanes.
2	Substitution reactions occurs in alkanes.	Addition reactions occurs in alkenes.
3	Example: They do not react with bromine.	Example: They react with bromine, decolourizing its colour.

Q.9. Why addition reactions take place in ethene and ethyne but not in ethane.

Ans. Reason for addition reaction, occurring in ethene and ethyne:

Carbon atom has four electrons in its valance shell and it can directly form bond with maximum of four atoms.

Ethene and ethyne are unsaturated hydrocarbons containing carbon-carbon double and triple bonds respectively. Therefore, the two carbon atoms of ethene and ethyne are directly bonded with less than 4 other atoms. Therefore, more atoms can be added to them by the breaking of double or triple bonds. That is why addition reactions occur in ethene and ethyne.

Reason for addition reaction, not occurring in ethane:

Ethane is saturated hydrocarbon containing C-C and C-H single bonds. Carbon is directly bonded to 4 other atoms therefore, no further atom can be added to it i.e. addition reaction does not occur. Only substitution reactions occur in ethane by the replacement of H-atoms.

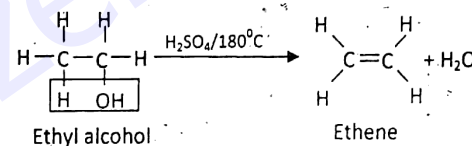
Q.10. Write equations for the preparation of ethene from ethyl alcohol and ethyl chloride.

Ans. The answer of the given question is explained under the following headings:

1. Preparation of ethene from ethyl alcohol:

When ethyl alcohol is heated up to 180°C in the presence of concentrated sulphuric acid as catalyst, a molecule of water is eliminated from ethyl alcohol, forming ethene.

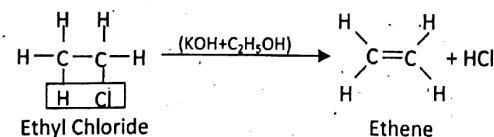
Chemical Equation:

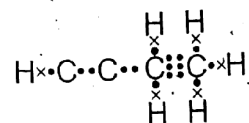


2. From Ethyl Chloride:

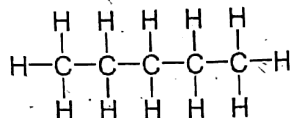
When ethyl chloride is heated with an alcoholic solution of potassium hydroxide, a molecule of hydrogen chloride is removed to form ethene.

Chemical Equation:

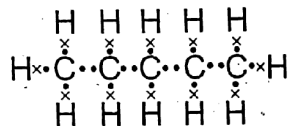


Dot And Cross Formula:

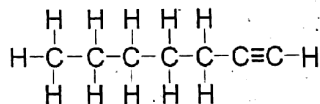
Butyne

(c) Pentane Structural Formula:

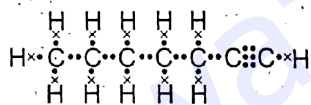
Pentane

Dot And Cross Formula:

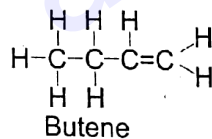
Pentane

(d) Heptyne Structural Formula:

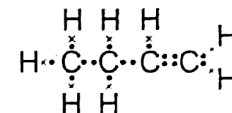
Heptyne

Dot And Cross Formula:

Heptyne

(e) Butene Structural Formula:

Butene

Dot And Cross Formula:

Butene

Q 2. (a) The general formula of alkanes is C_nH_{2n+2} . Determine the general formula of cycloalkanes.

Ans. General formula of cyclo-alkanes:

Cyclo-alkanes are formed by removing two hydrogen atoms from the corresponding alkanes. Thus the general formula of cyclo-alkanes is C_nH_{2n} .

Examples:

i. The formula of cyclo-hexane is C_6H_{12} .

ii. The formula of cyclo-heptane is C_7H_{14} .

(b) Write a balanced equation for the complete combustion of each of the following.

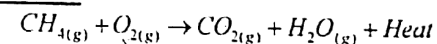
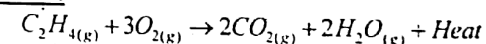
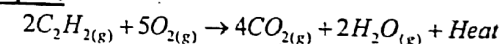
(a) methane

(b) Ethene

(c) Ethyne

Ans. Complete combustion of methane, ethane and ethyne:

All the given compounds react with excess oxygen to form carbon dioxide, water and heat. This is called complete combustion. The chemical equation for each of them is given below:

a. Methane:b. Ethene:c. Ethyne:

(c) Explain briefly that why ethylene (acetylene) undergoes addition reaction in two steps.

Ans. Reason for ethyne, undergoing addition reaction in two steps:

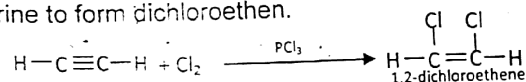
Ethyne contains carbon-carbon triple bond. It undergoes addition reaction in two steps because in first step the carbon-carbon triple bond is broken down and two atoms are added. Thus, the triple bond is converted to double bond. While in second step the double bond is broken down and two more atoms are added. Thus, double bond is converted to single bond.

Example**Chlorination Of Ethene:**

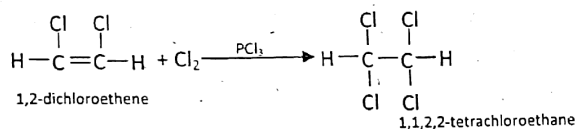
It occurs in two steps which are given below:

Step-i:

In first step triple bond is converted into double bond by the addition of two atoms of chlorine to form dichloroethene.

**Step-ii:**

In this step double bond is converted to single bond by the addition of two atoms of chlorine to form tetrachloroethane.



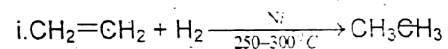
Q 3. (i) Give an example reaction that would yield the following products?

Name the organic reactant and product in each reaction.

- (a) Alkane (b) Monohalogenated alkane
(c) Dihalogenated alkane (d) Tetrahalogenated alkane

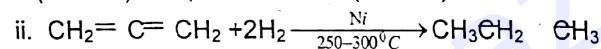
Ans. (a) Reaction yielding alkane:

Unsaturated hydrocarbons like alkenes and alkynes yield alkanes by reacting them with hydrogen in the presence of nickel as catalyst at 250-300 °C or in the presence of platinum as catalyst at room temperature.



(Ethene)

(Ethane)

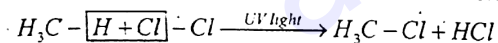


(Propene)

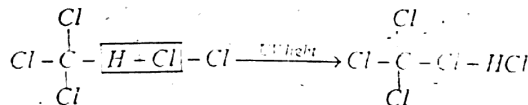
(Propane)

(b) Reaction yielding monohalogenated alkane:

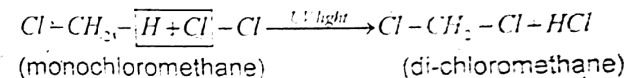
In the presence of ultra violet rays methane reacts with chlorine to form monochloromethane which is a monohalogenated alkane.



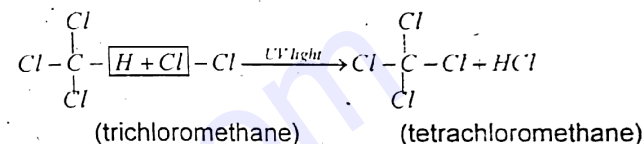
chloromethane

**(c) Reaction yielding dihalogenated alkane:**

In the presence of ultra violet rays monochloromethane reacts with chlorine to form dichloromethane which is a dihalogenated alkane.

**(d) Reaction yielding tetrahalogenated alkane:**

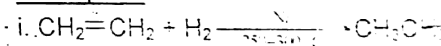
In the presence of ultra violet rays trichloromethane reacts with chlorine to form tetrachloromethane which is a tetrahalogenated alkane.



ii. (a) Alkenes are unsaturated hydrocarbons. Explain the word unsaturated?

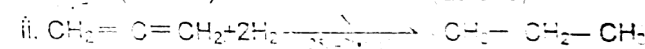
Ans. Explanation of word unsaturated for alkenes:

The word unsaturated for alkenes means that further atoms can be added to them. As they contain carbon-carbon double bonds therefore, more atoms can be added to them by the breaking of double bonds. Hence they are unsaturated hydrocarbons.

Examples:

(Ethene)

(Ethane)



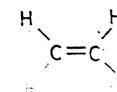
(Propene)

(Propane)

(b). Describe the bonding between the two carbon atoms in Ethene.

Ans. Bonding between two carbon atoms in ethene:

In ethene the two carbon atoms have double covalent bonds i.e one sigma and one pi bond. Each carbon atom is then bonded to two hydrogen atoms through single covalent bonds.

Structure:

Ethene

(c). Which functional group is present in alkenes?

Ans. Functional group in alkene:

The functional group is the active part of an organic compound. The functional group of alkene is the carbon-carbon double bond.

(d). Describe a simple chemical test to determine whether an unknown hydrocarbon is unsaturated. Describe the result if the test is positive?

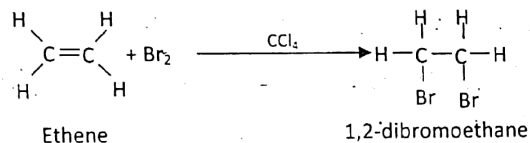
Ans. Simple test to determine saturated and unsaturated hydrocarbons:

The simple test for the determination of unsaturated and saturated hydrocarbons is reacting them with bromine water.

The colour of bromine water discharges on addition to alkene because it chemically reacts with alkene. On the other hand, alkanes do not discharge its colour because they do not react with bromine water.

Example:

Bromine (a red liquid) is reacted with ethene it adds to ethene to form 1,2-dibromoethane. During this reaction the red colour of bromine disappears due to its addition to ethene.



Positive Result:

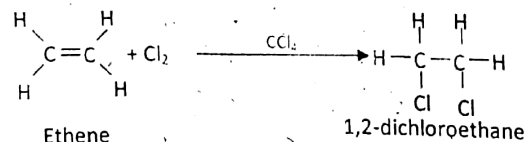
If the result is positive i.e. bromine water is decolourized. Then, the compound will be an alkene.

Q 4. Using structural formula. Give balanced equations for the following reactions.

- Ethene with chlorine
- Ethene with hydrogen. Name the catalyst used. Which industrial process uses a similar reaction?
- Ethene with hydrogen bromide
- Ethene with KMnO_4

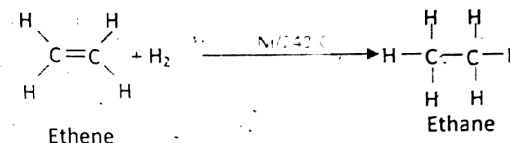
Ans. (a) Reaction of ethene with chlorine:

Ethene reacts with chlorine in the presence of CCl_4 as catalyst to form 1,2-dichloroethane.



(b) Reaction of ethene with hydrogen:

Hydrogen is added to ethene in presence of nickel as catalyst and 240°C . to form ethane.

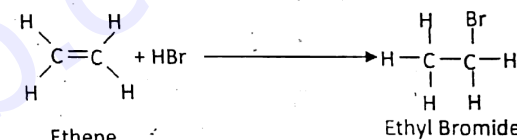


Industry which uses similar reaction:

Hydrogenation of alkenes is used by Ghee industry to convert vegetable oil to ghee.

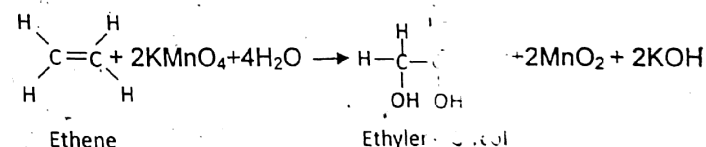
(c) Reaction of ethene with hydrogen bromide:

Ethene reacts with hydrogen bromide to form ethyl bromide or bromo-ethane.



(d) Reaction with KMnO_4 :

Ethene reacts with acidified solution of potassium permanganate to produce ethylene glycol, manganese dioxide and potassium hydroxide due to which the purple colour of potassium permanganate solutions disappears. This is a very useful test for the detection of alkenes and is called Bayer's test.



Q 5. Illustrate the following accordingly as been instructed

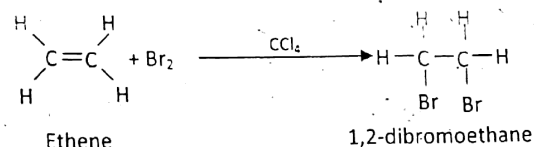
(a) Alkane from alkyl halide

Ans: Preparation of alkane from alkyl halide:

For answer see question no.4

(b) Bromoethane from ethene**Ans: Preparation of bromoethane from ethene:**

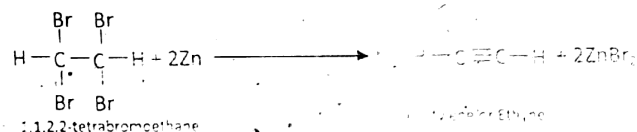
Ethene reacts with bromine water in presence of CCl_4 as catalyst to form 1,2-dibromoethane. During this reaction the red colour of bromine disappears. Thus, bromine is used to detect the double bonds of alkenes:

**(c) Ethylene glycol (1,2-ethanediol) from Ethene****Ans. Preparation of ethylene glycol from ethene:**

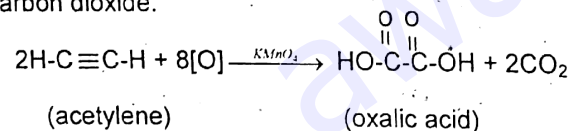
For answer see above question no.4(d)

(d) Ethyne from Tetrahalides**Ans. Preparation of ethyne from tetrahalides:**

When alkyl tetrahalides like 1,1,2,2-tetrabromoethane is reacted with an active metal like zinc dust, bromine atoms are removed and ethyne (acetylene) is formed.

**(e) Oxalic acid from Acetylene****Ans. Preparation of oxalic acid from acetylene:**

When acetylene (ethyne) is oxidized with solution of potassium permanganate, the triple bond of acetylene is broken to form oxalic acid and carbon dioxide.

**Additional Questions****Q. Why alkane is inert in nature?**

Ans. Alkanes are chemically inert in nature due to the following reason:

Reason:

Alkanes are chemically inert in nature because they contain carbon-carbon single bonds. The single bonds are very strong and stable and high energy is required to break them, therefore, alkanes are chemically inert as compared to alkynes and alkenes because they contain double or triple bonds which can easily be broken.

Q. What is Baeyer's test?**Ans: Baeyer's test:**

This test was introduced by German organic chemist Adolf Von Baeyer, therefore, it is called Baeyer test.

Purpose of Baeyer's test:

This test is used for the detection of alkenes.

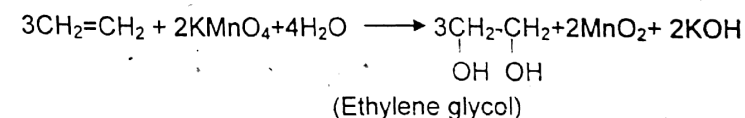
Baeyer's reagent:

The chemical used in Baeyer's test are called Baeyer's reagent. Baeyer's reagent consists of alkaline dilute solution of potassium permanganate which is a strong oxidizing agent.

Reaction:

Alkenes react with cold dilute potassium permanganate solution (alkaline) to form glycol. Glycols are the compounds containing two hydroxyl groups (-OH) on two adjacent carbon atoms.

The reaction of potassium permanganate with ethene is given below:



During this reaction potassium permanganate is changed to manganese dioxide and potassium hydroxide due to which its purple colour disappears.

Q. What are addition reactions?**Ans. Addition reactions:**

Generally addition reactions are of two types.

"The reactions in which two or more substances react to form only one substance are called addition reactions."

Shams Notes

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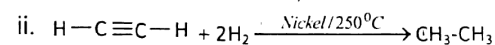
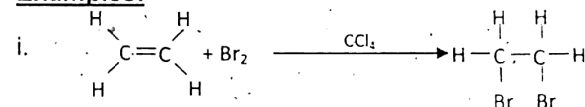
Hydrocarbons

With regard to organic compounds addition reactions can be defined as:

"The reaction in which molecules like H_2 , Cl_2 , HCl etc are added to alkenes or alkynes is called addition reaction."

Addition reactions occur only in unsaturated hydrocarbons i.e. alkenes and alkynes. During addition reactions unsaturated hydrocarbons are changed to saturated hydrocarbons.

Examples:



Additional MCQs

- are called saturated hydrocarbons.
(a) alkane (b) alkyne (c) alkene (d) aromatic compounds
- Chemically inert hydrocarbons are called-----
(a) alkane (b) alkyne (c) alkene (d) aromatic compounds.
- Hydrocarbons are referred to as:
(a) Paraffin (b) paramagnetic (c) diamagnetic (d) both a & d.
- Hydrogenation of alkenes and alkynes is done through the catalyst----at $200-300^\circ C$ to form alkane.
(a) Ni (b) Pt (c) Mn (d) Fe.
- Alkenes contain at least----double bonds.
(a) One (b) two (c) three (d) four.
- Hydrogenation of alkenes is industrially used for the conversion of ---- oils into ghee.
(a) Animals fats (b) cod liver (c) vegetables (d) both a & b.
- Alkynes are hydrocarbons which contains at least----bond.
(a) Single (b) double (c) triple (d) one hydrogen bonding.
- Addition of halogen in double and triple bonds of hydrocarbon are called
(a) Halogenations (b) hydrogenation (c) halo hydrogenation (d) Both a & d.
- Dehydration of ethyl alcohol with conc. H_2SO_4 results in the formation of:
(a) Ethane (b) methane (c) acetylene (d) ethene.

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Hydrocarbons

- Which one of the following reagents distinguishes ethene from acetylene?
(a) Alkaline solution of $KMnO_4$. (b) Bromine solution. (c) Carbon tetrachloride solution (d) Alcoholic KOH.
- Which one of the following decolorizes Br_2 water:
(a) propane (b) ethene (c) ethane (d) methane.
- Ethene reacts with HBr , the compound formed is:
(a) CH_3-CH_2-Br . (b) $Br-CH_2-CH_2-Br$. (c) $CH_3-CH_2-CH_3$. (d) Acetylene.
- Which of the following statements is not true for alkynes:
(a) They contain a triple bond. (b) They burn to form CO_2 . (c) They perform Baeyer's test. (d) They undergo addition reaction.
- General formula for alkenes is:
(a) $C_nH_{2n}O_n$ (b) C_nH_{2n-1} (c) C_nH_{2n-2} (d) C_nH_{2n} .
- All the members of alkane series have:
(a) All single bonds (b) at least one double bond (c) at least one triple bond (d) All types of bonds.
- Baeyer's reagent is:
(a) conc. $KMnO_4$ (b) alkaline $KMnO_4$ (c) acidic $KMnO_4$ (d) hot $KMnO_4$.
- Which one gives carboxylic acid with alkaline $KMnO_4$:
(a) Ethane (b) ethene (c) acetylene (d) methane.
- Baeyer's test shows the presence of:
(a) A single bond (b) a double bond (c) a triple bond (d) no bond.
- Which one is the least reactive:
(a) ethyne (b) propene (c) ethene (d) ethane.
- Ethane reacts with chlorine in the presence of:
(a) Carbon tetra chloride (b) ether (c) sunlight (d) water.
- Chlorination of methane is catalyzed by,
(a) Water (b) Heat (c) sunlight (d) HCl .
- Which one of the following corresponds to C_nH_{2n+2} .
(a) C_2H_6 (b) C_2H_4 (c) C_2H_2 (d) C_2H_5 .

Chapter No.13

Biochemistry

Q.1. Define Biochemistry.

Ans. Biochemistry:

"The branch of chemistry which deals with the study of synthesis, decomposition of substances and their reactions in living organisms such as plants and animals is called biochemistry". OR

"The branch of chemistry that deals with the chemical compounds and processes occurring in organism."

Q.2. What are biological molecules?

Ans. Biological molecules:

"The organic compounds present in living organisms are called biological molecules."

Biological molecules include carbohydrates, proteins, lipids or fats, enzymes, vitamins and nucleic acids.

Q.3. What are carbohydrates? Explain the classification of carbohydrates along with the uses of carbohydrates.

Ans. Carbohydrates:

Origin of name:

Since most of carbohydrates have the general formula $C_n(H_2O)_n$. (n can have a value of 3 or more than 3) therefore, they are called carbohydrates meaning hydrates of carbon.

However, now a days many carbohydrates have been discovered which do not have the general formula of $C_n(H_2O)_n$ and cannot be called hydrates of carbon however the name carbohydrate is still retained. e.g. Fructose ($C_6H_{12}O_5$).

Definition:

"Polyhydroxy ketones or polyhydroxy aldehydes are called carbohydrates." OR

"Polyhydroxy derivatives of aldehydes and ketones are called carbohydrates."

Polyhydroxy means having many hydroxyl groups.

Common name:

Carbohydrates are also called as sugars. They are also referred as saccharides (Latin word saccharum meaning sugar)

Composition:

Carbohydrates are poly functional (alcohol + aldehydes or ketones) organic compounds which mainly consist of carbon, hydrogen and oxygen some time along with nitrogen (chitin) or Sulphur (keratin sulphate).

Classification of carbohydrates:

Carbohydrates are classified into the following three groups:

1. Monosaccharides 2. Oligosaccharides 3. Polysaccharides

Their detail is given below;

1. Monosaccharides:

Definition:

"The simplest carbohydrates which cannot be further hydrolyzed into smaller units are called monosaccharides."

General formula:

They have the general formula of $C_n(H_2O)_n$, where $n=3,4,5$ and so on.

Composition:

Monosaccharides are either aldoses having aldehydic functional group (for example glucose) or ketoses having ketonic functional group for example fructose.

These may be trioses ($C_3H_5O_3$), tetroses ($C_4H_7O_4$), pentoses ($C_5H_{10}O_5$) and hexoses ($C_6H_{12}O_6$).

General properties of monosaccharides:

Some general properties of monosaccharides are:

i. Solubility:

They are soluble in water.

ii. Physical state:

They are crystalline solids

iii. Taste:

They have sweet taste

iv. Colour:

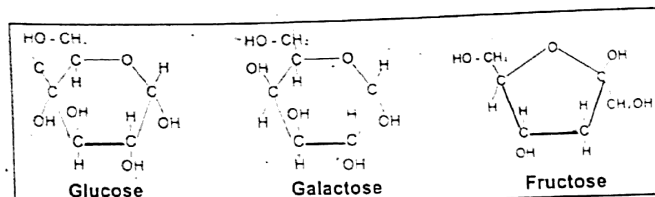
They are colourless.

v. Hydrolysis:

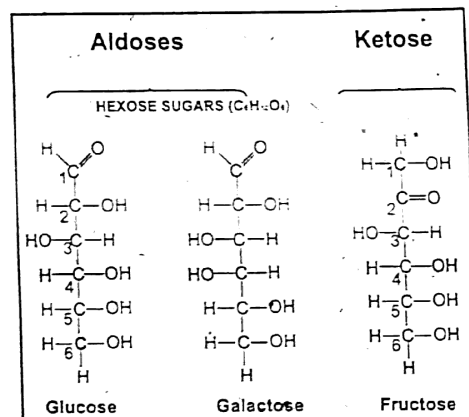
They cannot be hydrolyzed further.

