# POLYCET - 2025

# CHEMISTRY

## STUDY MATERIAL

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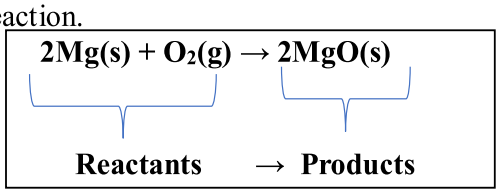
# 1.CHEMICAL REACTIONS AND EQUATIONS

## I. Chemical Reaction

- The transformation of chemical substance into another chemical substance is known as Chemical Reaction. **Ex:** Rusting of iron, the setting of milk into curd, digestion of food, respiration, etc.
- In a chemical reaction, a new substance is formed which is completely different in properties from the original substance, so in a chemical reaction, a chemical change takes place.
  **Only a rearrangement of atoms takes place in a chemical reaction.**
  **Example:** The burning of magnesium in the air to form magnesium oxide is an example of a chemical reaction.




- Before burning in air, the magnesium ribbon is cleaned by rubbing with sandpaper.
- This is done to remove the protective layer of basic magnesium carbonate ($MgCO_3$) from the surface of the magnesium ribbon.

**Reactant:** Substances which take part in a chemical reaction are called reactants.

**Ex: Mg and $O_2$.**

**Product:** New substance formed after a chemical reaction is called a product.**Ex: MgO.**

### Characteristics of Chemical Reactions :

**(i). Evolution of gas:** The chemical reaction between zinc and dilute sulphuric acid is characterised by the evolution of hydrogen gas.

**$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)\uparrow$**

- **Upward arrow (↑):** Represents a gas escaping from the reaction mixture.

**(ii). Change in Colour:** When lead nitrate ($Pb(NO_3)_2$) and potassium iodide (KI) are mixed, they react to form lead iodide ($PbI_2$) and potassium nitrate ($KNO_3$)

**$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) \downarrow + 2KNO_3(aq)$**

**The colour of lead iodide is yellow**

- **Downward arrow (↓):** Indicates a solid precipitate forming in the reaction.

**(iii). Change in state of substance:** The combustion reaction of candle wax is characterised by a change in state from solid to liquid and gas (because the wax is a solid, water formed by the combustion of wax is a liquid at room temperature whereas, carbon dioxide produced by the combustion of wax is a gas). There are some chemical reactions which can show more than one characteristics.

**(iv). Change in Temperature:** The chemical reaction between quick lime water to form slaked lime is characterized by a change in temperature (which is a rise in temperature). The chemical

reaction between zinc granules and dilute sulphuric acid is also characterised by a change in temperature (which is a rise in temperature). **$Zn + 2HCl \rightarrow ZnCl_2 + H_2$**

## II. Chemical Equation

- Representation of chemical reaction using symbols and formulae of the substances is called Chemical Equation.**Example:A + B → C + D**
- In this equation, A and B are called reactants and C and D are called the products. The arrow shows the direction of the chemical reaction. Condition, if any, is written generally above the arrow.
- When hydrogen reacts with oxygen, it gives water. This reaction can be represented by the following chemical equation:**Hydrogen + Oxygen → Water**
  **$H_2 + O_2 \rightarrow H_2O$**
- In the first equation, words are used and in second, symbols of substances are used to write the chemical equation. For convenience, the symbol of substance is used to represent chemical equations. A chemical equation is a way to represent the chemical reaction in a concise and informative way.
- A chemical equation can be divided into two types: Balanced Chemical Equation and Unbalanced Chemical Equation.

**(a). Balanced Chemical Equation:** A balanced chemical equation has the number of atoms of each element equal on both sides.
**Example:$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$**

- In this equation, numbers of zinc(Zn), hydrogen(H) sulfur(S) and Oxygen(O) are equal on both sides, so it is a Balanced Chemical Equation. **According to the Law of Conservation of Mass, mass can neither be created nor destroyed in a chemical reaction.** To obey this law, the total mass of elements present in reactants must be equal to the total mass of elements present in products.

**(b). Unbalanced Chemical Equation:** If the number of atoms of each element in reactants is not equal to the number of atoms of each element present in the product, then the chemical equation is called Unbalanced Chemical Equation.
**Example: $Fe + H_2O \rightarrow Fe_3O_4 + H_2$**

- In this example, a number of atoms of elements are not equal on two sides of the reaction. **Example:** on the left-hand side only one iron atom is present, while three iron atoms are present on the right-hand side. Therefore, it is an unbalanced chemical equation.
- **Balancing a Chemical Equation**: To balance the given or any chemical equation, follow these steps:

$$Fe + H_2O \rightarrow Fe_3O_4 + H_2$$

**Write the number of atoms of elements present in reactants and in products in a table as shown here**.

| Name of atom | No. of atoms in the reactant | No. of atoms in the product |
|---|---|---|
| Iron (Fe) | 1 | 3 |
| Hydrogen (H) | 2 | 2 |
| Oxygen (O) | 1 | 4 |

**Step 1 :** Balance the atom which is maximum in number on either side of a chemical equation.
In this equation, the number of oxygen atom is the maximum on the right hand side (RHS).
To balance the oxygen, one needs to multiply the oxygen on the left hand side (LHS) by 4, so that, the number of oxygen atoms becomes equal on both sides.
$Fe + (\mathbf{4 \times H_2O}) \rightarrow Fe_3O_4 + H_2$
**Step 2 :** Now, the number of hydrogen atoms becomes 8 on the LHS, which is more than that on the RHS. To balance it, one needs to multiply the hydrogen on the RHS by 4.
$Fe + (4 \times H_2O) \rightarrow Fe_3O_4 + (\mathbf{4 \times H_2})$
**Step 3 :** After that, the number of oxygen and hydrogen atoms becomes equal on both sides. The number of iron is one on the LHS, while it is three on the RHS. To balance it, multiply the iron on the LHS by 3.
$(\mathbf{3 \times Fe}) + (4 \times H_2O) \rightarrow Fe_3O_4 + (4 \times H_2)$
Now the number of atoms of each element becomes equal on both sides. Thus, this equation becomes a balanced equation.

| Name of atom | No. of atoms in the reactant | No. of atoms in the product |
|---|---|---|
| Iron (Fe) | 3 | 3 |
| Hydrogen (H) | 8 | 8 |
| Oxygen (O) | 4 | 4 |

After balancing, the above equation can be written as follows:

$$\mathbf{3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2.}$$