Examples:

The most important monosaccharides are glucose and fructose. They are hexoses having molecular formula of $C_6H_{12}O_6$. Glucose is pentahydroxy aldehyde while fructose is pentahydroxy ketone. Their structures are given below:



In straight forms these structures can be written as following



2. Oligosaccharides:

"Carbohydrates containing two to nine monosaccharide units are called oligosaccharides." OR

"The carbohydrates which yield two to nine monosaccharide units on hydrolysis in the presence of an acid or enzyme are called oligosaccharides."

Formation:

They are formed when two to nine monosaccharide molecules combine with each other by the loss of water molecules. These molecules are bonded with each other through glycosidic linkage.

Types:

Oligosaccharides have many types but two of them are described below:

a. Disaccharides:

"Those oligosaccharides which consist of two monosaccharide units are called disaccharides."

Examples:

Disaccharides



Monosaccharides

b. Trisaccharides:

"Those oligosaccharides which consist of three monosaccharide units are called trisaccharides."

Examples:

Raffinose, kestose and maltotriose (C₁₈H₃₂O₁₆) etc.

General properties of oligosaccharides:

Some general properties of oligosaccharides are:

i. Solubility:

They are soluble in water.

ii. Physical state:

They are crystalline solids.

iii. Taste:

They have sweet taste.

iv. Colour:

They are colourless.

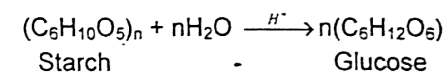
v. Hydrolysis:

They give two to nine monosaccharide units on hydrolysis.

3. Polysaccharides:

"The biopolymers of monosaccharides which consist of 100 or more monosaccharide units joined together through glycosidic linkage are called polysaccharides."

Polysaccharides have high molecular weight, they are macromolecules and they hydrolyzed to give many molecules of monosaccharides e.g.



General properties of polysaccharides:

i. Physical state:

They are amorphous solids.

ii. Taste:

They are tasteless and are called non-sugars.

iii. Solubility:

They are insoluble in water.

iv. Hydrolysis:

They give many molecules of monosaccharides on hydrolysis.

Examples:

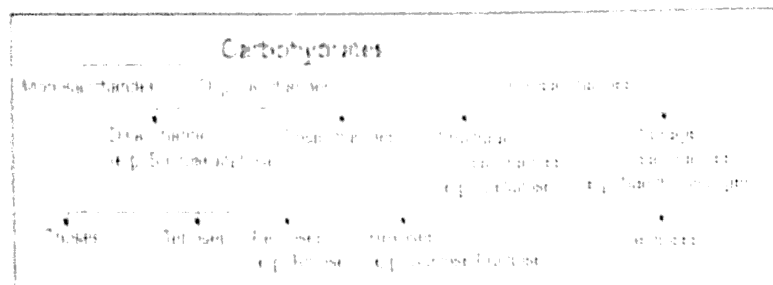
Cellulose, starch, glycine and glycogen are the examples of polysaccharides.

Function:

Polysaccharides perform two main functions in animals and plants.

They are used as energy storage of food.

i. They are used as structural material of food.



Classification of carbohydrates

Q 4. Describe the sources and uses of carbohydrates.

Ans. **Sources of carbohydrates:**

The sources of different types of carbohydrates are given below.

i. Sources Of Monosaccharides:

The sources of monosaccharides are given below.

a. fruits b. vegetable c. cereals d. honey etc.

ii. Sources Of Disaccharides:

Disaccharides like sucrose, lactose and maltose are the examples of disaccharides. Their sources are described as under:

a. Sources Of Sucrose:

The sources of sucrose are sugar cane, sugar beet and fruits like mango, apple, pineapple etc.

b. Sources Of Lactose:

The sources of lactose are milk and dairy products.

c. Sources Of Maltose:

The sources of maltose are cereals like barley, corn etc. Similarly, raffinose is a trisaccharide composed of galactose, glucose and fructose. It can be found in beans, cabbage, broccoli and asparagus etc.

iii. Sources Of Polysaccharides:

Cellulose and starch are the examples of polysaccharides. Their sources are given below.

a. Sources Of Cellulose:

Plants are the main source of cellulose. For example cotton is pure cellulose obtained from cotton plant. Cellulose is also the major constituent of paper, paperboard etc.

b. Sources Of Starch:

It is found in cereal crops like barley, wheat, maize, rice, potatoes etc.

Uses of carbohydrates:

Carbohydrates play a vital role in our daily life. Some of their uses are given below:

i. Textile industry:

Carbohydrates like cellulose in the form of cotton is used in the manufacture of cloth.

ii. Paper industry:

Cellulose is used in making of paper.

iii. Medical uses:

Constipation and diarrhea are controlled by the use of fibers which are carbohydrates. Similarly, cellulose helps to lower cholesterol level and regulates blood pressure.

iv. As a source of energy:

Carbohydrates also act as a chief source of energy in living organisms. For example, glucose in the form of glycogen is stored in animal liver and muscles cells. It is converted back into glucose when needed. Plants store excess food in the form of starch.

v. As a structural material:

They act as a structural material for plants.

vi. In furniture:

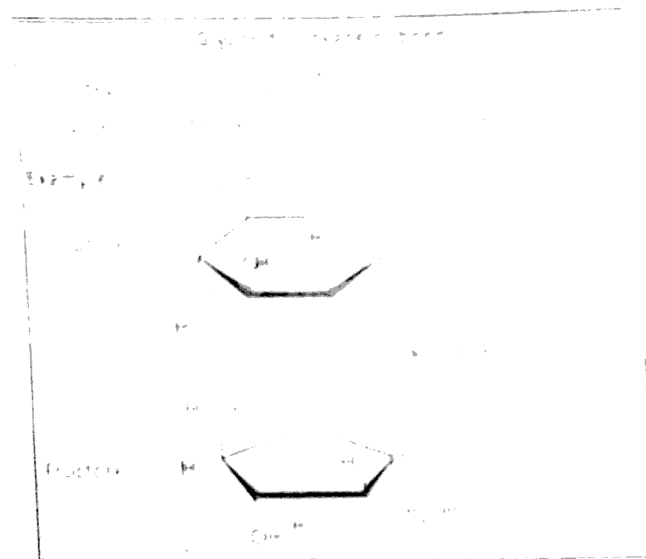
Cellulose in form of wood is used in making furniture.

vii. For food sweetness:

Sugar is a common carbohydrate used as a food sweetener.

viii. As a source of food

Carbohydrates serve as a source of food



Society, Technology and Science

Dextrose crystals are used to sweeten soft drinks and sports drinks and hospitals. In this process, dextrose crystals are taken place in the cloud which is composed of water and water with the release of energy. That is why it is called as the source of energy but compensate a lot of water to be a drink.

Do you know

All the carbohydrates are of plant origin except for a few of animal origin. Supersaturated solutions of carbohydrates are not stable in water at normal conditions but they are stable if the solution is not soluble in water at normal conditions. Their solubility increase with heating but they do not give true solutions.

Q 5. Describe proteins, the nature of bonding in proteins and their uses.

Ans. 1. Proteins Origin of word protein:

Protein is derived from Greek word "Proteios" which means "of prime importance". Because they are essential for the growth and maintenance of life. Proteins are biopolymers of amino acids.

Definition: "The nitrogenous compounds essential for the growth and maintenance of life and organisms are called proteins" (OR)

"The nitrogenous compounds that have globular or fibrous structure composed of linked amino acids are called proteins."

Explanation:1. Composition of proteins:

Proteins consist of elements like nitrogen, carbon, hydrogen, oxygen and sulphur. Amino acids are the building blocks of proteins.

Proteins are the major components of cells. About 50-55% of dry weight of cells is made of proteins.

In the protein polymer, the amino acids are linked together through peptide linkage.

2. Formation of proteins:

Proteins are polymers formed by the condensation of alpha-amino acids. Their molecular weight is greater than 10000.

3. Collective name of protein, carbohydrate and lipid:

Proteins, carbohydrates and lipids are important food stuffs called macromolecules. Triamylates is Latin word meaning group.

Examples:

Some examples of proteins are given below;

i. Hemoglobin ii. Globulin iii. Keratin iv. Albumin etc.

2. Nature of bonding in proteins:

In proteins three types of bonding may occur:

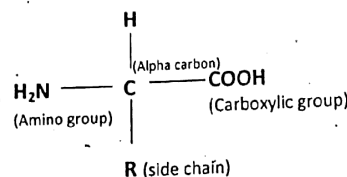
- i. Peptide bonding
- ii. Hydrogen bondings
- iii. Disulphide bridges

As proteins are formed from the joining of amino acid molecules therefore first we discuss bonding in amino acids:

2.1 Bonding in amino acids:

Amino acids consist of carbon, hydrogen, oxygen and nitrogen bonded through covalent bonds. Some amino acids also contain sulphur.

The general structure of amino acids consist of carboxylic group (COOH) and amino group (NH₂) attached to the same carbon atom (alpha carbon). Each amino acid also has an alkyl group R called the side chain, carbon). The R may be simple e.g. in glycine R is a H-atom while it may be complex e.g. in tryptophan R includes two ring structures. Twenty different amino acids are commonly found in proteins.

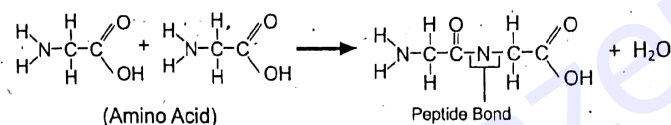


General structure of amino acid

2.2 Protein formation from amino acids:

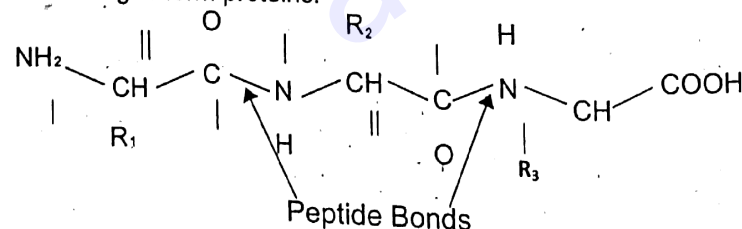
Protein molecules are formed from 20 different types of amino acids when they linked together with the elimination of water molecules. This process is called condensation. As a result, a linear protein polymer is formed.

In these 20 amino acids 10 are prepared by our body which are non-essential while the rest are essential amino acids which are obtained through the food we eat.



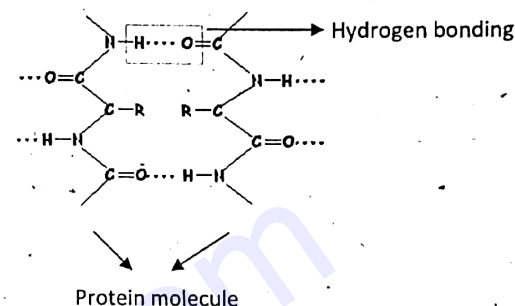
2.3 Peptide linkage/bonding:

The bonding between carbonyl group (-C=O) and NH group are called peptide linkage or bonding. Amino acids main skeleton are linked through peptide bonding to form proteins.



Hydrogen bonding:

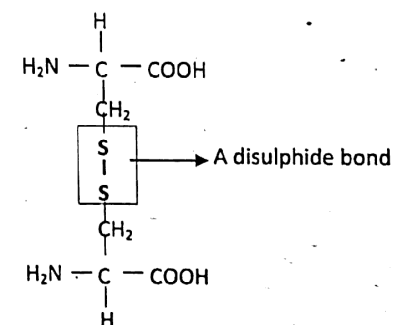
The hydrogen bonding establishes between O of carbonyl group ($\text{C}=\text{O}$) and H of -NH- group in proteins.



2.4 Disulphide bridges/bonding:

The disulphide bonds or bridges occur only in sulphur containing proteins. In these -SH- group are bonded to form disulphide linkage, -H-S-S-H-.

Due to disulphide bonding and hydrogen bonding the protein molecules get folded and refolded to give secondary, tertiary and quaternary structures.



Protein molecules may be globular as in haemoglobin and antibodies or they may be fibrous e.g. keratin in skin and nails.

Uses/function/Importance of proteins:

The following are the uses of proteins;

i. Body structure:

They support body structure e.g. skin, nail, feather, hoofs horns are composed of proteins

ii. As oxygen carrier:

Haemoglobin is a protein which carries oxygen to all cells of body.

iii. As body regulators:

Proteins like hormones and enzymes are chemical regulators in the body.

iv. Commercial uses of enzymes(proteins):

Enzymes are proteins with catalytic function. They change starch into sugar. They also help in improving the quality of products such as textile detergents foods and beverages. Vinegar and cheese are also produced due to the use of enzymes in yeast and bacteria.

v. Body defense system:

Proteins like antibodies increase the immune power of the body.

vi. Growth:

Proteins are essential for the physical and mental growth especially in children.

vii. In bakery items:

Protein like gelatin is used in bakery items.

viii. In making leather:

Animal hides are also made up of proteins which are used to make leather.

ix. Enzymatic action:

Enzymes are proteins which catalyze biochemical reactions, occurring in living things.

Q.6. Describe the sources of proteins.**Ans. Sources of proteins:**

Plants and animals are the main sources of proteins. They are discussed below:

Animal sources:

Eggs, milk, cheese, meat, fish etc. are the animal sources of proteins.

Plant sources:

Pulses, beans are the plant sources of proteins.

Activity 1:**Take an egg**

1) Boil it in water and see what happens.

2) Compare and record the observation about the denaturing of proteins.

Ans: When an egg is boiled in water, the structure of its protein molecules (albumin) is disturbed and it is denatured.

Denaturation:

It is a process in which proteins lose their secondary structure (shape of protein molecules caused by hydrogen bonding) and tertiary structure(folding and bending of proteins caused by R groups) by heat or some chemical substances.

Q.7. Explain lipids with classification, sources and uses?**Ans. Lipids:****Origin of word lipid:**

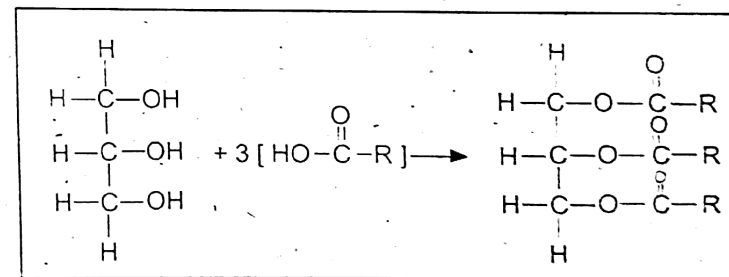
The term lipid is derived from Greek word "lipose" which means fats.

Definition:

"Naturally occurring organic compounds of plant and animal origin which are insoluble in water and soluble in organic solvents like acetone, ether etc are called lipids."

Composition:

Lipids are generally composed of carbon, hydrogen and oxygen. Generally, lipids are long chain fatty acids of esters and alcohols. These esters are made up of three fatty acids called triglycerides. Thus the primary building block of lipids are fatty acids and alcohols.



Glycerol

Fatty acids

Fat molecule

Examples:**Several Types Of Lipid:**

They are given below:

- a. Fats and oils
- b. Steroids like cholesterol
- c. Turpentine oil
- d. Sex hormones
- e. Phospholipids
- f. Vitamins like A,D,E and K.
- g. Waxes

Classification of lipids:

Lipids are classified into the following two groups:

- i. Simple lipids
- ii. Complex lipids

Their detail is given below:

i. Simple lipids:

"The type of lipids which produce fatty acids and alcohols on hydrolysis are called simple lipids or triglycerides."

Examples:

Fats, oils and waxes.

ii. Complex lipids:

"The type of lipids which produce alcohols, fatty acids along with some other compounds on hydrolysis are called complex lipids."

Examples:

Phospholipids, glycolipids, sulfolipids etc.

Sources of lipids:

There are two main sources of lipids (fats and oils)

i. Animal sources:

Animal fats are particularly present in adipose tissue. Butter and ghee are special type of animal fats which are made from milk. Marine oils are obtained from marine animals like salmon and whales.

ii. Plant sources:

Vegetable oils are mainly present in seeds and nuts of plants e.g. mustard, olive, sunflower, maize etc.

Uses/importance of lipids:

The uses/importance of lipids are given below;

i. As a source of energy:

They are good source of energy and make the food tasty. One gram of fats nearly contain double energy than one gram of protein or carbohydrates.

ii. Effect on nervous system:

They exert an insulating effect on nervous system which is necessary for proper function of nervous system.

iii. As thermal insulators in body:

In mammals a layer of fat is present under the skin. This layer acts as thermal insulator which insulates body from excessive heat or cold.

iv. As a part of protoplasm:

They are present in the protoplasm and cell membrane.

v. As a precursor(basic):

Some lipids act as precursor of very important physiological compounds. For example, cholesterol is the precursor of steroid hormones.

vi. For cooking:

Butter, oil and ghee are used for cooking and frying food items and for cooking confectionaries.

vii. Protection of some organs:

A protective layer of fats around our heart, kidneys etc reduces the impact of any external jerk or shock.

viii. As solvent:

Lipids acts as a solvent for some vitamins like A, D and E.

Q.8: Write a note on fatty acids?**Ans: Fatty Acids:**

Fatty acids are carboxylic acids with a long chain which may be saturated or unsaturated.

General Formula:

The general formula of fatty acids is $R-COOH$.

Types:

On the basis of single or double bonds, present in fatty acids, they are of two types:

Saturated fatty acids:

They have carbon-carbon single bonds.

Examples:

- i. Butyric acid ($CH_3(CH_2)_2COOH$) present in butter.

- ii. Stearic acid ($\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$) present in animal fats etc.
- iii. Caproic acid ($\text{CH}_3(\text{CH}_2)_4\text{COOH}$) present in goat milk.

Unsaturated fatty acids:

They have carbon-carbon double bonds.

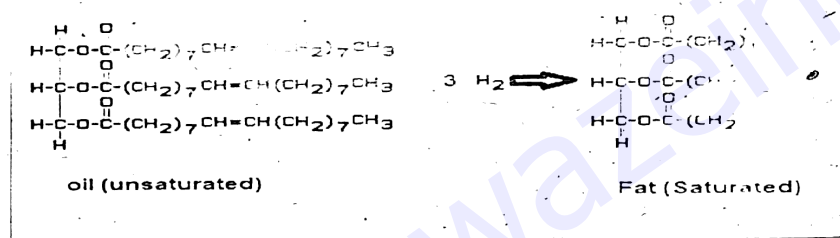
Examples:

- i. Myristoleic acid ($\text{CH}_3(\text{CH}_2)_3\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$)
- ii. Palmitoleic acid ($\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$) etc.

Q.9. Describe the difference between fats and oils.**Ans. Difference between fats and oils:**

Animal and vegetable fats and oils have similar chemical structures. They are triesters formed from glycerol and fatty acids. However, difference can be made between fats and oils which is given in the table below:

	Fats	Oils
1)	"Those triglycerides which contain higher proportion of saturated fatty acid components are called fats."	"Those triglycerides which contain higher proportion of unsaturated fatty acid components are called oils."
2)	They are soft solids.	They are liquids.
3)	They have high m.p and b.p.	They have low m.p and b.p.

4) Examples**Society, Technology and Science**

Vegetable oils have unsaturated molecules. In industry these oils are changed to saturated solid fat (ghee) by the process of hydrogenation. In this process hydrogen molecules are added to the double bond of oil in the presence of finely divided nickel as catalyst at about 250 °C temperature.

Q.10. What are nucleic acids? Describe its composition, types and uses.**Ans. Nucleic acid:****Discovery:**

Nucleic acids were first discovered in nuclei of WBC's in 1868 AD. Later on they were discovered in the head of sperm cell by Friedrik Miescher in 1872 AD.

Definition:

"Complex organic compounds consisting of nucleotides which synthesize proteins and transmit characters from parents to offspring's are called nucleic acids."

Explanation:

Nucleic acids are found in each and every cell and viruses. They are essential parts of genes. They consist of small units called nucleotides. Most of the nucleotides are biopolymers of nucleosides and phosphate group.

Types of nucleic acids:

Naturally occurring nucleic acids are of two types:

- i. Deoxyribonucleic acid (DNA)
- ii. Ribonucleic acid (RNA)

Composition of nucleic acids:

Nucleic acids consist of small units called nucleotides. These nucleotides in each of the nucleic acid consist of the following three parts:

Parts of nucleotides:**i. Sugar:**

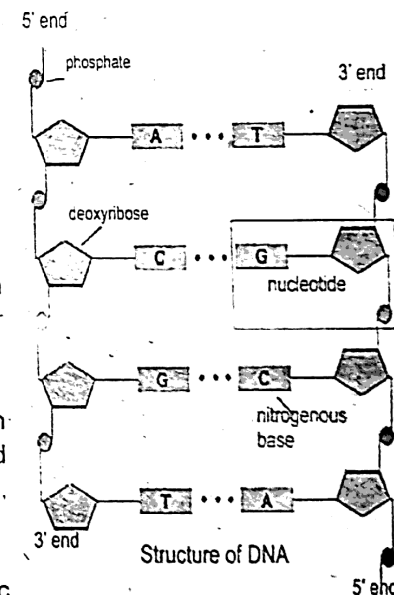
It has five carbon rings which may be ribose as in RNA or deoxyribose as in DNA.

ii. Nitrogenous base:

It is heterocyclic amine which is either purines (adenine and guanine) or pyrimidines (cytosine, thymine and uracil).

iii. Phosphate group:

It is the third part of nucleic acids.



Functions of nucleic acids:

Nucleic acids perform the following two main functions:

1. Genetic information and protein synthesis:

They store and transmit genetic information. The genetic information, for the cell, are present in DNA molecules in the form of special codes. These information are translated and expressed by synthesis of specific proteins. These proteins perform various functions according to the directions which are given by the codes present in DNA. Thus protein synthesis in cell are completed in two stages i.e. transcription (transference of genetic codes) and translation (the translation of information of codes).

2. Mutation:

"Any sudden chemical change in DNA which could lead to the synthesis of proteins with a disturbed amino acids sequence is called mutation."

Mutations occur during DNA replication when the chemical structure of genes undergoes random modifications.

Mutation is caused by various mutagens like radiations, chemical agents or viruses.

Majority of changes in DNA are repaired by special enzymes in the cell. However, when the enzymes fail to repair the change, mutation occurs.

Q.11: What are vitamins and how are they classified?

Ans: Vitamins:

Origin of word vitamin:

The name vitamin was originally vitamin because the first one that was found was an amine, hence the name vital amine or vitamin was adopted. Later on, it was found that all of them are not amines. So, the "e" was dropped.

Definition:

"Organic compounds that cannot be synthesized by an organism but very essential for the maintenance of normal metabolism are called vitamins."

Need of vitamins:

Vitamins are required by the body in small amounts to maintain health and function properly. The absence or deficiency of vitamins causes various diseases.

Types/Classification of vitamins:

There are two main types of vitamins:

1. Fat soluble vitamins:

These include vitamins A, D, E and K

2. Water soluble vitamins:

These include vitamins B-complex and vitamin C. Their detail is given below:

1. Fat soluble vitamin:**i. Vitamin A:**

Its chemical formula is $C_{20}H_{30}O$. It is also called retinol. It is a fat soluble vitamin which plays an important role in cell growth, vision and the immune system.

Sources:

Vitamin A is found in green vegetables and fruits like sweet potatoes, pumpkin, spinach, banana, plum etc. It is also found in fish liver oil, eggs, butter and cheese etc.

Vitamin A is not found in plants as such. It is present in the form of pro vitamin such as beta-carotene (a vitamin precursor found in vegetables like carrot, spinach etc). Vitamin A combines with a protein called opsin to produce a light absorbing compound called rhodopsin, which plays a vital role in vision.

Deficiency diseases:

Deficiency of vitamin A causes night blindness, which is inability of a person to see in dim light. Similarly, its deficiency also causes dryness of skin and irritation of eyes.

ii. Vitamin D:

Its chemical formula is $C_{24}H_{44}O$. It is also called calciferol due to its role in calcium metabolism. Vitamin D helps in the absorption of calcium and phosphate from intestine and deposits it in skeleton.

Sources:

Vitamin D is found in fish liver oil, milk, butter and vegetables. Vitamin D is also manufactured by the skin after exposure to sunrays.

Deficiency diseases:

Its deficiency causes weakness of bones and a disease called rickets (bowed legs and arms). It also causes osteomalacia (softening of bones).

iii. Vitamin E:

Its chemical formula is $C_{29}H_{46}O_2$. It is also called "Tocopherols" which means fertility because it has major role in reproduction. It has different uses for example it is used as antioxidant.

Sources:

Its main sources are green vegetables, corn oil, soya bean oil, egg yolk, liver, bread, rice etc.

Deficiency diseases:

Its deficiency causes a disease known as anemia due to the destruction of cell membrane of RBC by oxidation. People having anemia have symptoms like pale skin, shortness of breath, rapid heartbeat, low vitality, dizziness.

Its deficiency also causes sterility (reproductive system disease).

iv. Vitamin K:

Its chemical formula is $C_{31}H_{46}O_2$. It is also called phytomenadione. Vitamin K helps in blood clotting. Without this, bleeding would not stop.

Sources:

Its main sources are green vegetables, cheese, liver, meat, egg yolk etc.

Deficiency diseases:

Deficiency of vitamin K causes hemorrhage in which the blood fails to clot and thus the bleeding time is increased.

2. Water soluble vitamins:**i. Vitamin B-complex:**

Vitamin B-complex consist of vitamin B_1 , B_2 , B_3 , B_5 , B_6 , Biotin, Folic acid and B_{12} therefore, they are called vitamin B-complex.

Sources:

Vitamin B-complex are found in bread, rice, yeast, milk, meat, liver, fish, seeds, eggs, leafy vegetables, dry peas and beans etc.

Deficiency diseases:

Their deficiency causes skin diseases, tongue and lips inflammation, anemia, bleeding gums and beriberi (nervous system disease).

ii. Vitamin C:

Its chemical formula is $C_6H_8O_6$. It is also called ascorbic acid. Most of the animals can synthesize it but the human beings cannot due to the absence of enzymes.

Sources:

The main sources of vitamin C are citrus fruits such as lemon, oranges, grapes, strawberries and fresh green vegetables etc.

Deficiency diseases:

Its deficiency causes scurvy disease which is characterized by pain in joints and bleeding from gums.

Q.12. Write the importance of vitamins?**Ans. Importance Of Vitamins:**

Vitamins play a vital role in healthy development and growth of our body. For normal body functions, vitamins are necessary. A few important points regarding importance of vitamins are given below:

i. Blood Clotting:

Vitamin K is necessary for blood clotting.

ii. Blood Formation And Immune System:

Vitamin C is necessary for the formation of blood and improvement of immune system.

iii. Vision:

Vitamin A is necessary for vision. It also keeps the cornea moist.

iv. Defense Against Carcinogens:

Vitamin E is a defender against carcinogenic effects of certain types of chemicals.

v. Nerve Impulse Regulation:

Vitamin B_1 helps to regulate nerve impulse regulation.

vi. Blood Calcium Regulation:

Vitamin D regulates blood calcium which is necessary for proper growth of bones.

vii. Defense Against Diseases:

Vitamins protect us from various diseases like deficiency of vitamin B_{12} results in the inflammation of the corner of mouth and cracks in lips. Similarly, deficiency of vitamin A causes night blindness, deficiency of vitamin C causes scurvy, deficiency of vitamin D causes rickets, deficiency of vitamin E causes anaemia and deficiency of vitamin K causes hemorrhage.

EXERCISE

A. Choose the correct option.

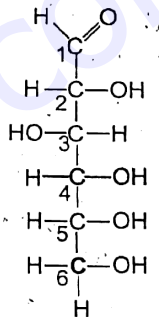
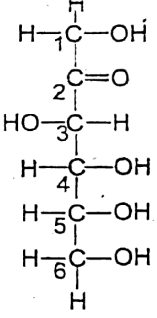
- Which one of the following is a disaccharide?
 - Glucose
 - Fructose
 - Sucrose**
 - Starch
- A large number of amino acids polymerizes into
 - Vitamins
 - Carbohydrates
 - Protein**
 - Lipids
- Glycogen is an example of
 - Fats
 - Nucleic acids
 - Carbohydrates**
 - Protein
- Deficiency of vitamin A causes
 - Scurvy
 - Rickets
 - Night blindness**
 - Aging
- The compound which is found in every living cell and serves as a centre of information and control is
 - Protein
 - Amino acid
 - DNA**
 - Glucose
- Triglycerides are the building blocks of
 - Protein
 - Carbohydrates
 - Lipids**
 - Vitamins
- Sugars are polyhydroxy derivative of
 - Alkyle halides
 - Aldehyde
 - Ketone
 - Aldehyde & Ketone**
- Peptide linkage is present in
 - Carbohydrates
 - Lipids
 - Protein**
 - Vitamins
- Plants convert glucose into
 - Amino acids
 - Lipids
 - Protein
 - Starch**
- All are present in DNA except
 - Deoxyribose
 - Ribose sugar**
 - Nitrogen base
 - Phosphate unit

SHORTQUESTIONS

Q.1. Differentiate between glucose and fructose?

Ans. Differences Between Glucose And Fructose:

The differences between glucose and fructose are given below:

	Glucose	Fructose
(1)	It is a monosaccharide which is polyhydroxy aldehyde.	It is also a monosaccharide but it is polyhydroxy ketone.
(2)	Glucose needs insulin for its metabolizing.	Fructose has no need of insulin for its metabolizing.
(3)	It has less sweet taste than fructose.	It is sweeter than glucose.
(4)	Structure:  Glucose	Structure:  Fructose

Q.2. Write down four uses of lipids.

Ans. For answer see Question no.7

Q.3. How would you differentiate between simple and complex lipids.

Ans. Differences Between Simple And Complex Lipids:

The differences between simple and complex lipids are given below:

	Simple Lipids	Complex Lipids
(1)	"The type of lipids which produce fatty acids and alcohols on hydrolysis are called simple lipids or triglycerides."	"The type of lipids which produce alcohols, fatty acids along with some other compounds on hydrolysis are called complex lipids."

(2)	They do not contain phosphates, nitrogenous bases and sulphates in their molecules.	They contain phosphates, nitrogenous bases and sulphates in their molecules.
(3)	They have low molecular masses than complex lipids.	They have high molecular masses than simple lipids.
(4)	Examples: Fats, oils and waxes.	Examples: Phospholipids, glycolipids, sulfolipids

Q.4. What is meant by denaturing of protein?

Ans. Denaturation:

It is a process in which proteins lose their secondary structure (shape of protein molecules caused by hydrogen bonding) and tertiary structure (folding and bending of proteins caused by R groups) by heat or some chemical substances.

Q.5. How would you classify vitamins?

Ans. For answer see Question no.11 without sources and deficiency diseases.

Q.6. Vitamins are vital for us, why?

Ans. For answer see Question no.12

Q.7. Write down the products of sucrose on hydrolysis.

Ans. Products of sucrose on hydrolysis:

Sucrose yields glucose and fructose on hydrolysis.

Chemical equation:

Sucrose + Water $\longrightarrow$ Glucose + Fructose

$C_{12}H_{22}O_{11} + H_2O \longrightarrow CH_2OH(CHOH)_4COH + CH_2OH(CHOH)_3COCH_2OH$

Q.8. Draw the general formula of amino acid. Identify the different parts and functional groups present in it.

Ans: For answer see Question no.5 heading 2.1

Q.9. Briefly describe the sources and deficiency symptoms of vitamin A.

Ans. For answer see Question no.11

Q.10. Identify the different sources of proteins? Also list the four uses of proteins.

Ans. For answer see Question no.5+6

LONG QUESTIONS

Q.1. What functions do carbohydrates perform in living organisms?

Ans. Functions performed by carbohydrates in living organisms:

Carbohydrates perform various functions in living organisms. Some of their uses are given below:

i. Medical uses:

Constipation and diarrhea are controlled by the use of fibers which are carbohydrates. Similarly, cellulose helps to lower cholesterol level and regulates blood pressure.

ii. As a source of energy:

Carbohydrates also act as a chief source of energy in living organisms. For example, glucose in the form of glycogen is stored in animal liver and muscles cells. It is converted back into glucose when needed. Plants store excess energy in the form of starch.

iii. As a structural material:

They act as a structural material for plants.

iv. As a source of food:

Carbohydrates serve as a source of food in living organisms.

Q.2(a) Distinguish between monosaccharides, disaccharides and polysaccharides and also give examples of each one.

Ans. For answer see Question no.3

(b) How are carbohydrates important to living organisms?

Ans. For answer see Question no.4

Q.3(a) How are proteins important to living organisms?

Ans. Importance Of Proteins:

For answer see Question no.5

(b) Describe the nature of bonding in protein?

Ans. For answer see Question no.5

Q.4(a) Define the term lipid.

Ans. For answer see definition of lipids in Question no.7 along with few examples.

(b) Distinguish between fats and oils.

Ans. For answer see Question no.9

(c) List four foods you eat that contain lipids.

Ans. Four Foods Containing Lipids:

The four foods, we eat, containing lipids are given below:

i. coconut ii. Sunflower iii. Peanut iv. walnut.

(d) How are lipids important to your body?

Ans. For answer see Question no.7

Q.5. (a) How would you justify DNA as genetic code of life?

Ans. DNA as a genetic code of life:

The genetic information's for the cell are present in DNA molecules in the form of special codes. These information are translated and expressed by synthesis of specific proteins. These proteins perform various functions according to the directions which are given by the codes present in DNA. Thus protein synthesis in cell are completed in two stages i.e. transcription (transference of genetic codes) and translation (the translation of information's of codes).

Thus, DNA is genetic code of life containing all information of body like size, colour etc of various organs

(b) Distinguish between DNA and RNA

Ans: Differences Between DNA And RNA:

The differences between DNA and RNA are given below:

	DNA	RNA
(1)	DNA stands for deoxyribo-nucleic acid.	RNA stands for ribonucleic acid.
(2)	Its structure consists of deoxy ribose sugars, nitrogenous bases and phosphate groups.	Its structure contains ribose sugars, nitrogenous bases and phosphate groups.
(3)	The nitrogenous bases of DNA are adenine, guanine, cytosine and thymine.	The nitrogenous bases of RNA are adenine, guanine, cytosine and uracil.
(4)	Three types of RNA's are present in an organism i.e. mRNA in nucleolus while tRNA and rRNA in cytoplasm.	DNA is present in nucleus, nucleolus, mitochondria and chloroplast.

(c) Explain the functions of DNA.

Functions Of DNA:

For answer see question no.10

Q.6 (a): Define the term vitamin and classify it?

Ans. For answer see Question no.11 without sources and deficiency diseases.

(b). Explain the important sources of vitamins?

Ans. For answer see Question no.11 with sources of all vitamins.

(c) Write down the names of five vitamins and their importance.

Ans. For answer see Question no.12.

Additional MCQs

- Poly hydroxy compounds of aldehyde and ketones are called:
(a) **carbohydrates** (b) proteins (c) lipids (d) vitamins.
- Wheat, rice and honey are the sources of:
(a) Vitamins (b) proteins (c) **carbohydrates** (d) lipids.
- is a basic component of paper industry:
(a) **Cellulose** (b) maltose (c) glucose (d) lipids.
- Polymers of amino acid are----
(a) Vitamins (b) **proteins** (c) lipids (d) carbohydrates.
- Nucleic acids are of -----types.
(a) **Two** (b) three (c) four (d) five.
- Vitamin-----is called ascorbic acid:
(a) A (b) B (c) **C** (d) E.
- Fats and oils are called-----
(a) Carbohydrates (b) **lipids** (c) proteins (d) vitamins.
- is a factor related to blood clotting:
(a) Vitamin A (b) Vitamin B (c) Vitamin C (d) **Vitamin K.**
- drips are administered to the dehydrated and weak patients in clinic and hospitals.
(a) Dextrose (b) maltose (c) fructose (d) **glucose.**
- Constipation and diarrhea are controlled by ----fibers.
(a) Protein (b) **carbohydrates**
(c) glycoprotein's (d) glycolipids.
- All the carbohydrates are plants origin except----which is of animal origin.
(a) **Lactose** (b) maltose (c) fructose (d) glucose.
- In protein polymers amino acids are joined together by-----
(a) hydrogen bonding (b) **peptide linkage**
(c) coordinate covalent bond (d) both a & b.
- In protein molecules---types of bonding may occur.
(a) 3 (b) 5 (c) 2 (d) 4.
- All proteins contain-----essential elements.
(a) C, H, O, N (b) **C, H, N, S.**
(c) C, H, O, Fe (d) C, O, Fe, S.
- different amino-acids are commonly found in proteins.
(a) 20 (b) 15 (c) 25 (d) 30.

16. Gum disease scurvy is caused by-----
 (a) **vitamin-c** (b) vitamin-k (c) vitamin-B (d) vitamin-A.
17. Vegetable oils (unsaturated molecules) are converted into saturated solid fat (ghee) by a process called-----
 (a) Halogenations (b) **Hydrogenation**
 (c) Halo hydrogenation (d) Chlorination.
18. The building units of nucleic acids are -----
 (a) amino-acid (b) fatty-acid (c) **nucleotide** (d) glycerol.
19. Each nucleotide of RNA, DNA is composed by -----
 (a) **Sugar, N-Base, phosphate group**
 (b) sugar, amino-acid, Disulphide.
 (c) Sugar, N-Base, fatty-acid
 (d) amino-acid, glucose, fatty-acid.
20. A sudden change in DNA molecule is called-----
 (a) **Mutation** (b) gutation (c) wilting (d) plasmolysis.
21. A chemical substance that has a smell or odour is called-----
 (a) **Fragrance** (b) volatile (c) non-volatile (d) odorance.
22. Night-blindness is caused by the deficiency of-----
 (a) **vitamin-A** (b) Vitamin-B (c) vitamin-D (d) Vitamin-C.
23. The deficiency of vitamin-D produces a disease called-----
 (a) **Rickets** (b) measles (c) Scurvy (d) night-blindness.
24. Vitamin-E deficiency cause-----
 (a) Anemia (b) measles. (c) **Scurvy** (d) night-blindness.
25. In intestine vitamin-K is synthesized by-----
 (a) Protozoa (b) **bacteria** (c) Ascarus (d) virus.
26. Inflammation of lips, dryness & burning of eyes is caused by-----
 (a) vitamin-B₁ (b) vitamin-B₂ (c) Vitamin-C (d) **Vitamin-A.**
27. Vitamin-C is chemically known as-----
 (a) Acetic acid (b) **ascorbic acid** (c) steric acid (d) retinol.
28. Mutation is a chemical change in-----
 (a) lipid (b) protein (c) RNA (d) **Genes.**
29. Fructose is a poly-hydroxy derivative of-----
 (a) **Ketone** (b) aldehyde (c) alkyl (d) amine.
30. Which one of the following vitamin is water soluble----
 (a) A (b) **C** (c) D (d) K.

Chapter No.14

Environmental Chemistry I: Atmosphere

Q.1. Describe the layers of environment.

Ans. Environment consists of four layers which are:

- | | |
|-----------------------------|-----------------|
| i. Lithosphere or Geosphere | ii. Hydrosphere |
| iii. Biosphere | iv. Atmosphere |

i. Lithosphere:

Lithosphere consists of rocky crust of earth, soil minerals and organic matter.

ii. Hydrosphere:

Hydrosphere consists of all water bodies like oceans, lakes, rivers, streams, springs, glaciers and underground water.

iii. Biosphere:

The biosphere is the region of the earth that is capable to support life. Biosphere consists of plants animals and all the things to support them.

iv. Atmosphere:

The layers of gases surrounding the earth is called atmosphere. It contains gases like oxygen, nitrogen, carbon dioxide and noble gases.

Q.2. What is environmental chemistry?

Ans. Environmental chemistry (or) Ecology:

"The branch of chemistry which deals with the study of environment and the changes occurring in it, is called environmental chemistry." OR

"The branch of chemistry which deals with the study of interactions of chemical substances/processes with the environment and their effects on it is called environmental chemistry."

Air pollution and water pollution are the two main areas studied in this branch of chemistry.

Q.3. Define Atmosphere? Explain the composition and layers of atmosphere.

Ans. Atmosphere:

"A thick protective blanket of air/gases around the earth which helps to sustain life is called atmosphere."

1. Composition of atmosphere:

The composition of atmosphere is given below:

i. Major constituents:

The major constituents of atmosphere are nitrogen (78.1% by volume) and oxygen (20.9% by volume)

ii. Minor constituents:

The minor constituents of atmosphere are:

- i. carbon dioxide about 0.03%
- ii. noble gases (about 1%) i.e. helium, neon, argon, krypton, xenon
- iii. Varying amount of water vapours and some other gases like methane, carbon monoxide etc.

iii. Mass:

The mass of atmosphere is about 4.5 to 5×10^{15} metric tones.

iv. Density:

The density of atmosphere is 0.0013g/cm^3 , which gradually decreases with altitude.

v. Temperature and pressure:

The temperature and pressure of atmosphere change with the increase in altitude. The temperature ranges from -92°C to 1200°C . The pressure of atmosphere at sea level is 1atm but at high altitude, about 100Km, above sea level it decreases to $3 \times 10^{-7} \text{atm}$.

Serial No.	Gases	Amount (in percentage)
A.	Main Gases	
1.	Nitrogen	78.1 %
2.	Oxygen	20.9 %
B.	Secondary Gases	
1.	Argon	0.9
2.	Carbon dioxide	0.03
3.	Hydrogen	0.01
4.	Neon	0.0018
5.	Helium	0.0005
6.	Ozone	0.00006
7.	Others	9%
C.	Water Vapours	0.0 to 4%

2. Layers of atmosphere:

The total height of atmosphere from earth surface is about 500Km. Atmosphere is divided on several bases but the most important division is made on the basis of temperature which ranges from -92°C to 1200°C . On this basis atmosphere can be divided into the following four layers or zones:

- i. Troposphere
- ii. Stratosphere
- iii. Mesosphere
- iv. Thermosphere

Their detail is given below:

i. Troposphere:

It is the lowest layer of atmosphere. Its detail is given below:

a. Height:

Its height depends upon latitudes, seasons and pressure. At equator its height is 16Km from earth surface and at 45° latitude is 9.65Km. However its average height is 11km.

b. Temperature range:

The average temperature range of troposphere is from 15°C near the surface to -56°C at the top. The temperature changes at a rate of 6.5°C per km.

c. Major components:

The major components of troposphere are nitrogen (N_2), oxygen (O_2), carbon dioxide (CO_2), water vapours. About 70-75% of the atmosphere's gases are present in this layer.

d. Phenomenon occurring in troposphere:

Most of the weather phenomenon takes place in troposphere. The cloud formation also takes place at the top of the troposphere.

ii. Stratosphere:

It is the second layer of atmosphere which is above troposphere. Its detail is given below:

a. Height:

The stratosphere extends from 11Km to 50Km (39Km).

b. Temperature range:

The stratosphere shows positive lapse rate i.e. the temperature increases from -56°C to -2°C . This is because ozone absorbs UV rays of sun which cause increase in temperature.

c. Major components:

The major component of stratosphere is ozone (O_3), therefore, it is called ozonosphere.

d. Phenomenon occurring in stratosphere:

The stratosphere absorbs ultra violet (UV) radiation. Thus protecting living organisms from the harmful effects of UV radiation.

iii. Mesosphere:

It is the third and middle layer of atmosphere present above the stratosphere. Its detail is given below:

a. Height:

Its height is from 50Km to 85Km (35Km).

b. Temperature range:

The temperature decreases from -2°C to -92°C i.e. shows negative laps rate. The decrease in temperature with height is due to low level of UV absorbing species like O_3 .

c. Major components:

The major components of this region are O_3^+ and NO^+

iv. Thermosphere:

It is the fourth layer of atmosphere just above the mesosphere. Its detail is given below:

a. Height:

The height of this layer is from 85Km to 500Km(415Km).

b. Temperature range:

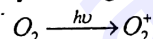
The temperature increase from -92°C to 1200°C with increase in height and shows positive laps rate.

c. Major components:

The major components of this layer are O_3^+ , NO^+ , O^+ .

d. Phenomenon occurring in thermosphere:

In this region various gases absorb UV radiation therefore, its temperature increases. They undergo ionization process:



Due to the presence of ions in this layer it is also called ionosphere.

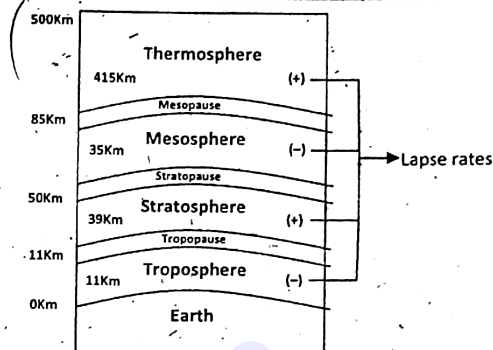


Figure: Layers of atmosphere

Q.4. Describe the importance of atmosphere.**Ans. Importance of atmosphere:**

The importance of atmosphere is given below;

i. Protection of life:

It protects the life on earth by absorbing the dangerous cosmic rays and UV rays of the sun.

ii. Maintaining heat balance:

It maintains the heat balance by absorbing the heat radiation reemitted by earth.

iii. Importance in seeing of objects:

Atmosphere allows visible light of sun to come on earth as a result of this we are able to see things. If the atmosphere did not allow the visible radiation then we would not be able to see anything.

iv. Source of important gases:

It is the main source of different important gases which is important for life i.e. oxygen is necessary for life on earth, carbon dioxide is necessary for plants photosynthesis and nitrogen is also an important macro-nutrient of plants.

v. Important for hydrological cycle:

Atmosphere is an important carrier of water from ocean to land which is very important for hydrological cycle.

vi. Importance in flow of energy:

It helps in flow of energy.

vii. Importance in radio-communication:

It helps in radio-communication.

viii. Importance in aircrafts movements:

It helps in the movement of aircrafts

Q.5. What is air pollution? Explain major sources of air pollution.

Ans. Air pollution:

Definition:

"The addition of any substance to environment which badly affects the quality of environment and causes damage to humans, animals and plants is called pollution

According to world health organization (WHO), air pollution is defined as

"The substances released to air either by human activities or by natural activities, in sufficient concentration, to cause harmful effects to humans, plants and other living things is called air pollution"

Air pollutants:

"The substances which are responsible for causing air pollution are called air pollutants

Types of air pollutants:

Major air pollutants are of two types

i. Primary pollutants:

Those pollutants which are released directly to air are called primary pollutants e.g. CO_2 , NO_2 and SO_2 etc.

ii. Secondary pollutants:

Those pollutants which are derived from primary pollutants when they react with some chemical substances are called secondary pollutants e.g. photochemical smog, acid rain etc.

On the basis of state pollutants are classified into the following types

1. Particulates:

These are the small particles of liquids and solids e.g. carbon particles, dust particles etc.

2. Gaseous pollutants:

The different gases which act as pollutants are CO , SO_2 , NO , NO_2 etc.

Sources of air pollution:**A. Sources of particulate pollutants:**

There are two major sources for particulate matter which are given below.

Natural sources:

The natural sources for the emission of particulate pollutants are volcanic eruption, soil erosion by wind, dust storms, natural forest fires and salt spray from oceans.

It has been estimated that natural sources release 800-2000 million tonnes of particulate matter per year.

Anthropogenic sources:

The anthropogenic or man-made sources of particulates are combustion of fuels, construction, mountain blasting, mining and other industrial processes. The most important anthropogenic source is the fly ash from power plant smelters and smoke from incomplete combustion.

It has been estimated that man-made sources release 200-400 million tonnes of particulate matter per year.

B. Sources of gaseous air pollutants:**1. Oxides of carbon (CO_x):****i. Carbon monoxide:****Natural sources:**

The natural sources are volcanic eruptions, natural gas emissions, electrical discharge during storms, seed germination and marsh gas production etc.

Anthropogenic sources:

Most of CO gas is released to air by human activities.

a. It has been estimated that about 75% of CO emission results from automobile due to internal combustion engines.

b. Forest burning emits 16.9% while agriculture burning emits 7.2% of CO to air.

c. Iron and steel industries release 9.6% of CO to air.

d. Smelter is also a contributor of CO emission.

ii. Carbon dioxide**Natural Sources:**

The natural sources of carbon dioxide are animal and plant respiration, decomposition of organic matter, forest fires and emissions from volcanic eruptions.

Anthropogenic Sources:

The main anthropogenic source of carbon dioxide are burning fuels.

2. Oxides of nitrogen:

There are three oxides of nitrogen found in air i.e. nitrous oxide (N_2O), nitrogen dioxide (NO_2) and nitric oxide (NO). In these nitrous oxide (N_2O) is found in higher quantity. Their sources are given below:

Natural sources:

The natural sources for the oxides of nitrogen are soil, bacteria and other micro-organisms e.g. pseudomonas bacteria fixes atmospheric nitrogen to oxides of nitrogen. It has been estimated that natural sources release about 5×10^8 tonnes of oxides of nitrogen (NO_x) per year.

Anthropogenic sources:

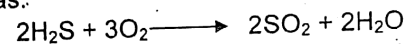
These sources include automobiles, industries, furnaces, thermal power plants and the most important are the emission from jet engine aeroplanes.

3. Oxides of sulphur:

There are two colourless oxides of sulphur which pollute the air i.e. sulphur dioxide (SO_2) and sulphur trioxide (SO_3). Their sources are given below:

Natural sources:

The natural sources of oxides of sulphur are volcanic eruptions, rock weathering, sulphate spray from oceans and other biological activities. These sources either emit SO_2 or H_2S which is then oxidized to SO_2 as:



It has been estimated that natural sources release 68% of SO_x .

Anthropogenic sources:

The combustion of fossil fuels i.e. coal and oil, is the major anthropogenic source of SO_x because these are contaminated with sulphur.

About 32% of SO_x pollution is caused by anthropogenic sources in which 75% is contributed by combustion of fossil fuels. Other man made sources are transportation (2%), industries (22%) and combustion of other sulphur compounds (1%).

4. Volatile organic compounds (VOC):**Natural sources:**

The largest natural source of natural organic compounds like methane is wetlands. About 78% of methane is produced by wetlands.

Animals like cow, goat, sheep etc. also produce large amounts of methane during digestion. Termites also release methane to environment.

Anthropogenic sources:

When there are fuels burning, mining or extraction, volatile organic compounds are produced. Automobile exhausts are also the source of volatile organic compounds.

Q.6. What are the harmful effects of air pollutants?**Ans. Harmful Effects of air pollutants:**

The various harmful effects of air pollution are given below:

i. Carbon monoxide:

- It is a colourless, odourless and a very poisonous gas.
- It affects the respiratory activity by reducing the oxygen carrying capacity of haemoglobin.
- Its excessive amount causes blurred vision, nausea, unconsciousness which finally results in death.
- It damages CNS and heart.

ii. Carbon dioxide:

- The increase in carbon dioxide levels causes global warming.
- Excessive carbon dioxide is dangerous for animals and causes unconsciousness and finally results in death.

iii. Sulphur dioxide:

- It causes respiratory problems, irritation of eyes, nose and throat.
- It also causes pneumonia, asthma, severe headache, yellowing paper, damage to limestone and marble, damage to leather, increases rate of corrosion of iron etc.

iv. Nitrogen oxides:

- Oxides of nitrogen react with ozone and causes acid rain.
- They cause respiratory problems and heart failure in mammals.
- They badly affect the skin and eyes.
- They badly affect photosynthesis in plants.
- They also form smog which makes the air hazy.

v. Volatile organic compounds:

Volatile organic compounds like polyaromatic compounds (PAC), polyaromatic hydrocarbons (PAH) are carcinogenic which may cause leukemia and other diseases.

vi. CFCs:

CFCs or chlorofluorocarbons destroy ozone layer due to which ultraviolet rays of sun reaches earth which is very dangerous for life on earth.

vii. Particulate matter:

Particulate matter like lead halides are produced by combustion of leaded gasoline products which are toxic and affect man and other living organisms.

Q.7. Describe environmental effects of pollutants:**Ans. Environmental effects of pollutants:**

The environmental effects of pollutants are given below:

1. Acid rain:

The rain having pH less than 5.6 is called acid rain. Acid rain destroys vegetation and causes damage to skin, hair etc. It also destroys monuments and historical places.

2. Eutrophication:

"The enrichment of nutrients(nitrogen, phosphorus etc) in water bodies to enhance the harmful overgrowth of algae is called eutrophication."

It decreases fishes and causes deterioration of water quality.

3. Increase in ground level ozone:

Increase in ground level ozone can cause different health problems such as asthma. It also damages vegetation.

4. Green house effect:

Greenhouse gases like CO₂, CH₄ etc. trap sun rays which is called greenhouse effect. It causes global warming.

5. Global warming:

The increase in average temperature of earth is called global warming. It is affecting environment due to which climate changes are occurring. Due to global warming the ice caps and glacier will melt and would may be drowned.

6. Ozone depletion:

Pollutants also deplete ozone layer which protects us from harmful ultraviolet rays of sun.

Q.8. Discuss acid rain. How does it affect the environment?**Ans. Acid rain:****Definition:**

"The rain having pH less than 5.6 is called acid rain." OR
The excessive acid in rain water is called acid rain."

Explanation:

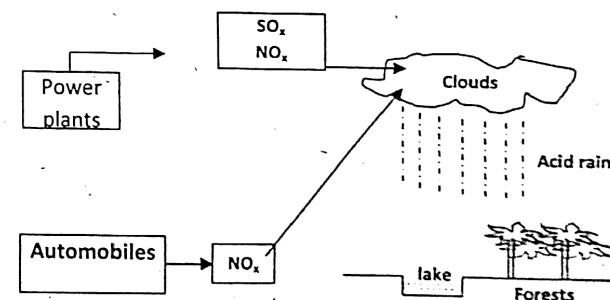
Normal rain has a pH value of 5.6 to 6 because of dissolved CO₂, when some other gases like oxides of sulphur and nitrogen dissolve in it, it becomes more acidic and thus acid rain occurs. Rain with low pH as 2.1 has been reported.

Mechanism of acid rain:

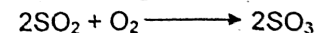
Acid rain will occur when there is high concentration of oxides of sulphur, carbon, nitrogen and other organic compounds in air.

Energy sources like coal, oils and wood etc contain sulphur, carbon, nitrogen and other hydrocarbons. When these fuels are burnt the sulphur is changed to SO_x(SO₂ and SO₃) and nitrogen is changed to NO_x(N₂O, NO₂ and NO) and carbon change to CO₂. These gases are highly soluble in rain water and they react with rain water producing different acids as:

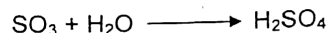
SO_x are converted to H₂SO₄ and NO_x are changed to HNO₃, and CO₂ are changed to H₂CO₃. The organic compounds are changed to CH₃COOH.

**Figure: Acid rain****1. Acid rain due to SO_x:**

Oxides of sulphur are two i.e. SO₂ and SO₃. The SO₃ directly dissolves in water and forms H₂SO₄ while the SO₂ is first oxidized to SO₃ i.e.



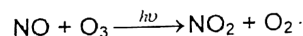
The SO_3 is highly reactive and it dissolves in water to form sulphuric acid, H_2SO_4 i.e.



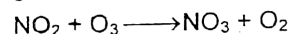
2. Acid rain due to NO_x :

The NO_x are converted to HNO_3 as:

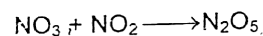
i. The nitric oxide reacts with ozone to form nitrogen dioxide and oxygen gas:



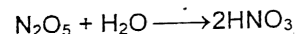
ii. The nitrogen dioxide further reacts with ozone to form nitrogen trioxide and oxygen gas:



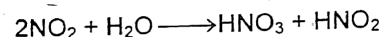
iii. The nitrogen trioxide reacts with nitrogen dioxide to form nitrogen pentaoxide;



iv. The nitrogen pentaoxide react with water present in the atmosphere to form nitric acid:

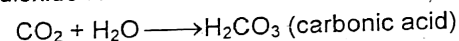


Similarly NO_2 converts to HNO_3 as:



3. Acid rain due to CO_2 :

The carbon dioxide reacts with water to form carbonic acid:



Effects of acid rain:

The effects of acid rain are given below:

i. Effects on humans:

- In humans acid rain damages lungs, skin and hair.
- The heavy metals released by acid rain may also cause potential threat to human health.
- Acid rain also increases the acidity of water which give rise to "waterborn diseases" like cholera, dysentery etc.

ii. Effects on plants:

- Plants are also damaged by acid rain. It destroys their leaves.
- The young plants especially the newly growing buds and tips are seriously damaged by acid rain. Thus growth of plants is affected by acid rain.

c. Similarly, acid rain decreases the nutrients from the soil which are needed for the growth of plants.

iii. Effect on soil:

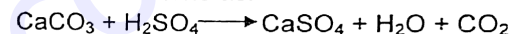
The acid rain increases the acidity of soil thus affects the availability of plants nutrients.

iv. Effect on aquatic life:

The aquatic animals like fish, plant and microorganisms are very sensitive to acidity. At pH of 5 fish eggs cannot hatch. At low pH, some adult fishes die. Those who survive has no foods to eat as their preys cannot survive in low pH. For example frog can survive in pH of 4 but Mayflies, they eat, cannot survive below pH value of 5.6.

v. Effects on building materials and statues:

a. Acid rain damages building and sculptures as well as other things made of marble and limestone as:



The CaSO_4 is soluble in water and is washed away by rain water.

b. The deformation of historical statues in Greece and Italy was reported to be due to acid rain. Taj Mahal in India has also been damaged by acid rain.

Q.9. What is ozone? Write its occurrence and formation.

Ans. Ozone Origin:

Ozone is derived from Greek word ozoater meaning smell and the name ozone was given to it due to its irritating smell.

Discovery:

It was discovered by Schonbein in 1840 in an experiment when he passed electric discharge from oxygen(air).

Molecular formula And Molecular mass:

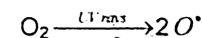
The molecular formula of ozone is O_3 and molecular mass is 48 g/mol.

Ozone formation:

Ozone is naturally formed from molecular oxygen in the presence of UV radiation. It is formed in two steps

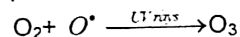
Step-1:

In the first step oxygen molecule is broken down by solar ultra violet rays to form oxygen free radicals which are highly reactive:

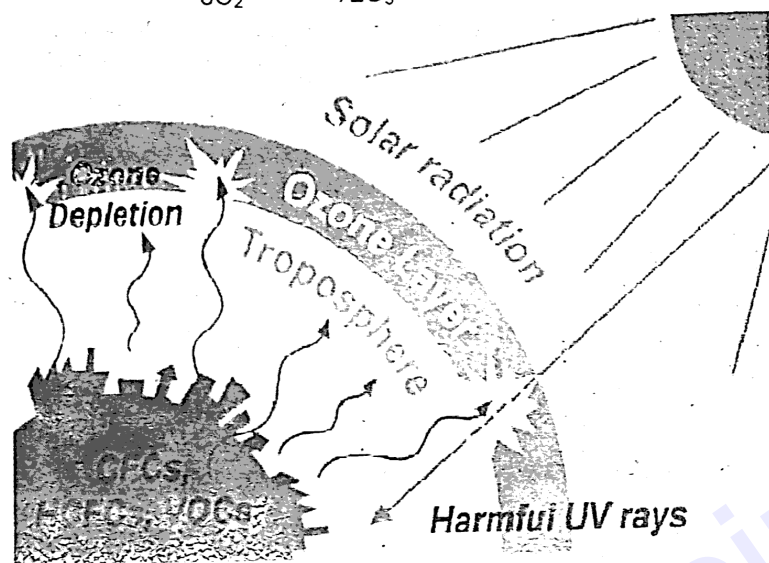
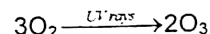


Step-2:

In the second step each of the oxygen free radical reacts with oxygen molecule to produce ozone:

**Overall Reaction:**

The overall reaction of ozone formation is given below:

**Occurrence of ozone:**

Ozone is an important species present in stratosphere. Its concentration increases with increase in height and at about 30Km it reaches to its maximum value of 10ppm (parts per million).

Due to the presence of ozone in stratosphere it is also called ozonosphere. If all the ozone present around the earth is condensed, it will form a layer of 2.5mm thickness on earth surface. Ozone is also found in densely populated cities but here it is a pollutant.

Q.10. List the physical properties of ozone.**Ans. Physical properties of ozone:**

The physical properties of ozone are under:

i. Colour:

It is bluish in colour.

ii. Odour:

It has garlic like smell.

iii. Solubility:

Ozone is soluble in water, turpentine oil, glacial acetic acid and carbon disulphide.

iv. liquefaction temperature:

It can be liquefied at -112.4°C which has a pale blue colour.

v. Effects on rubber:

Ozone causes rubber to harden and crack.

vi. Effect on respiration:

It is respiratory irritant if present in excess.

Q.11. What is ozone depletion? Write its causes.**Ans. Ozone depletion:**

"The decrease in ozone concentration below its natural level is called ozone depletion."

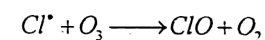
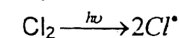
The region where ozone layer depletes is called ozone hole.

Causes of ozone depletion:

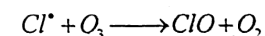
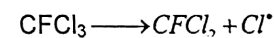
Ozone depletion results from human as well as natural activities. Due to these activities various chemical pollutants are released to atmosphere which react with ozone and destroy it. The various chemicals causing ozone depletion are described below:

i. Ozone depletion due to chlorine:

Chlorine released by volcanic activity also destroys ozone layer as:

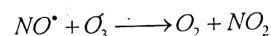
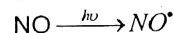
**ii. Ozone depletion due to CFC:**

Chloro-fluoro-carbon (CFC) which is produced by industries, commercial and household appliances also destroys ozone layer very rapidly. CFCs deplete almost 80% of the total ozone layer depletion.

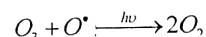
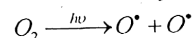


iii. Ozone depletion due to NO_x :

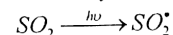
Oxides of nitrogen react photochemically with ozone and cause its depletion. These oxides are nitrous oxide (N_2O), nitric oxide (NO) and nitrogen dioxide (NO_2).

**iv. Ozone depletion due to atomic oxygen:**

Atomic oxygen also destroys about 18% of ozone layer as:

**v. Ozone depletion due to SO_2 :**

SO_2 and SO_3 are the oxides of sulphur present in atmosphere. Out of these SO_2 photochemically reacts with ozone and destroys it as:

**Q.12. How does ozone depletion adversely affect our life?****Ans. Adverse effects of ozone depletion:**

Both organisms and materials are affected by ozone depletion. Some of the adverse effects of ozone depletion are given below:

1. Effects on humans and animals:

Due to ozone depletion dangerous cosmic and UV rays of sun come to earth and cause various problems both for humans and animals.

I. Skin diseases:

- In minor cases the cosmic and UV radiation cause sun burn disease.
- In major cases they damage the skin tissues and cause skin cancer which kills about 12000 people each year in U.S.A. It has been estimated that 1% decrease in ozone causes 5% increase of skin cancer.
- Exposure to UV rays accelerates the aging of our skin.

II. Eye diseases:

- The UV and cosmic radiations also cause an eye disease known as "CATARACTS". It has been estimated that about 12 million people have become blind due to this disease and about 18 million people have lost a part of their eye sight.

- Pink eyes and eye cancer are also found in cattles when they are exposed to UV radiation by ozone depletion.

III. Damage to immune system:

The UV rays weakens the immune system.

IV. Effects on marine life:

The cosmic and UV radiation are highly energetic and penetrate in water (about 20m) and kill the micro-organism present there in water which are sensitive to these radiation.

3. Effects on plants:

Ozone depletion has an adverse effect on production of plants. The UV radiations coming from ozone depletion decrease plant production e.g. it has been estimated that 25% increase in UV radiations decrease 25% soybean crop product. UV radiations also affect young tobacco and tomato plants.

4. Effects on materials:

Due to ozone depletion the UV rays comes to earth and decrease the life time of different materials like plastics, cotton, nylon and Styrofoam etc. It causes rubber to harden and crack. Thus it shortens the life time of automobiles tyres and other rubber items.

5. Effect on earth's weather:

Due to ozone depletion temperature of the earth increases which cause global warming.

Q.13. Describe some ways to bring down ozone depletion?**Ans. Ways to bring down ozone depletion:**

Ozone is very important layer for the whole world as it absorbs harmful ultra violet rays of the sun. Some of the ways to bring down ozone depletion are given below:

- Use of air conditions, aerosol sprays and refrigerators that do not have CFCs.
- Using public transport will reduce the use of vehicles and the gases dangerous for ozone like CO will be minimized.
- Use of recycled products.
- Repair and recycle the air conditions and refrigerators as their malfunctions cause more CFCs to escape in air.
- Avoid using pesticides because most of them releases CFCs to environment.

Q.14. Write a note on global warming.

Ans. Global warming:

"The gradual increase in the average temperature of the earth due to emission of greenhouse gases is called global warming."

Explanation:

Greenhouse gases are those gases which retain the energy of the earth provided by the sun. These gases are CO_2 , CH_4 , NO_2 and O_3 . These gases act like a greenhouse around the earth. They allow the visible light of sun to reach the earth but do not allow the heat to escape back into the space. Therefore, this entrapped heat cause global warming.

Effects of global warming:

Global warming adversely affects the climate, sea level, ozone layer, crop yield, precipitation (rain and snow fall) and health. The detail of some its effects are described below:

1. Desertification:

Increase in temperature of the earth causes changes in water cycle which leads to desertification of certain areas.

2. Sea level rise:

Increase in temperature causes the ocean to expand due to thermal expansion due to which the sea level rises. Similarly, due to increased temperature the glaciers melt and the water level rises.

3. Stronger storms and cyclones:

Global warming increases the frequency of strong cyclones. Increase in temperature above the sea surface results in the increase of frequency of storms.

4. Melting of snow and ice:

Due to global warming the snow and ice are melting continuously. More than a million square miles of ice has misplaced in recent years.

EXERCISE

Multiple Choice Questions

A. Choose the Correct Option.

- Ozone is present in
a. Mesosphere
b. Thermosphere
c. **Stratosphere**
d. Troposphere
- All are air pollutants except,
a. NO_2
b. N_2
c. SO_2
d. SO_3
- Which one of the following is responsible for global warming?
a. increase in concentration of N_2
b. **increase in concentration of CO_2**
c. increase in concentration of O_2
d. increase in concentration of O_3
- The pH of acid rain is less than
a. 13.6
b. 10.6
c. 7.6
d. **5.6**
- The coldest region in the atmosphere is
a. Troposphere
b. Stratosphere
c. **Mesosphere**
d. Thermosphere
- Ozone is formed in the presence ultraviolet radiations from
a. O and O
b. **O_2 and O**
c. O_2 and O_2
d. O_2 and O_3
- The gas (es) which is/are responsible for acid rain is/are
a. SO_2
b. NO_2
c. CO_2
d. **All of them**
- On the basis of temperature variation, the numbers of atmospheric region are
a. Five
b. Two
c. Three
d. **Four**
- The gas which protects the earth surface from ultraviolet radiation is
a. CO_2
b. N_2
c. **O_3**
d. O_2
- Lowest temperature in troposphere is,
a. 5°C
b. -5°C
c. 56°C
d. **-56°C**

SHORT QUESTIONS

Q 1. How ozone layer is depleted in the atmosphere?

Ans. For answer see question no 11

Q 2. a. Differentiate between primary and secondary pollutants

b. Write the name and sources of greenhouse gases of the atmosphere

Ans (a) For answer see question no 1

Ans (b) Names of greenhouse gases

The names of greenhouse gases are carbon dioxide

methane (CH₄)

Water vapour (H₂O)

Nitrogen dioxide

Ozone (O₃)

Sources of greenhouse gases

The sources of greenhouse gases are given below

i. Sources of carbon dioxide

The various natural and anthropogenic sources of carbon dioxide are given below

Natural Sources:

The natural sources of carbon dioxide are volcanic eruption, respiration, decomposition of organic matter, forest fires, etc. and from volcanic eruption.

Anthropogenic Sources

The main anthropogenic sources of carbon dioxide are burning of fossil fuels.

ii. Methane

Natural sources:

The largest natural source of methane is wetlands. The second largest source of methane is produced by wetlands. Animals like cows, goats, sheep etc. also produce large amounts of methane during digestion. Termites also release methane to environment.

Anthropogenic sources:

Anthropogenic sources of methane include leaks during fossil fuels mining, raising livestock, automobile exhausts etc.

iii. Nitrogen dioxide:

Natural sources:

The natural sources for the oxides of nitrogen are soil, bacteria and other micro-organisms. Lightning is also a natural source of nitrogen dioxide.

Anthropogenic sources:

These sources include automobiles, industries, furnaces, thermal power plants and the most important are the emission from jet engine aeroplanes.

iv. Ozone

Natural sources:

Ozone is naturally formed from molecular oxygen in the presence of solar ultraviolet radiation.

Anthropogenic sources:

Anthropogenic sources of ozone are automobiles exhausts, electric boilers, refineries, chemical plants etc.

Q 3. Define environmental chemistry and atmosphere?

Ans. For answer see question no 2 and question 3 along with the composition and names of its layers.

Q 4. Sketch and briefly discuss the composition of atmosphere, by mentioning the percentage of each component?

Ans. For answer see question no 3

Q 5. How the acid rain affect the building material or statues?

Ans. For answer see question no 8 heading no v

Q 6. Increase in concentration of CO₂ cause greenhouse effect, justify it?

Ans. CO₂ high concentration causing greenhouse effect:

Greenhouse effect is the trapping of sun's radiated rays by earth's surface. This is caused by various greenhouse gases like carbon dioxide, methane, nitrogen dioxide and ozone.

The normal percentage of carbon dioxide in air is 0.03%. Above this percentage it traps the earth's radiated rays and cause the temperature of earth to increase. Thus, if the concentration of carbon dioxide is increased the trapping of earth's radiated rays are increased. Consequently it causes the greenhouse effect.

Q 7. Briefly discuss how the acid rain affects the aquatic life.

Ans. For answer see question no 8 heading no iv

Q 8. List the sources which produce CO and CO₂ to the atmosphere.

Ans. For answer see question no 5

Q 9. What are the adverse effects of global warming?

Ans. For answer see question no 14

Q 10. What is the importance of ozone?

Ans. Importance of ozone:

Ozone is an allotropic form of oxygen present in the stratosphere. It is very important for all living organism as it absorbs the poisonous and dangerous ultra-violet rays of the sun. If these rays reach the earth's surface they cause various diseases in living organisms like:

- Skin diseases e.g. skin cancer
 - Eye diseases e.g. cataract
 - Immune system disorder
 - Damaging plants
 - Damaging marine animals
- Besides these, it also alters weather conditions etc.
From the above discussion it is cleared that ozone is very important for the whole world.

LONG QUESTIONS

Q 1.(a) Sketch and identify the different layers of atmosphere.

Ans. For answer see question no.3

(b) Differentiate between stratosphere and troposphere?

Ans. Differences between stratosphere and troposphere:

Both troposphere and stratosphere are the layers of atmosphere.

The main differences between them are given below:

Atmospheric layer	Position	Height (km)	Temperature range(°C)	Components
Troposphere	1 st layer	0 to 11	15 to -56	Nitrogen, oxygen, carbon dioxide, noble gases and water vapours.
Stratosphere	2 nd layer	11 to 50	-56 to -2	Ozone is its major component

Q 2. (a) Air is polluted in the big cities of Pakistan, justify the statement?

Ans. Polluted air in big cities of Pakistan:

The big cities of Pakistan like Karachi have polluted air due to the following reasons:

i. Large no. of industries:

The big cities of Pakistan like Karachi, Faisalabad, etc contains a large no. of industries which releases poisonous and dangerous gases like oxides of sulphur and nitrogen to the air. These causes various diseases and they also cause acid rain.

ii. Large no. of vehicles:

Besides industries there are large no. of vehicles in big cities of Pakistan which releases carbon monoxide and carbon dioxide along with methane gas to the air which pollutes the air. Carbon monoxide cause

respiratory diseases and its excess amount can cause death. Similarly, methane and carbon dioxide cause global warming.

iii. Large no. of houses:

In big cities of Pakistan, there are a large no. of houses which cause air pollution by doing various household activities like cooking, use of air conditions and refrigerators which release CFCs, combustion releasing CO₂ and CO to the air.

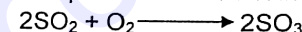
(b) Enlist the main sources of air pollution.

Ans. For answer see question no.5

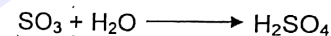
(c) Prove that the oxides of nitrogen and Sulphur causes air pollution.

Ans. Oxides of Sulphur causing air pollution:

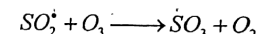
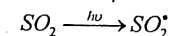
- It causes respiratory problems, irritation of eyes, nose and throat.
- It also causes pneumonia, asthma, severe headache, yellowing paper, damage to limestone and marble, damage to leather, increases rate of corrosion of iron etc.
- Oxides of sulphur cause acid rain as given below:



The SO₃ is highly reactive and it dissolves in water to form sulphuric acid, H₂SO₄ i.e.

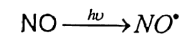


- The oxides of sulphur also cause ozone depletion:

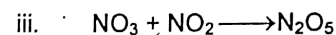
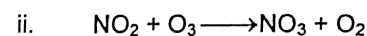
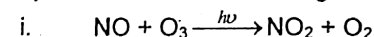


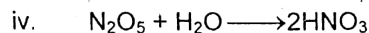
Nitrogen oxides causing air pollution:

- Oxides of nitrogen react with ozone and cause ozone depletion as given below:

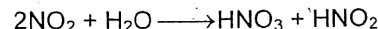


- They cause respiratory problems and heart failure in mammals.
- They badly affect the skin and eyes.
- They badly affect photosynthesis in plants.
- They also form smog which makes the air hazy.
- They also cause acid rain as given below:





Similarly NO_2 converts to HNO_3 as:



(d). Enlist the effects of air pollution?

Ans. For answer see question no.6

Q 3 (a). What would be the result if Rainwater is acidic?

Ans. For answer see question no.8

(b). What could be done to minimize the formation of acid rain?

Ans. Ways to minimize acid rain:

Following are the some of the ways by which the formation of acid rain can be minimized:

i. Use of alternate fuels instead of fossil fuels:

As fossil fuels releases oxides of nitrogen oxides, sulphur oxides and carbon dioxide are fossil fuels. Therefore, alternate sources of energy like solar energy and wind energy should be used.

ii. Minimum use of vehicles:

Vehicles exhausts releases oxides of nitrogen, sulphur and carbon dioxide which cause acid rain. Therefore, the use of vehicles must be minimized.

iii. Use of public transport:

Public transport must be used in order to minimize the release of gases to the air causing acid rain.

iv. Use of special methods by industries:

There are special methods and techniques which converts the acid causing gases, released by industries, to un-harmful substances. Industries must use these methods and techniques to avoid acid rain.

(c) Write down the effect of acid rain on.

- (i) Humans (ii) plants (iii) Soil (iv) materials

Ans. For answer see question no.8

4. (a) Explain ozone layer depletion?

Ans. For answer see question no.11

(b) Where does ozone layer lie in the atmosphere?

Ans. For answer see "occurrence of ozone" in question no.9

(c) What evidence can you find that depletion of ozone occurs in the atmosphere?

Ans. Evidence to show ozone depletion:

The ozone layer depletion allows the ultra-violet rays of sun to come to the earth which results various diseases in plants and animals and also creates environmental problems. By the presence of the following diseases and problems, it can be said that ozone depletion has been occurred.

I. Skin diseases:

- In minor cases the cosmic and UV radiation cause sunburn disease.
- In major cases they damage the skin tissues and cause skin cancer.
- Exposure to UV rays accelerates the aging of our skin.

II. Eye diseases:

- The UV and cosmic radiations also cause an eye disease known as "CATARACTS".
- Pink eyes and eye cancer are also found in cattles when they are exposed to UV radiation by ozone depletion.

III. Damage to immune system:

The UV rays weaken the immune system.

IV. Effects on marine life:

The cosmic and UV radiation are highly energetic and penetrate in water (about 20m) and kill the micro-organism present there in water which are sensitive to these radiation.

3. Effects on plants:

Ozone depletion has an adverse effect on production of plants. The UV radiations coming from ozone depletion decrease plant production.

4. Effects on materials:

Due to ozone depletion the UV rays comes to earth and decrease the life time of different materials like plastics, cotton, nylon and Styrofoam etc. It causes rubber to harden and crack. Thus it shortens the life time of automobiles tyres and other rubber items.

5. Effect on earth's weather:

Due to ozone depletion temperature of the earth increases which cause global warming

(d) Recommend few ways to protect the ozone layer.

Ans. Ways to protect ozone layer:

For answer see question no.13

Q 5. (a) Summarize the components of stratosphere and troposphere.

Ans. For answer see question no.3

(b) Describe ozone formation.

Ans. For answer see question no.9

(c) Greenhouse effect is good or bad for us, explain.

Ans. Greenhouse effect is good if the greenhouse gases are present in their normal amounts however it is very harmful for our environment if the amount of greenhouse gases increase.

Shams Notes

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Atmosphere

Good effects of greenhouse effect:

Greenhouse effect is the trapping of earth's radiated rays by greenhouse gases like CO_2 , CH_4 , NO_2 and O_3 . It is a natural phenomenon without which life on earth would probably be impossible. Because without the greenhouse effect the average temperature of the earth would be -18°C which is now 15°C . The natural greenhouse effect maintains the average temperature of the earth due to which human's and other organisms can survive on earth.

Harmful effects of greenhouse effect:

If the greenhouse effect increases due to the increase in the amounts of greenhouse gases, then it causes global warming which leads to various environmental problems as given below:

1. Desertification
2. Sea level rise
3. Stronger storms and cyclones
4. Melting of snow and ice

(d) Predict the outcomes of global warming.

Ans. Outcomes of global warming:

For answer see effects of global warming in question no.14

Additional MCQs

1. The major component of troposphere is:
(a) Argon (b) nitrogen (c) hydrogen (d) carbon.
2. The coldest region in atmosphere is:
(a) Troposphere (b) stratosphere
(c) mesosphere (d) stratosphere.
3. Ozone depletion causes:
(a) blood cancer (b) skin cancer (c) malaria (d) T.B.
4. The pH of acid rain is less than:
(a) 14 (b) 10 (c) 7 (d) 5.6.
5. Ozone is----- gas.
(a) Greenish (b) yellowish (c) bluish (d) redish.
6. The most important base for the division of atmosphere is-----.
(a) Temperature & density (b) temperature and mass
(c) mass & density (d) both a & b.
7. The mass of atmosphere is approximately -----metric tones.
(a) $4.5 \text{ to } 5 \times 10^{15}$ (b) 6×10^{15}
(c) 7×10^{15} (d) 3×10^{15} .

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Atmosphere

8. The pressure of atmosphere at the sea level is:
(a) 1 atm (b) 2 atm (c) 4 atm (d) 5 atm.
9. The density of atmosphere is-----.
(a) 0.0013 g/cm^3 (b) 0.00013 g/cm^3
(c) 0.0023 g/cm^3 (d) 1.225 kg/m^3 .
10. The total height of atmosphere from the earth surface is about ----km.
(a) 500 (b) 600 (c) 700 (d) 800.
11. Atmosphere is divided into-----layers.
(a) 4 (b) 6 (c) 7 (d) 5.
12. The lowest layer of atmosphere is-----.
(a) Troposphere (b) stratosphere
(c) mesosphere (d) thermosphere.
13. The change from positive lapse rate to negative lapse rate at the troposphere is called-----.
(a) Temperature inversion (b) temperature diversion
(c) Temperature constant (d) temperature variable.
15. Cloud formation takes place at the top of -----.
(a) Troposphere (b) mesosphere
(c) thermosphere (d) hydrosphere.
16. Troposphere constitutes -----% of atmosphere.
(a) 70% (b) 60% (c) 80% (d) 50%.
17. Stratosphere is also called:
(a) Ozonosphere (b) ionosphere
(c) lithosphere (d) hydrosphere.
18. Ozone will form a layer of----thickness on earth surface, if all the ozone is condensed.
(a) 2mm (b) 3mm (c) 5mm (d) 7mm.
19. Which one of the following is not a green house gas?
(a) CO_2 (b) CH_4 (c) CFC (d) none of these.
20. The maximum concentration of ozone is found in:
(a) troposphere (b) stratosphere (c) mesosphere (d) exosphere.
21. Ozone is allotropic form of:
(a) Carbon (b) oxygen (c) nitrogen (d) sulphur.
22. If the pH of a solution is 6, then its pOH will be:
(a) 4 (b) 7 (c) 8 (d) 14.
23. Acid rain is not caused by:
(a) NO_2 (b) SO_2 (c) CO_2 (d) NH_3 .

Chapter No.15

Environmental Chemistry II: Water

Q.1. Describe the occurrence/sources of water.

Ans. Occurrence of water:

Water is one of the most abundant natural resources present on earth. It has been estimated that the total volume of water present on earth is about 1.33 billion cubic kilometers. It covers nearly 70 percent of earth surface.

The major reservoirs of water on earth surface are oceans, ice caps, glaciers, underground water, inland water and atmospheric water.

The oceans contain more than 97 percent of the total water. The rest of water is in the form of glaciers, ice caps, underground water, inland water and atmospheric water.

The inland water includes rivers, lakes, streams, canals and soil moisture.

	Water reservoirs	Amount of water
1	Oceans	97.5%
2	Glaciers and ice caps	2.14%
3	Underground water	0.6%
4	Inland water	0.2%
5	Atmospheric water	0.001%

Although enormous amount of water is present on earth but the fresh water needed for humans is only 0.2% of the total.

Q.2. Describe the importance of water?

Ans. Importance of water:

Water is very important for us and for the whole world. After air, water is second important agent for the survival of life. Without water, life is impossible. In the holy Quran the importance of water has been revealed as mentioned in the following verse:

وَجَعَلْنَا مِنَ الْمَاءِ كُلَّ شَيْءٍ حَيٍّ

Translation: And we made every living thing from water.

Some importance of water is given below:

i. Importance for life survival:

Humans can live without food for more than two months but without water they cannot live for more than a week.

ii. Importance for body of humans and plants:

Human body contains about 65-70 percent of water while plants contain from 50 to 80 percent water.

iii. Importance for biological processes:

Water maintains various biological processes. The main function of protoplasm is due to the presence of constant amount of water in it. The various reactions which occur in our body, for our existence, are due to water.

iv. Medicinal Importance:

A large number of medicines are prepared in water.

v. Importance in transport:

Water is a good medium of transportation as ships and boats move on water.

vi. Importance as universal solvent:

Water is a universal solvent as it can dissolve many substances in it. Due to this property water is used for various purposes like cleaning, making medicines etc.

vi. Cooking and washing:

Cooking and washing is done in water.

vii. As coolant:

It is used as coolant in radiators of automobiles engines. It is also used as coolant in nuclear power plants, iron and steel industries and other heavy industries.

viii. Agricultural importance:

Large amount of water is needed to cultivate fruits, vegetables and other crops.

ix. Industrial importance:

Various industries require water for various purposes like textile industries, paint industries, fertilizer industries.

Thus in short it can rightly be said that without water life is impossible.

Q.3. Write a note on maintaining water quality.

Ans. Maintaining water quality:

It is explained under the following headings:

Good quality water:

Water which supports living organisms and protects their health is good quality water.

Basis of water quality:

The quality of water is determined on the basis of its physical, chemical, biological and radiological characteristics.

Ways to maintain good quality water:

A wide range of human activities are affecting the quality of water. If this is not controlled, not only the environment will suffer but we will face numerous problems like shortage of drinking water, irrigation problems etc.

Following are the some ways to maintain good quality water:

i. Awareness campaign:

As humans are responsible for affecting the good quality of water. Therefore, its quality can be maintained by promoting awareness among the people about water quality.

ii. Process waste materials:

Waste material must be properly processed and must not be added to water reservoirs.

iii. Process sewage water:

Sewage water must not be added to water reservoirs and must be processed properly.

iv. Avoid wasting water:

As only 0.2 percent of water is available of human use. Therefore, wastage of water must avoided. We must use the water whenever needed.

Q.4. Describe the composition of water.

Ans. Composition of water:

Water is a compound of hydrogen and oxygen. However, it was considered as an element before 1776 AD. In 1776 AD, Henry Cavendish, experimentally proved that water is not an element but a compound of hydrogen and oxygen. The composition of water is given below:

Composition by volume:

Water contains two parts of hydrogen and one part of oxygen by volume. This ratio can be determined experimentally by the electrolysis of water in Hoffman's voltmeter in the presence of an electrolyte. When electric current is passed through acidified water it gives two parts of hydrogen and one part of oxygen.

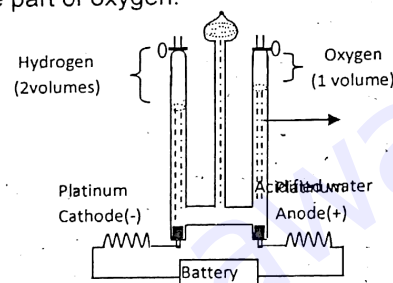


Figure: Electrolysis of water (Hoffman voltmeter)

Composition by mass:

Water contains one part of hydrogen to eight parts of oxygen by mass. It was experimentally determined by Joseph Proust in 1799. Since the atomic mass of hydrogen is one while that of oxygen is sixteen, so,

according to the formula H_2O the ratio between masses of hydrogen and oxygen is 1:8.

Percentage composition:

The percentage of hydrogen and oxygen in water by mass is given below:

$$\% \text{ of H} = \frac{2(\text{atomic mass of H})}{\text{molecular mass of } H_2O} \times 100$$

Putting the values we get:

$$\% \text{ of H} = \frac{2(1)}{18} \times 100$$

$$\Rightarrow \% \text{ of H} = 11.11$$

$$\text{Now } \% \text{ of O} = \frac{1(\text{atomic mass of O})}{\text{molecular mass of } H_2O} \times 100$$

Putting the values we get:

$$\% \text{ of O} = \frac{1(16)}{18} \times 100$$

$$\Rightarrow \% \text{ of O} = 88.88$$

Ratio between hydrogen and oxygen is:

$$\begin{array}{cc} \text{H} & \text{O} \\ 11.11 & 88.88 \\ 1 & 8 \end{array}$$

Q.5. Describe the physical properties of water.

Ans. Physical properties of water:

Physical properties of water are given below:

1. Physical state:

Water exists in nature in all the three states i.e. solid (ice), liquid and gas (vapours)

2. Taste, odour and colour:

Pure water is colourless, odourless and tasteless. The taste of drinking water is due to the presence of dissolved substances in it.

3. Melting point and boiling point:

Under normal atmospheric pressure the melting point of water is 0°C while the boiling point is 100°C .

4. Density:

The density of water is 1g/cm^3 at 4°C .

5. Heat capacity:

The specific heat capacity of water is $4.18\text{J/g}^\circ\text{C}$ which is higher than any other common substances.

6. Latent heat of fusion:

The latent heat of fusion of water is 6KJ/mol (334KJ/Kg)

7. Latent heat of vaporization:

The latent heat of vaporization of water is 41KJ/mol (2277KJ/kg)

8. Surface tension:

Water has high surface tension.

9. Polarity:

Water is a polar molecule.

10. Electrical conductivity:

Pure water is bad conductor of electricity.

11. Neutral nature:

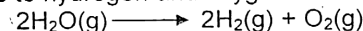
Pure water is neutral i.e. It has a pH value of 7.

Q.6. Describe the chemical properties of water.**Ans. Chemical properties of water:**

The chemical properties of water are given below:

1. Thermal stability:

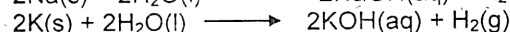
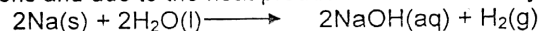
Water is thermally stable and only one percent of its molecules decomposes to hydrogen and oxygen at about 2000 °C.

**2. Reaction with metals:**

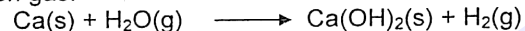
Water reacts with metals in different ways. The reactivity of metals depends on their position in reactivity series. Some reactions of various metals with water are given below:

i. Reaction with alkali metals:

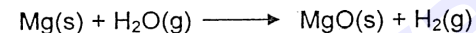
Alkali metals like sodium, potassium reacts vigorously with cold water, forming metal hydroxides and hydrogen gas. These are exothermic reactions and due to the heat produced the liberated hydrogen catches fire.

**ii. Reaction with alkaline earth metals:**

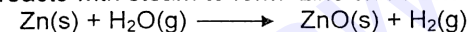
Calcium reacts with water on heating to produce calcium hydroxide and hydrogen gas.



Magnesium reacts with steam to form magnesium oxide and hydrogen gas.

**iii. Reaction with transition metals:**

Zinc reacts with steam to form zinc oxide and hydrogen gas



Steam reacts with red hot iron to form magnetic oxide and H₂ gas:

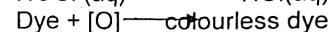
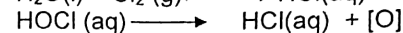
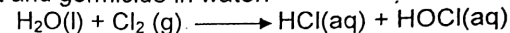
**3. Reaction with non-metals:**

Water reacts with non-metals under different conditions to form different compounds.

a. Reaction with chlorine:

Water reacts with chlorine to hydrochloric acid (HCl) and hypochlorous acid (HOCl). Hypochlorous acid is unstable and decomposes

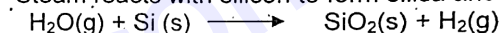
to hydrochloric acid and atomic oxygen which decolourizes the dye molecule and also kill the germs. So chlorine can be used as bleaching agent and germicide in water.

**b. Reaction with carbon:**

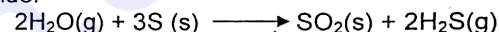
Water in the form of steam reacts with red hot coke to form a mixture carbon monoxide and hydrogen which is called water gas. Water gas is used as fuel.

**c. Reaction with silicon:**

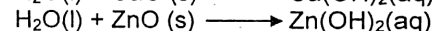
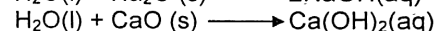
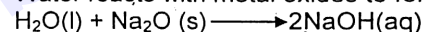
Steam reacts with silicon to form silica and hydrogen gas.

**d. Reaction with sulphur:**

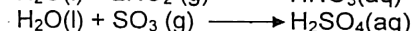
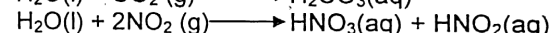
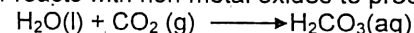
Steam reacts with sulphur to form sulphur dioxide and hydrogen sulphide.

**4. Reaction with metal oxide:**

Water reacts with metal oxides to form metal hydroxides (bases).

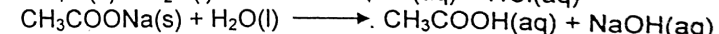
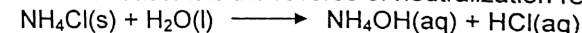
**5. Reaction with non-metal oxide:**

Water reacts with non-metal oxides to produce acids.

**6. Hydrolysis reaction:**

"The reaction of salt of weak acid or weak base with H₂O in such a way by breaking H—OH bond to form basic or acidic solution is called hydrolysis."

Hydro means water and lysis mean breaking. In hydrolysis reaction the water molecules splits up into H⁺ and OH⁻ ions by the reaction of salt of weak acid or base. It is the reverse of neutralization reaction.

**Q.7. Explain water as a universal solvent.****Ans. Water as universal solvent:**

Water can dissolved a large number of solutes in it due to which it is called universal solvent.

This property of water is due to the following three reasons: -

1. Polarity
2. Hydrogen bonding
3. Dielectric constant

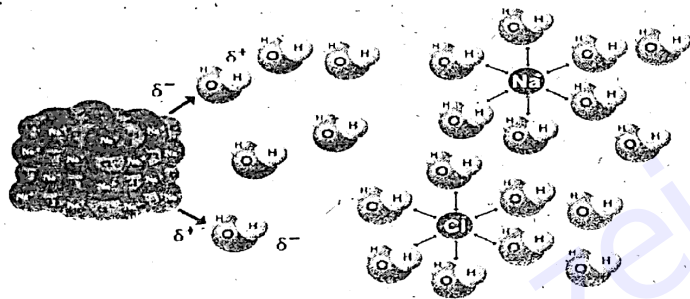
The detail is given below:

1. Polarity:

Consider the structure of water molecule which is polar due to high electronegativity, oxygen end of water is partial negatively charged while hydrogen end is partial positively charged. Due to this fact majority of ionic and polar solutes dissolve in water.e.g. mineral acids, salts, base, alcohols, sugar etc.

Dissolution of an ionic compound in water:

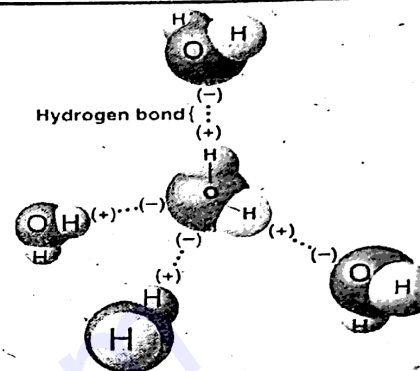
When an ionic compound like NaCl is added to water, the water splits its crystal to Na^+ and Cl^- ions. These ions will be surrounded by the water molecules. The Na^+ ions are surrounded by water molecules in such a way that its negative end is directed towards positive end of water (H^+) while the Cl^- ions are surrounded by water molecules in such a way that its positive end is directed towards negative end of water. This process is called hydration. Majority of ionic solutes are dissolved in water by this process.



2. Hydrogen bonding:

In water partial positive hydrogen end of one water molecule make bond with partial negative oxygen atom of another molecule. This is hydrogen bonding. As one water molecule has two partial positive hydrogen atoms and two lone pairs on oxygen atom. Therefore, a water molecule forms four hydrogen bonds with other water molecules in tetrahedral manner.

Due to hydrogen bonding, polar molecules like sugar, glucose, alcohols are dissolved in water. On the other hand non-polar molecules like alkanes, alkenes, alkynes, benzene etc are not dissolved in water.



3. Dielectric constant:

"The measure of the ability of a substance to reduce the forces of attraction between the oppositely charged ions is called dielectric constant."

Explanation:

According to Coulomb's law the force of attraction between two oppositely charged bodies is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

Mathematically:

$$F \propto \frac{Q_1 Q_2}{r^2}$$

$$\Rightarrow F = \frac{Q_1 Q_2}{D r^2}$$

Where Q_1 and Q_2 are oppositely charged bodies, r is the distance between them and D is constant of proportionality called dielectric constant of the medium in which the charged particles are present.

Relation of dielectric constant with the solubility:

Dielectric constant is directly proportional to solubility. Greater the dielectric constant lower will be the force of attraction between the solute ions. Thus they can easily be separated and dissolved. Thus it will be easy to separate ions of an ionic or polar solute in a solvent having high dielectric constant value.

Water has a high dielectric constant value i.e. 80 at 18°C due to which the ionic and polar solutes particles have less force of attraction and remain soluble in it. The dielectric constant value of other solvents are extremely small therefore, they are not good solvents.

Q.8. What is soft water and hard water?

Ans. Soft water:

"Water which produces lather easily with soap is called soft water."

Hard water:

"Water which produces scum or curd with soap and affects the cleaning effect of soap is called hard water." OR

"Water which does not produce lather easily with soap is called hard water."

Hard water wastes soap because it does not produce lather easily.

Causes of hardness of water:

Hardness of water is due to the presence of dissolved bicarbonates, sulphates and chlorides of calcium and magnesium. e.g.

- Calcium bicarbonate $[\text{Ca}(\text{HCO}_3)_2]$
- Magnesium bicarbonate $[\text{Mg}(\text{HCO}_3)_2]$
- Calcium sulphate (CaSO_4)
- Magnesium sulphate (MgSO_4)
- Calcium chloride (CaCl_2)
- Magnesium chloride (MgCl_2)

Q.9. Describe the types of hard water.

Ans. Types of hard water:

There are two types of hard water which are as follows:

- Temporary hard water
- Permanent hard water

Their detail is given below:

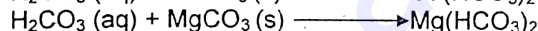
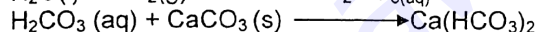
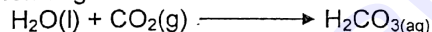
i. Temporary hard water:

"The water which contains dissolved calcium bicarbonate or magnesium bicarbonate is called temporary hard water."

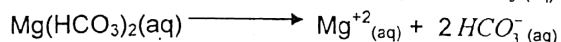
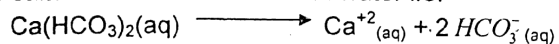
It is called temporary hard water because it can be removed simply by boiling.

Mechanism of formation of temporary hard water:

Rain water dissolves CO_2 of air forming carbonic acid, H_2CO_3 , which reacts with insoluble calcium carbonate or magnesium carbonate of rocks forming dissolved calcium bicarbonate or magnesium bicarbonate.



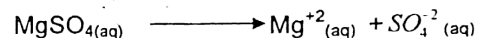
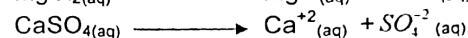
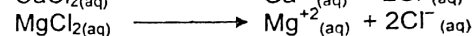
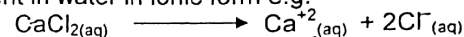
These salts exist in the form ions in water i.e.



ii. Permanent hard water:

"The water which contains dissolved sulphates and chloride of calcium and magnesium is called permanent hard water."

It cannot be removed by boiling therefore, it is called permanent hard water. These salts are dissolved by water from the earth. They are present in water in ionic form e.g.



Q.10. How temporary hardness of water can be removed? OR

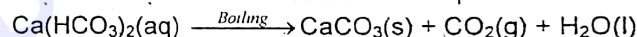
Describe the methods to remove temporary hardness of water.

Ans. Methods for removal of temporary hardness of water:

There are two methods for removal of temporary hardness of water which are given below:

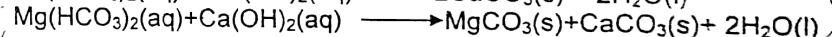
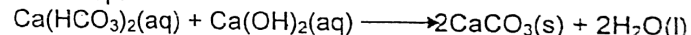
i. Boiling method:

In this method temporary hard water, containing dissolved bicarbonates of calcium and magnesium, are converted to insoluble carbonates by boiling. The carbonates of calcium and magnesium settle down and thus water becomes soft which will produce lather easily.



ii. Clark's method:

This method is used to remove temporary hardness of water on a large scale. In this method a calculated amount of slaked lime, $\text{Ca}(\text{OH})_2$, is added to the reservoirs containing temporary hard water. The slaked lime converts the soluble bicarbonates of calcium and magnesium to insoluble carbonates which settle down. Thus water becomes soft which is removed from the top.



Q.11. How permanent hardness of water can be removed? Or Describe the methods to remove permanent hardness of water.

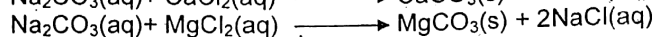
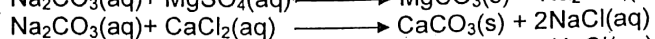
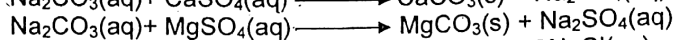
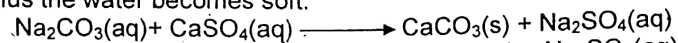
Ans. Methods to remove permanent hardness of water:

There are two methods to remove permanent hardness of water which are given below:

i. Reaction with washing soda:

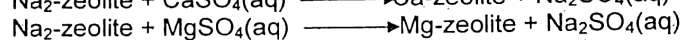
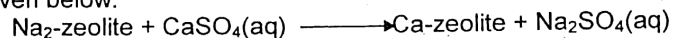
In this method washing soda (Na_2CO_3) is added to permanent hard water. The dissolved Ca^{+2} and Mg^{+2} ions of sulphates and chlorides are

converted into insoluble calcium carbonate and magnesium carbonate and thus the water becomes soft.

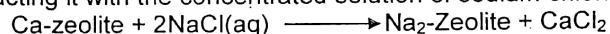


ii. Ion exchange method:

In this method hard water is passed through sodium zeolite ($\text{Na}_2\text{Al}_2\text{Si}_2\text{O}_8$). The sodium ion of sodium zeolite is changed with soluble calcium or magnesium ion of permanent hard water forming calcium zeolite or magnesium zeolite. Thus the water becomes soft. The reactions are given below:



Sodium zeolite can be obtained naturally or it may be prepared artificially. It becomes inactive after some days and it can be made active by reacting it with the concentrated solution of sodium chloride.



Q.12. Describe the disadvantages of hard water.

Ans. Disadvantages of hard water:

The disadvantages of hard water are given below:

i. Wastage of soap:

Due to hard water a large quantity of soap is wasted in the formation of scum or curd and more soap will be needed for actual washing.

ii. Wastage of fuel:

The hard water produces insulating scales in steam engines or turbines. As a result more fuel is used in producing steam.

iii. Damage to the boiler:

As hard water produces insulating scales in boiler therefore, it damages the material of boiler due to overheating. It may also cause explosion.

iv. Cause of diseases:

Drinking hard water causes various diseases of stomach and intestine.

Q.13. What is water pollution? Describe the major sources of water pollutants.

Ans:1. Water pollution:

"When harmful biological or chemical substances called pollutants are added with water, then it is called water pollution."

2. Water pollutants:

Harmful substances causing water pollution are called water pollutants.

Common water pollutants include human or animal wastes, disease producing organisms, radioactive material, toxic metals such as mercury or lead, pesticides and acid rain. Besides these heated water discharged from power plants cause thermal pollution.

3. Major sources of water pollutants:

The major sources of water pollutants are:

- Industrial wastes
- Household wastes
- Agricultural wastes
- Animal wastes.

Their detail is given below:

i. Industrial wastes:

Many industries discharge their wastes directly to streams, rivers and canals which are highly toxic and harmful to life. The industrial wastes contain highly toxic compounds of mercury, arsenic, cadmium, chromium, lead and antimony. In addition to these it also contains acids, bases, dyes, oils and grease.

Some industries and power stations use water for cooling purposes. The water become hot after use and when this hot water discharged to rivers, it destroys aquatic life especially when the temperature is above 30°C .

ii. Household wastes:

Household waste is the waste which is produced daily by cleaning of houses. It contains many things like plastics, cans, glasses, paper, burnt light bulbs etc. Household wastes can broadly be classified into three categories:

- Waste water or grey water
- Untreated sewage or black water
- Solid wastes

a. Waste water or grey water:

It includes the water we use in kitchens, washrooms and cleaning floors etc. This waste water is discharged directly to water bodies. It contains harmful chemicals because in most washing detergents and powder are used which contain phosphates to soften water. Besides these it may also contains acids, medicines, bleaches, dyes, insecticides, rodent killer, waxes, hair color etc. which badly affect aquatic life.

b. Untreated sewage or black water:

Untreated sewage is the major source of water pollution because it contains pathogens such as bacteria, viruses and protozoans.

The drinking water supply pipes and open sewage water go side by side and due to leakage the sewage water pollute the drinking water. The sewage water also seeps into ground and thus pollutes the underground water.

c. Solid wastes:

It is also called domestic waste or urban waste. It is either in solid or semisolid form. It contains newspapers, glasses, glass bottles, cans, metals, plastics etc.

In cities these wastes are collected by municipality and are placed in open fields without proper disposal. Chemicals from these wastes dissolve in rain water which is called leaching and the resulting mixture is called leachate. It contains decomposed organic matter, newspaper ink, pesticides, fertilizer and other dangerous chemicals. The leachate either seeps into the ground or pollutes underground water or it finds its way to stream and rivers through rain water.

iii. Agricultural wastes:

Agricultural wastes are produced as a result of various agricultural activities. It includes manure, waste from poultry farms and slaughterhouses, harvest waste, fertilizer run off from fields, pesticides and insecticides etc.

Non-natural or synthetic waste includes packaging, agrochemicals, used syringes, oils, tyres, batteries and building wastes like asbestos sheeting. These pollutants are very dangerous and harmful.

iv. Animal wastes:

They also pollute the water. The animal's excreta are usually discharged into the canals and rivers which pollutes the water with micro-organisms.

Q.14: Explain water borne diseases.

Ans: Waterborne diseases:

The diseases spread by water or by the substances made by using polluted water, are called waterborne diseases.

These diseases are very dangerous and can cause death. For example, according to WHO 1.8 million people die every year by a water born disease diarrhea.

Some examples of waterborne diseases are given below:

1. Bacterial infections:**i. Dysentery:**

It is one the most common waterborne diseases. It is an intestinal disease which causes abdominal cramps, anal pain and bloody stool.

ii. Cholera:

It is also a water born disease which affects the intestine. Its symptoms are watery diarrhea and vomiting. Due to this, dehydration occurs.

iii. Typhoid fever:

This is also a waterborne disease which is caused by a bacterium. It enters the blood stream, making the person infected with typhoid fever. The main symptoms of typhoid fever are high temperature and headache.

2. Viral infections:**i. Polio:**

Polio is a viral disease which usually enters the environment through the feces of infected person. This virus easily spread through air, water etc. It destroys CNS and cause paralysis.

ii. Hepatitis A and E:

These two types of hepatitis spread through contaminated water or food. These viruses attack liver and cause jaundice and even liver failure.

3. Protozoal infections:

These include Ameobosis in which amoeba enters contaminated water. The people face gastrointestinal illness.

4. Paracitic infections:

Guinea worm and pinworm infections are common parasitic infections. It is mainly found in children. They spread by eating the eggs of these worms through contaminated water or food. They cause ulcer, fever, vomiting, nausea etc.

5. Arsenicosis:

It is a disease caused by drinking water with high levels of arsenic. It is also called arsenic poisoning. The symptoms of arsenic poisoning are excess of saliva, vomiting, nausea, blood in urine etc. The WHO recommends limit of arsenic in drinking water as 0.01mg/m^3 .

6. Fluorosis:

It is a disease caused by drinking water with excess of fluorine. It damages bones and teeth.

Q.15: What are the effects of water pollutants?

Ans: Effects of water pollutants:

The effects of water pollutants are not only dangerous for humans but also for other living organisms. Polluted water is unsuitable for drinking, recreation, agriculture and industry. Polluted water destroys aquatic life and reduces its reproductive ability.

The major effects of water pollutants are as under:

a. Cause of infectious diseases:

Human infectious diseases are among the most serious effects of water pollutants especially in developing countries like Pakistan. These diseases occur when parasites or other disease causing micro-organisms are transmitted through contaminated water.

The infectious diseases caused by water pollution include typhoid, dysentery, cholera, amoebiasis, ascariasis and hepatitis etc.

b. Nutrient pollution:

It is the most dangerous problem in coastal areas, rivers, streams and lakes. The discharge of nitrogen, phosphorus and other nutrients comes from agriculture, waste disposal, coastal development and fossil fuels.

This enrichment of nutrients (nitrogen, phosphorus etc) in water bodies to enhance the harmful overgrowth of algae is called eutrophication.

Eutrophication causes nutrient pollution. Red and brown algae etc are toxic and they have a direct effect to pollute water.

Algae also pollute water when they die they are decomposed during which oxygen is used and shortage of oxygen occur in water in which fish species and other aquatic animal die. Algal growth also blocks the sunlight which is needed by sea grasses which serve as food and shelter for many fish species.

Effects of chemical contamination:

Some of the major effects of chemical contamination are given below:

i. Effects of pesticides:

Pesticides affect and damage nervous system, liver, endocrine system, glands and DNA. They also cause cancer and other dangerous disease that last for a long period of time.

ii. Effects of oils and petrochemicals:

Oil and petrochemical change the ecology of aquatic habitats and the psychology of marine animals. In humans it causes gastro intestinal irritation, liver and kidney damage nervous system effects.

iii. Effects of mercury and its compounds:

In young children mercury and its compounds cause autism, brain damage, learning defects and incomplete mental development. In adults they cause Parkinson, Alzheimer's diseases and heart diseases.

iv. Effect of persistent organic pollutants:

Persistent organic pollutant (POP) such as DDT(dichlorodiphenyltrichloroethane), dioxins and PCB(polychlorinated biphenyl) enter our body through food. POPs cause disruption of hormones in humans and animals, affect reproductive system and cause breast cancer in women.

d. Thermal water pollution:

The heated water is used in many industries which is directly thrown to rivers, streams etc. It affects the aquatic life in two ways:

- The warmer water decreases the solubility of oxygen and many aquatic organisms die due to shortage of oxygen.
- Many aquatic animals especially young animals cannot survive above 30 °C and will die.

EXERCISE

A. Choose the correct Option.

- Water has the ability to dissolve ionic compounds due to
 - Ionic forces
 - Dipole-dipole forces
 - Ionic-dipole forces
 - Hydrogen bonding
- All salts cause the water become hard except
 - Calcium Chloride
 - Calcium Bicarbonate
 - Magnesium sulphate
 - Sodium chloride
- The salt which causes temporary hardness in water is
 - Magnesium sulphate
 - Calcium Chloride
 - Magnesium chloride
 - Calcium bicarbonate
- Chlorine acts as bleaching agent in the presence of
 - HCl
 - H₂O
 - NaOH
 - HNO₃
- Permanent hardness of water is removed by adding
 - Washing soda
 - Soda lime
 - Caustic soda
 - Baking Soda
- Most of the aquatic animals cannot survive in water above,
 - 20°C
 - 25°C
 - 30°C
 - 35°C
- The destiny of water maximum at
 - 40°C
 - 40°C
 - 4°C
 - 4°C
- The disease which cause liver infection
 - Hepatitis
 - Cholera
 - Typhoid
 - dysentery
- All are waterborne disease except
 - Hepatitis
 - Malaria
 - Typhoid
 - dysentery
- Water gas is a mixture of
 - CO and H₂
 - C and H₂
 - CO and H₂O
 - C and H₂O

SHORT QUESTIONS

Q 1. Identify the factors which are responsible for dissolving polar substances in water?

Ans. Factors responsible for dissolving polar substances in water:

The following two factors are responsible for dissolving polar substances in water:

- Polarity of water
- Hydrogen bonding

The detail is given below:

1. Polarity:

Consider the structure of water which is polar. Due to high electronegativity, oxygen end of water is partial negatively charged while hydrogen end is partial positively charged. Due to this fact majority polar solutes dissolve in water. e.g. alcohols, sugar etc.

2. Hydrogen bonding:

In water partial positive hydrogen end of one water molecule make bond with partial negative oxygen atom of another molecule. This is hydrogen bonding. As, one water molecule has two partial positive hydrogen atoms and two lone pairs on oxygen atom. Therefore, a water molecule forms four hydrogen bonds with other water molecules in tetrahedral manner.

Due to hydrogen bonding, polar molecules like sugar, glucose, alcohols are dissolved in water. On the other hand non-polar molecules like alkanes, alkenes, alkynes, benzene etc are not dissolved in water.

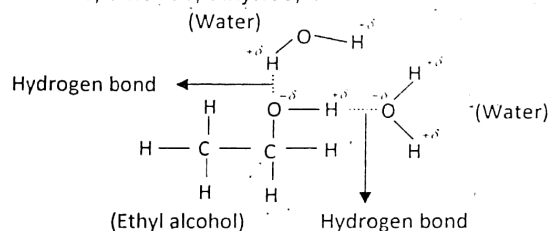


Figure: Hydrogen bonding between ethanol and water molecules

Q 2. Explain why it is advisable to drink boiled water?

Ans. Reason for boiled water being good for drinking:

When water is boiled the disease causing micro-organisms are killed. Besides this the temporary hardness of water which is also dangerous for health is removed. That is why it is advisable to drink boiled water.

Q3. Why ice floats on the surface of water?

Ans. Reason for floating of ice on water surface:

The density of ice (0.917g/ml). It is less than the density of water (1g/ml) because in ice, the water molecules are arranged hexagonally in which six molecules of water are arranged in the form of a ring having empty spaces due to which the volume of ice increases and density decreases. Thus due to low density, ice floats on water surface.

Q 4: Explain the importance of water and its quality?

Ans: For answer see questions no. 1 and 2

Q 5. What is eutrophication? How does it pollute water?

Ans. Eutrophication:

"The enrichment of nutrients (nitrogen, phosphorus etc) in water bodies to enhance the harmful overgrowth of algae is called eutrophication."

Water pollution by eutrophication:

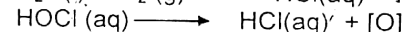
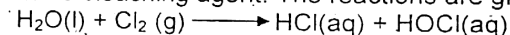
- Eutrophication causes nutrient pollution. Red and brown algae etc are toxic and they have a direct effect to pollute water.
- Algae also pollute water when they die they are decomposed during which oxygen is used and shortage of oxygen occur in water in which fish species and other aquatic animal die.
- Algal growth also blocks the sunlight which is needed by sea grasses which serve as food and shelter for many fish species.

Q 6. How chemistry helps to maintain clean swimming pools?

Ans. Chemistry helping to maintain swimming pools:

Chlorine gas is a chemical element produced through chemical processes. It is used in calculated amount in swimming pools to kill micro-organisms.

Actually, chlorine reacts with water to form hydrochloric acid (HCl) and hypochlorous acid (HOCl). Then the hypochlorous acid decomposes to produce atomic oxygen and HCl. The atomic oxygen kills the germs. It also acts as bleaching agent. The reactions are given below:



However, the amount of chlorine must be in the range of 0.5mg/dm³ to 1.5mg/m³. Because, in excess amount it causes eye irritation.

Q 7. Make the distinction between soft water and hard water.

Ans. Distinction between hard and soft water:

The distinction between hard and soft water is given below:

	Soft water	Hard water
(1)	"Water which produces lather easily with soap is called soft water."	"Water which do not produce lather easily with soap is called hard water."
(2)	It does not produce scum or curd with soap.	It produces scum or curd with soap.
(3)	It does not contain dissolved bicarbonate, sulphates and chlorides of calcium and magnesium.	It contains dissolved bicarbonate, sulphates and chlorides of calcium and magnesium.
(4)	It is suitable for drinking.	It is not suitable for drinking.

Q 8. Why water is universal solvent?

Ans. Water as universal solvent:

For answer see question no.7

Q 9. Give some disadvantages of detergents?

Ans. Disadvantages of detergents:

Some of the disadvantages of detergents are given below:

i. Non-biodegradable:

The major disadvantage of detergents is that they are non-biodegradable.

ii. Cause water and soil pollution:

They cause water and soil pollution.

iii. Damage to fabric:

Excessive alkalies used in some detergents can damage the fabric.

iv. Wastage of water:

Detergents waste large amount of water, as more amount of water is required for rinsing and removing foam.

Q 10. Identify the toxic substances in household wastes.

Ans. Toxic substances in household wastes:

Household wastes are classified into three categories. These categories and their toxic substances are given below:

a. Waste water or grey water

b. Untreated sewage or black water

c. Solid wastes

a. Waste water or grey water:

It includes the water we use in kitchens, washrooms and cleaning floors etc. It contains harmful chemicals because in most washing detergents and powder are used which contain phosphates to soften water. Besides these it may also contains acids, medicines, bleaches, dyes, insecticides, rodent killer, waxes, hair color etc. which badly affect aquatic life.

b. Untreated sewage or black water:

Untreated sewage is the major source of water pollution because it contains pathogens such as bacteria, viruses and protozoans.

c. Solid wastes:

It is also called domestic waste or urban waste. It is either in solid or semisolid form. It contains newspapers, glasses, glass bottles, cans, metals, plastics etc.

Chemicals from these wastes dissolve in rain water which is called leaching and the resulting mixture is called leachate. It contains decomposed organic matter, newspaper ink, pesticides, fertilizer and other dangerous chemicals.

LONG QUESTIONS

Q 1.(a) Enlist the main sources of water.

Ans. For answer see question no.1

(b) How would you categorize physical properties of water?

Ans. For answer see question no.5

(c) Predict the products of reaction with water?

i. K ii. Cl_2 iii. CaO iv. CH_3COONa v. C

Ans:

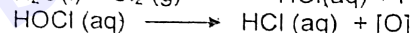
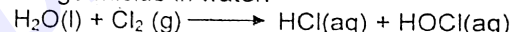
i. Reaction of water with potassium:

Potassium reacts vigorously with cold water, forming potassium hydroxide and hydrogen gas. This is an exothermic reaction and due to the heat produced the liberated hydrogen catches fire.



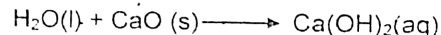
ii. Reaction with chlorine:

Water reacts with chlorine to hydrochloric acid (HCl) and hypochlorous acid (HOCl). Hypochlorous acid is unstable and decomposes to hydrochloric acid and atomic oxygen which decolourizes the dye molecule and also kills the germs. So chlorine can be used as bleaching agent and germicide in water.



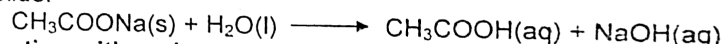
iii. Reaction with calcium oxide:

Water reacts with calcium oxide to form slaked lime or calcium hydroxide.



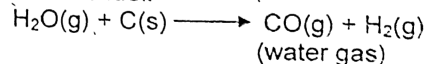
iv. Reaction with sodium acetate:

Water reacts with sodium acetate to form acetic acid and sodium hydroxide.



v. Reaction with carbon:

Water in the form of steam reacts with red hot coke to form a mixture carbon monoxide and hydrogen which is called water gas. Water gas is used as fuel.



Q 2: Water is an excellent solvent. Explain how this property is beneficial for life but sometimes harmful for us?

Ans: Benefits of water as an excellent solvent:

Water is an excellent solvent and dissolved a large number of solutes in it. This property of water is very beneficial for us for example

- We make a large number of solutions in water which are used for drinking, washing and other purposes.
- A large number of medicines are made by dissolving chemical substances in it.
- Water plays an important role in removing waste materials from the body by dissolving them which are removed in the form of sweat.
- Water dissolves many salts and minerals which are then taken by plants and enhances their growth.
- Rain water and irrigation water dissolves the fertilizers given to the plants which are then taken by plant. As these fertilizers cannot be used by plants in solid state.

Harmful effects of water as an excellent solvent:

- As water is an excellent solvent therefore, a large number of harmful substances also get dissolved in it making it unsuitable for drinking. This water causes various diseases in humans and other organisms.
- It causes hardness of water by dissolving bicarbonates, sulphates and chlorides of calcium and magnesium.

Q 3.(a) Classify temporary hard and permanent hard water?**Ans. Classification of temporary hard water:**

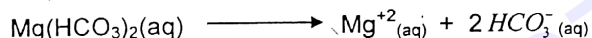
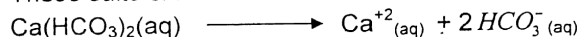
"The water which contains dissolved calcium bicarbonate or magnesium bicarbonate is called temporary hard water."

It is called temporary hard water because it can be removed simply by boiling.

Thus temporary hard water types:

i. Due to bicarbonates of calcium**ii. Due to bicarbonates of magnesium****iii. Due to mixture of above salts**

These salts exist in the form ions in water i.e.

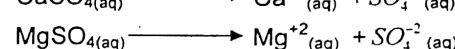
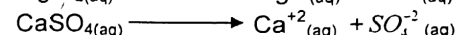
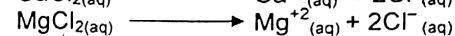
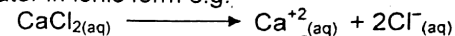
**ii. Classification of permanent hard water:**

"The water which contains dissolved sulphates and chloride of calcium and magnesium is called permanent hard water."

It cannot be removed by boiling therefore; it is called permanent hard water. Thus permanent hard water has the following types:

i. Due to sulphates of calcium**ii. Due to sulphates of magnesium****iii. Due to chlorides of calcium****iv. Due to chlorides of magnesium****v. Due to mixture of above salts**

These salts are dissolved by water from the earth. They are present in water in ionic form e.g.



(b) What methods could be adopted to remove temporary hardness of water?

Ans. For answer see question no. 10

(c) What methods could be adopted to remove permanent hardness of water?

Ans. For answer see question no. 11

Q 4.(a) Why water is important for us?

Ans: For answer see question no. 2

(b) Write disadvantages of hard water.

Ans. For answer see question no. 12

(c) Enlist the advantages of waste water treatment.

Ans. Advantages of waste water treatment:

Some of the advantages of waste water treatment are given below:

i. Quality improvement:

Waste water treatment improves the quality of water and makes it fit for drinking.

ii. Germs removal:

Waste water treatment also eliminated germs from water which are dangerous to health.

iii. Prevention from diseases:

Waste water treatment protects us from various waterborne diseases.

iv. Water preservation:

It also preserves water as it makes large amount of water fit for use. Otherwise it could be wasted.

Q 5.(a): How would you evaluate the effects of water pollution?

Ans. For answer see question no. 15

(b) Explain how industrial wastes pollute the environment?

Ans. For answer see question no. 13

(c) Support the view that domestic wastes cause pollution?

Ans. Water pollution by domestic wastes:

Domestic wastes definitely cause water pollution. This fact is explained below:

For further detail see household wastes in question no. 13

(d) How would you relate agricultural wastes and water pollution?

Ans. Agricultural wastes and water pollution:

Agricultural wastes are produced as a result of various agricultural activities. It includes manure, waste from poultry farms and slaughterhouses, harvest waste, fertilizer run off from fields, pesticides and insecticides etc.

Non-natural or synthetic waste includes packaging, agrochemicals, used syringes, pills, tyres, batteries and building wastes like asbestos sheeting. These pollutants are very dangerous and harmful.

Thus, agricultural wastes pollute the water through various toxic pollutants.

Additional MCQs

- Human body contains about -----of water.
(a) 70% (b) 60% (c) 90% (d) 80%
- Plant contains about -----of water.
(a) 70% (b) 60% (c) 90% (d) 80%
- The density of water by cooling below 4°C .
(a) Increase (b) decrease (c) remain same (d) negligible.
- Glycol is added to car radiator to prevent-----of water.
(a) Freezing (b) boiling
(c) contaminating (d) evaporation.
- one gram of water requires -----of heat to raise its temperature by one degree centigrade:
(a) 4.2 joules (b) 4.9 joules (c) 5.6 joules (d) 4.18 joules.
- The vital function of protoplasm is due to the presence of,
(a) Water (b) minerals (c) fats (d) calcium.
- The quantity of fresh water present on earth surface is only about.
(a) 2.5% (b) 2.2% (c) 0.04% (d) 0.2%.
- In water, ratio of oxygen and hydrogen by mass is,
(a) 2:1 (b) 1:2 (c) 8:1 (d) 1:8.
- The reason of unusual physical properties of water is due to the presence of,
(a) Hydrogen bonding (b) covalent bond
(c) Coordinate covalent bond (d) none of these.
- The density of water is one gram per centimeter cube at,
(a) 0°C (b) 4°C (c) 60°C (d) 100°C .

- The volume of water increase, when its temperature decrease below,
(a) 4°C (b) 5°C (c) 10°C (d) 20°C .
- The enormous quantity of water present on earth surface act as giant thermostat, due to its high,
(a) boiling point (b) density
(c) heat capacity (d) latent heat values.
- The latent heat of fusion of water is:
(a) 333kj/kg (b) 6kj/mol (c) 4.2kj/mol (d) 2.4kj/mol.
- Water gas is a mixture of,
(a) Steam & air (b) hydrogen & oxygen
(c) CO & Hydrogen gas (d) H_2O & O_2 .
- Chlorine acts as bleaching agent in the presence of,
(a) HCl (b) H_2O (c) NaOH (d) HNO_3 .
- The chemical formula of magnetic oxide is,
(a) Fe_3O_4 (b) Fe_2O_3 (c) FeO (d) $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$.
- Rain water is acidic in nature, because air contain,
(a) Oxygen (b) carbon dioxide (c) nitrogen (d) all of these.
- Nutrient pollution of water bodies is caused by,
(a) Pathogens (b) calcium & magnesium
(c) nitrates & phosphates (d) acid rain.
- Most of the aquatic animals cannot survive above,
(a) 20°C (b) 25°C (c) 30°C (d) 40°C .
- In water, ratio of oxygen and hydrogen by mass is-----
(a) 2:1 (b) 1:2 (c) 8:1 (d) 1:8.
- Ocean contain-----of water.
(a) 97% (b) 80% (c) 50% (d) 60%.
- Small organism that cause diseases are called-----
(a) pathogen (b) muloosca (c) pesticides (d) herbicides.
- The minimum concentration of chlorine in swimming pool is-----
(a) 0.5mg/L (b) 0.4mg/L (c) 0.7mg/L (d) 0.3mg/L.
- The maximum concentration level of chlorine in swimming pool is-----
(a) 1.5mg/L (b) 1-7mg/L (c) 2mg/L (d) 1.9mg/L.
- The unusual physical properties of water are due to-----
(a) covalent bond (b) non-polar (c) hydrogen bond (d) both a & c.
- Temporary hardness of water is caused by
(a) CaO (b) $\text{Ca}(\text{OH})_2$ (c) CaCl_2 (d) $\text{Ca}(\text{HCO}_3)_2$.

Chapter No.16

Chemical Industries

Q.1. Define mineral, ore, native metal, compound metal and gangue?

Ans. Mineral:

"A naturally occurring substance present in rocks and ground that has its own chemical composition is called mineral." e.g. diamond, quartz, garnet etc.

Ore:

"A type of mineral from which metal is obtained is called ore." OR Impure form of metal is called ores. e.g. hematite, bauxite, chalcocite etc.

Native metal:

"A metal in free state is called native metal."

Compound metal:

"A metal in combined state is called compound metal. It is also called mineral"

Gangue:

"The unwanted impurities present in an ore are called gangue."

Q.2. Define metallurgy. What are its steps?

Ans. Metallurgy:

"The art and science of making metals and alloys from their ores is called metallurgy." OR

"The extraction of metals from their ore and conversion of them to alloys is called metallurgy."

Basic metallurgical operations/steps:

During metallurgy the following general steps are carried out which are called basic metallurgical operations:

- i. Mining
- ii. Grinding and crushing
- iii. Concentration
- iv. Roasting and calcination
- v. Smelting and reduction
- vi. Electro-refining

Q.3. Describe the basic metallurgical operations in detail.

Ans. Basic metallurgical operations:

Basic metallurgical operations are the various physical and chemical processes by which metals are not only extracted from their ores but also made them suitable for use. Metals are extracted from their ores by different methods.

The selection of the method depends on:

- a. Type of ore i.e. oxide, carbonate etc.
- b. Reactivity of metal
- c. Nature of gangue present in ore.

During metallurgy the following general steps are carried out which are called basic metallurgical operations:

- i. Mining
- ii. Grinding and crushing
- iii. Concentration
- iv. Roasting and calcination
- v. Smelting and reduction
- vi. Electro-refining

Their detail is given below:

1. Mining:

Extracting ores from the ground by digging the earth is called mining.

2. Concentration:

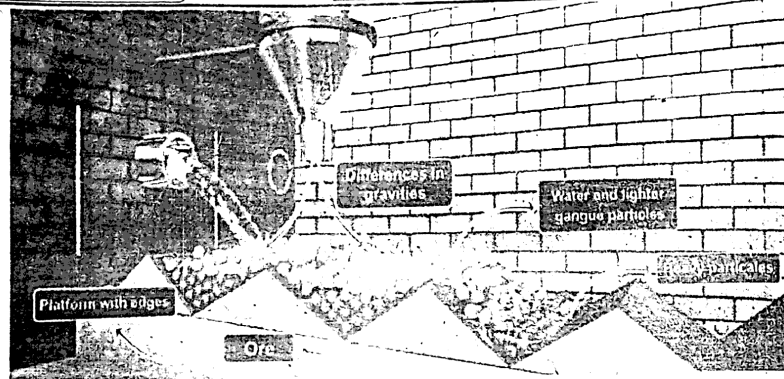
The ore contain a large amount of gangue or useless rocky portion. In order to remove sufficient amount of gangue, concentration of ore is carried out. Various methods are used for concentration of ore these include grinding and crushing, gravity separator, froth floatation process etc. The detail is described below:

a. Grinding and crushing:

The ore obtained by mining consists of large pieces. In this step the ore is converted to small pieces with the help of grinders and crushers. These small pieces are then converted into fine powder with the help of ball mill or stamp mill. This process is called pulverization

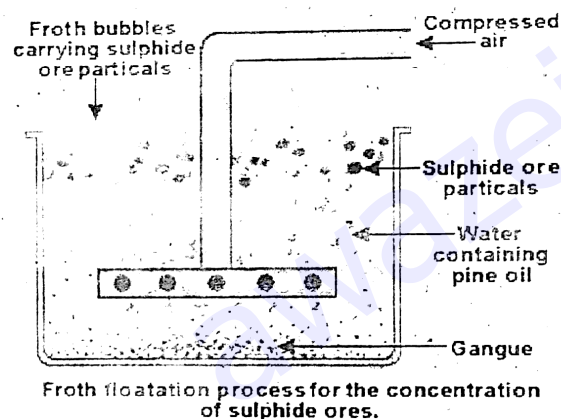
b. Gravity separation (Hydraulic washing):

This method is based on the difference in densities of ore and gangue. In this method, the ore containing gangue is poured over a hydraulic classifier. The hydraulic classifier is a vibrating inclined table with grooves. Then a jet of water is allowed to flow over the ore and gangue. The ore particles are denser, they settle in grooves while the lighter gangue particles are washed away.

**c. Froth flotation process:**

It is an important method of concentration of ores. This is specially used for sulphide ores.

In this method the crushed ore is added to water containing pine oil. The mixture is agitated by passing a strong current of air. The particles of ores are wetted by pine oil and float at the top along with the froth which are removed while the particles of gangue are wetted by water and settle down. The froth is transferred to another container, washed with water and then filtered to obtain concentrated ore.

**3. Extraction of metals:**

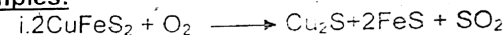
When the gangue is removed from ore, then metal is extracted from it. This includes various steps which are given below:

a. Conversion to oxide ore:

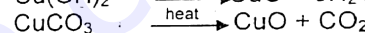
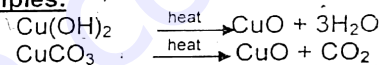
It is very easy to extract metals from oxide ores as compared to sulphide, carbonate or any other form. Therefore, usually the metal ore is converted to oxide ores by the following ways:

i. Roasting and calcination:

The heating of ore in the presence of air is called roasting. The temperature of this process is varied for different ores but usually it is from 500°C to 700°C

Examples:

The removal of water from hydroxide ore or removal of CO₂ from carbonate ore by heating the ore in absence of air is called calcinations.

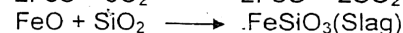
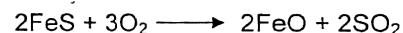
Examples:**b. Smelting:**

It is the process in which oxide ore in the fused form is reduced with reducing agents like coke to get the metal.

The roasted ore is mixed with coke and smelted into a blast furnace.

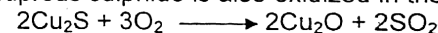
Example:

For example during smelting of copper sulphide ore containing iron sulphide, the iron sulphide gets oxidized to iron oxide. The iron oxide then reacts with silica (SiO₂) to form iron silicate (slag).

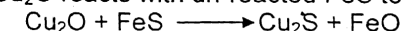


Iron silicate or slag is impurity which is lighter than molten sulphides of copper and iron. Hence, it is removed at the upper hole.

The cuprous sulphide is also oxidized in the blast furnace and forms Cu₂O.

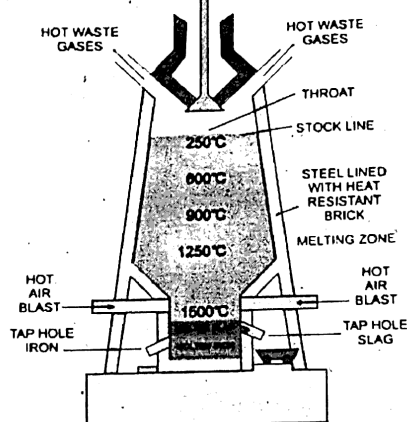


The Cu₂O reacts with un-reacted FeS to form Cu₂S and FeO.



This FeO also reacts with SiO₂ in the furnace to form slag which is removed by the upper hole.

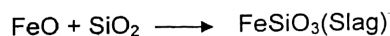
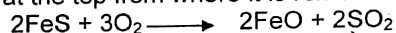
Molten cuprous sulphide (Cu₂S) and iron sulphide (FeS) is called matte which is removed through the slag hole.



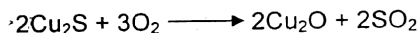
c. Bessemerization:

This process was introduced by Henry Bessemer. This process is carried out in a special egg-shaped furnace called Bessemer converter.

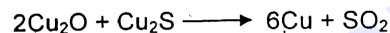
In this process, the molten matte is poured in Bessemer converter and calculated amount of sand is added to it. The iron sulphide (FeS) is oxidized to iron oxide which reacts with sand (SiO₂) to form slag which floats at the top from where it is removed.



The cuprous sulphide is converted into cuprous oxide.



The Cu₂O reacts with Cu₂S to form copper in molten form along with sulphur dioxide.



The Cu, in molten form obtained, is called blister copper because of its porous surface which is due to the release of sulphur dioxide gas during solidification. It is 95 to 97% pure copper containing impurities like Fe, Mn, Ag, Au etc.

vi. Electro-refining:

In electro-refining electrolysis process is done in which the impure metal is made the anode and pure metal is made the cathode and they are dipped in a container containing the electrolyte of the metal to be purified. Electric current is passed through the solution. As a result, the pure metal from the anode dissolves, leaving the impurities called anode mud and deposited over the cathode.

Electro-Refining of blister copper:

The blister copper obtained from the metallurgy of copper is 95 to 97 %pure. Therefore it is made pure by the electrolysis process.

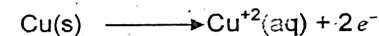
Construction of the cell:

The electrolytic cell consists of a block of anode made of blistered copper. Cathode consists of a thin sheet of copper. These two electrodes are suspended in a solution of copper sulphate and sulphuric acid.

Working:

The potential difference is 1.3volts. When electric current is passed, the impure copper from the anode dissolves to give Cu²⁺ ions which move towards cathode. At cathode each Cu²⁺ picks up two electrons and reduced to pure metallic copper. Thus pure copper is deposited over the cathode. The reactions occurring at electrodes are given below:

At anode:



At cathode:

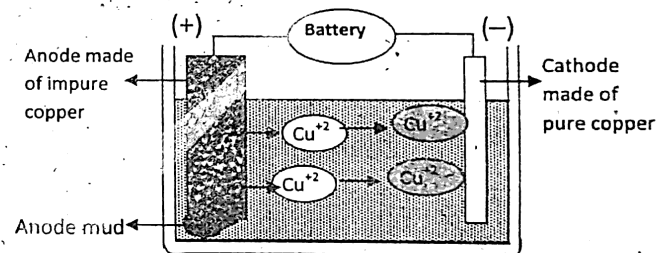
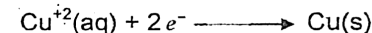


Figure: Electrolytic refining of Cu

The impurities like Au, Ag, and Pt present in the blister copper remain un-dissolved due to their less reactivity. They settle at the bottom of the tank as anode mud where they are removed. By electrolytic refining of copper 99.99% pure copper is obtained.

Q.4. Describe the manufacture of sodium carbonate? OR Describe in detail the Solvay's process.

Ans. Solvay's process:

Sodium carbonate is commercially prepared by Solvay's process. This process was invented by the Belgian chemical engineer, Ernest Solvay. It is explained below:

Raw materials:

- The raw materials of this process are:
- Ammonia (NH_3)
 - Sodium chloride (NaCl)
 - Lime stone (CaCO_3)
 - Water (H_2O)

Procedure:

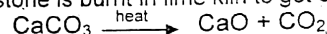
This process is carried out by the following steps:

i. Saturator or ammonia absorber:

The saturated solution of sodium chloride called brine is entered to saturating tank. Here the brine solution is saturated with ammonia to form ammoniacal brine.

ii. Lime kiln:

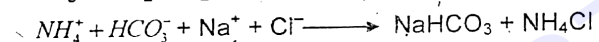
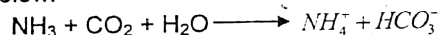
Lime stone is burnt in lime kiln to get carbon dioxide and calcium oxide:



The CO_2 is sent to carbonating tower while the CaO is slaked by adding large amount of water to it and sent to ammonia recovery tower for the formation of ammonia from NH_4Cl .

iii. Carbonation tower:

The ammoniacal brine is entered to carbonation tower or Solvay's tower, where carbon dioxide gas from lime kiln is passed through this solution from the bottom. First ammonium bicarbonate is formed which then reacts with sodium chloride to form sodium bicarbonate which is insoluble and is precipitated. The reactions occurring in this tower are given below:

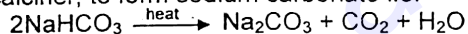


iv. Filtration of precipitate:

The precipitated Sodium bicarbonate is removed by filtration. It is used as baking soda.

v. Calcination:

The sodium bicarbonate is then heated in a rotatory furnace called calciner, to form sodium carbonate i.e.

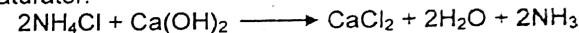


The carbon dioxide is recirculated to carbonation tower.

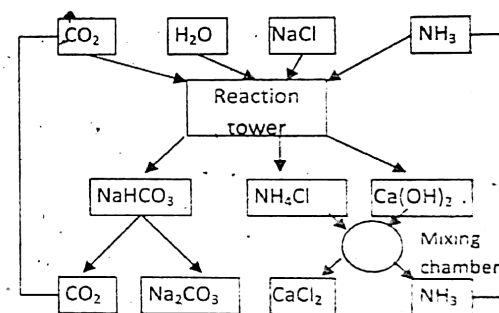
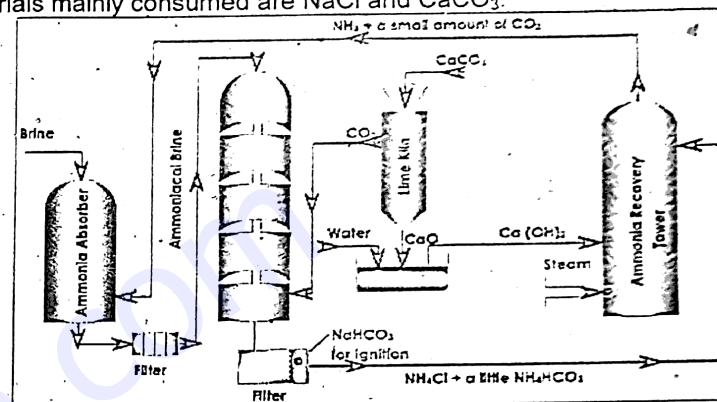
vi. Ammonia recovery tower:

The filtrate containing NH_4Cl , left by filtering sodium bicarbonate solution, is entered to ammonia recovery tower. In this tower NH_4Cl is

reacted with slacked lime [Ca(OH)_2] to form ammonia which is entered to the saturator.



The Solvay's process is almost self-sufficient. The only raw materials mainly consumed are NaCl and CaCO_3 .

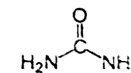


Flow sheet diagram of Solvay's process

Q.5: How is urea commercially manufactured?

Ans: Manufacture of urea:

Urea is an important nitrogenous fertilizer. Urea is also called carbamide. It is an organic compound having two NH_2 groups attached to functional group C=O



Composition of urea:

The composition of urea is given below:

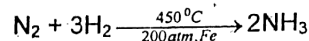
S.No	Element	Percentage
(1)	Nitrogen(N)	46.67%
(2)	Oxygen(O)	26.67%
(3)	Carbon(C)	20.00%
(4)	Hydrogen(H)	6.66%

Raw materials:

The following are the raw material for manufacturing of urea:

1. Ammonia:

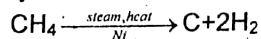
Ammonia is prepared by Haber's process. In this process hydrogen and nitrogen are reacted in the presence of iron as catalyst at 450°C and 200 atm pressure.

**Manufacture of nitrogen:**

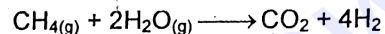
For Haber's process, nitrogen is obtained by liquefaction and fractional distillation of air

Manufacture of hydrogen:

Hydrogen is prepared by passing methane and steam over heated nickel as catalyst. The methane decomposes to form hydrogen gas.

**2. Carbon dioxide:**

Carbon dioxide is the second raw material used for the manufacture of urea which is obtained by reacting steam with natural gas in the presence of nickel as catalyst.

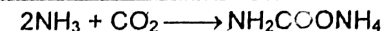
**Main process and reactions:**

The manufacture of urea involves the following steps:

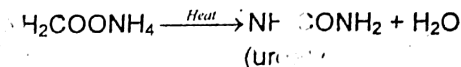
i. Reaction of ammonia and carbon dioxide:

Carbon dioxide and ammonia are heated at 170-200 °C and 100-200atm pressure.

The ammonia and carbon dioxide react to form ammonium carbamate as:

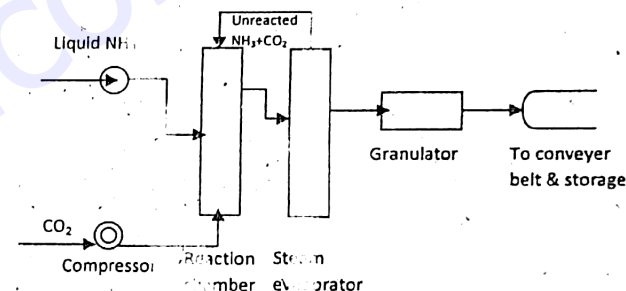
**ii. Urea formation:**

The ammonium carbamate is heated which decomposes into urea and water as:

**iii. Evaporation and granulation:**

In this step, liquid urea is concentrated in vacuum evaporators. It is sprayed from the top of the tower under pressure and hot current of air is introduced from the bottom which evaporates water from liquid urea. It is rapidly cooled and send to granulator tower. In granulator tower, small granules are made from it and stored in packs.

A simplified flow sheet diagram of urea manufacture is given below:



Q.6. What are the uses of urea?

Ans. Uses of urea:

The uses of urea are given below:

i. As fertilizer:

About 86% of urea is used as fertilizer.

ii. As adhesive/glue:

Urea-formaldehyde resins are used as plywood adhesives/glue.

iii. In explosives:

Urea is used to form urea nitrate which is highly explosive.

iv. As raw material:

Urea is used as raw material for many important things like plastic, resins, adhesives etc.

v. As flame proofing agent:

Urea is used as flame proofing agent.

vi. In various cosmetic products:

Urea is used in hair conditioners, facial cleaners and lotions.

vii. For deicing road ways and runways:

Urea is also used in the deicing of roadways and runways.

viii. In cigarettes:

It is used as flavour enhancing additive for cigarettes.

ix. In hair removers:

It is used as a main ingredient in hair remover creams.

x. In skinning creams:

Urea containing creams are used as tropical dermatological products to promote rehydration of skin.

Q.7. What is petroleum? Describe its origin.**Ans. Petroleum:**

"A dark brown coloured and unpleasing smelling liquid that consists of mixture of various hydrocarbons, found in sedimentary rock of earth is called petroleum."

Explanation:

Petro mean rock and oleum means oil, as it is present in sedimentary rocks of earth therefore it is called petroleum.

It is also called crude oil or mineral oil. Since the wealth of a country depends on its oil resources, it is also called liquid gold. The important oil producing countries are Iraq, Saudi Arabia and other Arab countries.

Origin of petroleum:

There are two theories about the origin of petroleum which are given below:

i. Inorganic or abiotic origin theory:

This theory was presented by Russian chemist Mendeleev. According to this theory, steam reacted with metallic carbides at high temperature and pressure, under the surface of the earth and produced petroleum. However, this theory did not gain popularity and was rejected.

ii. Organic origin theory:

This theory was stated by many scientist like Mikhail Lomonosov of Russia, T.S Hunt of Canada, Leo Lefer, Laroque of America etc.

According to this theory petroleum is believed to form from the decay of ancient plants and animals that were buried underground. Due to bacterial

decomposition, high temperature and pressure they were changed to petroleum after passage of a long time. This theory gained popularity and is widely accepted.

Q.8. What is the drilling of petroleum?**Ans. Drilling of petroleum:**

"The process by which petroleum is taken out from the earth by the use of various equipment is called drilling of petroleum."

Explanation:

Petroleum usually occurs at the depth 500ft or more. Petroleum can naturally come out of mines because it is usually present along with natural gas which exert pressure on its surface and take it out through the natural openings present in the earth.

In case of artificial mining, mines are bored. If the gas is present with the petroleum its pressure forces the petroleum to come out. If there is no natural gas then the air pressure is applied to force the oil from the well. The oil thus obtained is forced to oil refinery for refining.

Q.9. Discuss refining of petroleum? OR**How fractional distillation is carried out in petroleum?****Ans. Refining of petroleum:**

"The conversion of crude oil into useful products which are free from impurities is called refining of petroleum."

Petroleum is refined by the process of fractional distillation which is described below:

Fractional distillation:

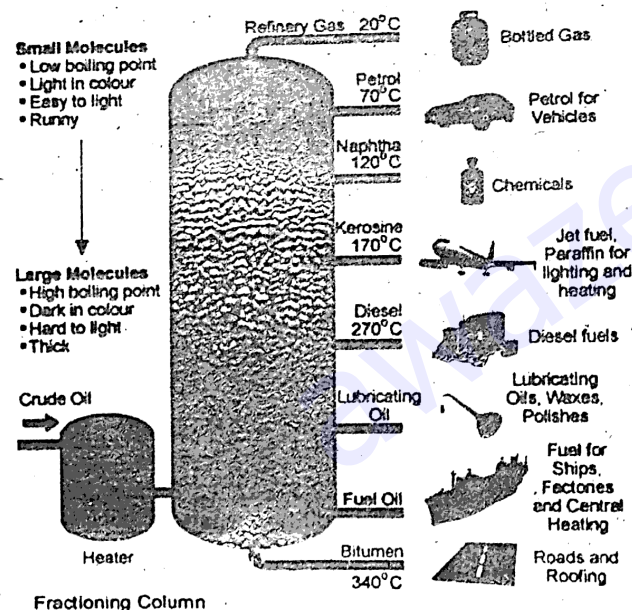
"The process of separation of a mixture into its fractions (components) on the basis of difference in boiling points is called fractional distillation."

Fractional distillation of petroleum:

First of all petroleum is heated in an electric furnace above 400 °C. The heated mixture is then entered to a fractionating column. The fractionating column or tower is divided into various compartments. Each compartment has a definite range of temperature. As the petroleum vapours rise in the fractionating column, they condense and separate out into various fractions. The important fractions of petroleum or composition of petroleum is given below:

Table: Fractions/composition of petroleum:

Fraction	Boiling point	No. of C-atoms	Uses
Petroleum gases	Below 40 °C	Upto 4 carbon atoms	Methane for cooking and butane for camping gas. Carbon-3 and Carbon-4 are valuable energy sources.
Petrol and naphtha	40-130 °C	4-12 carbon atoms	Naphtha for lighter fuel petrol for cars.
Paraffin oil(kerosene)	150-200 °C	10-16 carbon atoms	Paraffin for heating and jet fuel.
Diesel oil(DERV)	225-300 °C	14-25 carbon atoms	Fuel for lorries and ships.
Lubricating oil	300-400 °C	20-70 carbon atoms	For lubrication of machines and engines
Bitumen	Above 400 °C	Residue	Bitumen is heated with sand and gravel and made into road coal tar.



EXERCISE

Multiple Choice Questions

A. Choose the Correct Option.

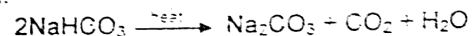
- When sodium Bicarbonate is heated to get sodium carbonate, all are Produced except
 - CO
 - CO₂
 - Na₂CO₃
 - H₂O
- Forth flotation process is concentration of ore by
 - Magnetically
 - Wetting the ore
 - Difference in density
 - chemically
- All are the raw materials for the manufacturing of soda ash except
 - Ammonia
 - Brine
 - Lime stone
 - Carbon monoxide
- Matte is a mixture of
 - CuS and FeS
 - Cu₂S and FeS
 - Cu₂ and FeS
 - Cu₂O and FeO
- The impurity present in mineral is called
 - Metal
 - Ore
 - Gangue
 - Salt
- All are the raw materials for the manufacturing of urea except
 - CO₂
 - NH₃
 - H₂O
 - NaCl
- Percentage of nitrogen in urea is
 - 14
 - 28
 - 60
 - 46
- Blister copper is refined through
 - Concentration
 - Reduction
 - Smelting
 - Electrolysis
- Petroleum is separated into different fractions by the process of
 - Simple distillation
 - Condensation
 - Fractional distillation
 - Destructive distillation
- All steps are used for the extraction of metals except
 - Roasting
 - Smelting
 - Evaporation
 - Bessmiraiztion

SHORT QUESTIONS

Q.1. How you convert NaHCO_3 into Na_2CO_3 ?

Ans. Conversion of NaHCO_3 into Na_2CO_3 :

We can convert sodium bicarbonate to sodium carbonate by heating. It decomposes to sodium carbonate, carbon dioxide and water on heating:



Q.2. Enlist the different uses of urea?

Ans. For answer see question no.6

Q.3. Differentiate between mineral and ore.

Ans. Differences between mineral and ore:

The differences between mineral and ore are given below:

	Mineral	Ore
(1)	"A naturally occurring substance present in rocks and ground that has its own chemical composition is called mineral."	"A type of mineral from which metal is obtained is called ore."
(2)	Mineral may not contain metals	Ore contain metals.
(3)	All minerals are not ores	All ores are minerals.
(4)	<u>Examples:</u> Diamond, quartz, garnet, hematite, bauxite, chalcocite etc.	<u>Examples:</u> Hematite, bauxite, chalcocite etc.

Q.4. Define metallurgy. What are its steps?

Ans. For answer see question no.2

Q.5. What is the function of froth floatation process?

Ans. Function of froth floatation process:

The main function of froth floatation process is to remove useless gangue from the ore. This is called concentration of the ore. This process is usually used for sulphide ores. The process is explained below:

Froth floatation process:

See question no.3

Q.6. On what basis the different fractions of petroleum are Separated?

Ans. Basis for different fractions of petroleum:

Different fractions of petroleum are separated from each other on the basis of difference in their boiling points which are given below:

Fraction	Boiling point	No. of C-atoms
Petroleum gases	Below 40°C	Upto 4 carbon atoms
Petrol and naphtha	$40-130^\circ\text{C}$	4-12 carbon atoms
Paraffin oil(kerosene)	$150-200^\circ\text{C}$	10-16 carbon atoms
Diesel oil(DERV)	$225-300^\circ\text{C}$	14-25 carbon atoms
Lubricating oil	$300-400^\circ\text{C}$	20-70 carbon atoms
Bitumen	Above 400°C	Residue

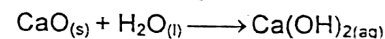
Q.7. What is slaked lime? How slaked lime is produced?

Ans. Slacked lime:

Slacked lime is a white inorganic compound with the formula $\text{Ca}(\text{OH})_2$. Its chemical name is calcium hydroxide.

Preparation of slacked lime:

Slacked lime is produced when quick lime (CaO) is mixed with water. The reaction is given below:



Q.8. Assess the composition of urea and calculate the percentage of nitrogen in it.

Ans. Percentage composition of urea:

It is given below:

S.No	Element	Percentage
(1)	Nitrogen(N)	46.67%
(2)	Oxygen(O)	26.67%
(3)	Carbon(C)	20.00%
(4)	Hydrogen(H)	6.66%

Calculation of percentage of nitrogen in urea:

The percentage of nitrogen in urea can be calculated by the following formula:

$$\% \text{ of N} = \frac{2(\text{atomic mass of N})}{\text{molecular mass of Urea}} \times 100$$

As, atomic mass of N = 14 a.m.u

and molecular mass of urea = 60 a.m.u

Putting the values we get:

$$\% \text{ of N} = \frac{2 \times 14}{60} \times 100$$

$$\Rightarrow \% \text{ of N} = 46.67\%$$

Q.9: What is gangue and where it is found?

Ans: Gangue and its occurrence:

"The unwanted impurities present in an ore are called gangue.

So, it is clear in the definition that gangue is found in the ores.

Composition of gangue:

Gangue is composed of earthy materials like clay, sand, rock and other substances which are useless in the ore.

Q.10: How blister copper is purified?

Ans: Purification of blister copper:

See question no.3 heading electro-refining of blister copper.

LONG QUESTIONS

1. (a) How could you convert the concentrated ore to its oxide?

Ans. Conversion of concentrated ore into oxide:

For detail answer see question no.3

(b). How would you use the roasting in extraction of copper?

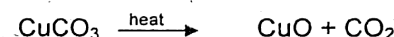
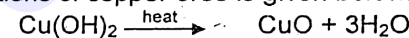
Ans. Roasting and calcinations in the extraction of copper:

The heating of ore in the presence of air is called roasting. The temperature of this process is varied for different ores but usually it is from 500°C to 700°C.

The roasting of copper ore is given below:



The removal of water from hydroxide ore or removal of CO₂ from carbonate ore by heating the ore in absence of air is called calcinations. The calcinations of copper ores is given below:



(c) What inference can you make of smelting in extraction of copper?

Ans. For answer see question no.3

(d) . Can you elaborate the reason of electro – refining of copper?

Ans. Reason for electro-refining of copper:

The blister copper obtained by the metallurgy of copper is only 95-97% pure. Therefore, to make it more pure, electro-refining of copper is carried out. As, copper is an important metal used in electric wires and electrical appliances like voltage regulators, transformers etc. therefore, it must be used in pure form. By electro-refining of copper, 99.99% pure copper is obtained.

2. (a). List the raw materials used in Solvay process?

Ans. For answer see question no.4

(b). What basic reactions would you use to support the manufacture of soda ash?

Ans. Basic reactions for the manufacture of soda ash:

Soda ash is manufactured by Solvay's process. The detail is given below:

Solvay's process:

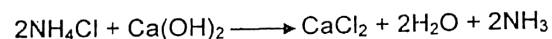
For more detail see question no.4

(c) Predict the byproducts in the Solvay's process?

Ans. By products of Solvay's process:

"The additional products obtained during the manufacture of a main product are called byproducts.

The only byproduct obtained during Solvay's process is calcium chloride (CaCl_2) which is obtained when ammonium chloride is heated with slaked lime in the ammonia recovery tower. The reaction is given below;



(d). Sketch the flow sheet diagram of the Solvay process.

Ans. For answer see question no.4

3. (a) Enlist the raw materials used in the manufacture of urea?

Ans. For answer see question no.5

(b) What basic reactions would you use to support the manufacture of urea?

Ans. For answer see question no.5

(c) What is the advantage of recycling of un-reacted compound in manufacture of urea?

Ans. Unreacted compounds in manufacture of urea:

During the manufacture of urea when ammonia is reacted with carbon dioxide then it forms ammonium carbamate. But not all the ammonia and carbon dioxide are changed to ammonium carbamate. Some are left un-reacted. Therefore, the main un-reacted compounds in urea manufacture are ammonia and carbon dioxide.

Advantage of recycling un-reacted compounds:

The un-reacted ammonia and carbon dioxide are the raw materials for the manufacture of urea. Therefore, by recycling them main process of urea manufacture is carried out. Therefore, their recycling is of great importance.

(d) Sketch the flow sheet diagram of the urea manufacture process.

Ans: For answer see question no.5

4. (a) Define refining of petroleum. Describe the composition of petroleum?

Ans: For answer see question no.9

(b) What are the two theories about the origin of petroleum?

Ans: For answer see question no.7

(c) Write a detail note on fractional distillation of petroleum.

Ans: For answer see question no.9

5. (a) Write a detail note on metallurgical operations.

Ans: For answer see question no.3

(b) Explain the process of smelting and bessemerization with reference to copper extraction.

Ans: For answer see question no.3

(c) Enlist the different uses of urea.

Ans: For answer see question no.6

Additional MCQs

1. The metal present in combine state is called-----

- | | |
|-------------|-------------|
| (a) Mineral | (b) metal |
| (c) solid | (d) alloys. |

2. The blister copper is refined by-----.

- | | |
|-------------------|---------------|
| (a) Concentration | (b) reduction |
| (c) electrolysis | (d) boiling. |

3. Sodium carbonate is commercially manufactured by-----process.

- | | |
|-------------|---------------|
| (a) Sovey's | (b) Ostwald's |
| (c) Haber's | (d) Frasch |

4. Chemical formula of urea is-----.

- | | |
|---------------------------------|--------------------------------|
| (a) $\text{NH}_2\text{COONH}_4$ | (b) NH_2CONH_2 |
| (c) NH_4Cl | (d) Na_2CO_3 |

5. Urea is probably most important-----fertilizer.
 (a) Nitrogenous (b) phosphate
 (c) organic (d) sulphur.
6. Raw material used for manufacturing urea are-----
 (a) CO_2 & NH_3 (b) H_2 & NH_3
 (c) HCl & NH_3 (d) CO_2 & H_2 .
7. Petroleum is mixture of many-----
 (a) Hydrocarbons (b) hydroxide
 (c) acids (d) salt.
8. Different fractions of petroleum are separated by-----
 (a) Fractional distillation (b) steam distillation
 (c) cooling (d) gravity concentration
9. Which one is a step of metallurgical process-----
 (a) Roasting (b) rusting
 (c) crystallization (d) sublimation.
10. The blister form of copper is -----copper.
 (a) pure (b) impure
 (c) refined (d) raw.
11. Urea is probably most important-----fertilizer.
 (a) sulphure (b) nitrogenous
 (c) phosphate (d) orgic.
12. An aggregate of mineral and other impurities is known as-----
 (a) ore (b) alloy
 (c) metal (d) Non-metal.
13. For fraction distillation petroleum is heated above-----in a furnace.
 (a) 400°C (b) 200°C
 (c) 300°C (d) 600°C .
14. Solvay process is used for the commercial preparation of:
 (a) NH_3 (b) Na_2CO_3
 (c) $(\text{NH}_2)_2\text{CO}$ (d) NaOH .
15. Petroleum is also called -----
 (a) crude oil (b) mineral oil
 (c) white gold (d) all of these
16. Coal is converted to petroleum by -----process.
 (a) FT (b) Hyber
 (c) brick land (d) All of these

Model Paper

Total Time: 3:00 Hours Chemistry (10th) Total Marks : 65
 (Fresh/New Course)

Note: There are three sections in this paper i.e Section A, B & C.

Time Allowed : 20 Minutes "Section-A" Marks : 12

Instructions:

- Attempt this Sections on the MCQs Answer Sheet only.
- Use black ball point or marker for shading only circle for correct option or a question.
- No marks will be awarded for cutting, Erasing, over writing and multiple circles shading.

Q. 1. Choose the correct option i.e A, B, C or D.

- The chemical formula of magnetic oxide is
 a. Fe_3O_4 b. Fe_2O_3 c. FeO d. $\text{Fe}_3\text{O}_3\text{H}_2\text{O}$
- Chemical formula of urea is
 a. $\text{NH}_2\text{COONH}_4$ b. Br_2CINH_2 c. NH_4Cl d. Na_2CO_3
- Ozones isgas.
 a. Greenish b. Yellowish c. bluish d. reddish
- When ethane reacts with HBr , the compound formed is
 a. $\text{CH}_3\text{-H}_2\text{-Br}$ b. $\text{Br-CH}_2\text{-CH}_2\text{-Br}$ c. $\text{CH}_3\text{-CH}_2\text{-CH}_3$ d. $\text{HC}\equiv\text{CH}$
- Those bases which give hydroxide ion (OH) in water are called...
 a. Acids b. alkalies c. salts d. amphoteric
- The next homologue of C_8H_{16} is
 a. C_8H_{16} b. C_9H_{20} c. C_9H_{18} d. C_7H_{20}
- Nucleic acids are oftypes.
 a. Two b. Three c. four d. five
- Vitaminis called ascorbic acid.
 a. A b. B c. C d. E
- Ethen reacts with chlorine is the presence of.....
 a. Carbon tetra chloride b. Ether c. sunlight d. water
- A $^\circ\text{C}$ Density of water is $1/\text{gcm}^3$.
 a. 0°C b. 4°C c. 60°C d. 100°C
- The pH of acid rain is less than
 a. 14 b. 10 c. 7 d. 5.6
- Water gas is a mixture of
 a. Steam and air b. hydrogen and oxygen
 c. carbon mono oxide and hydrogen d. none of these

Model Paper
Chemistry (10th) **Total Marks : 53**
(Fresh/New Course)

Note: There are three sections in this paper i.e Section A, B & C.

"Section-B"

Marks:32

Q2. Answer any Eight (8) parts of the following. Each part carries equal marks.

1. What do you mean by saturated hydrocarbons?
2. Why water has soothing effect on the body in summer?
3. How sodium carbonate is commercially prepared?
4. Write note on monosaccharides.
5. Differentiate between fats and oils.
6. Write note on occurrence of water.
7. Explain types of salts with examples.
8. Describe importance of equilibrium constant.
9. Describe importance of atmosphere.
10. Differentiate between soft and hard water.
11. Write characteristics of organic compound.

"Section-C"

Marks:21

Note: Answer any Three (3) questions. Each question carries equal marks.

- Q3. A) Describe the uses of carbohydrates.
B) What is neutralization?
- Q4. A) Define acid rain and write its mechanism.
B) Write Lewis concept of Acid and Base.
- Q5. A) Write functions of nucleic acid.
B) Describe conditions for chemical equilibrium.
- Q6. A) Define p^H and p^{OH} .
B) Write importance fractions of petroleum.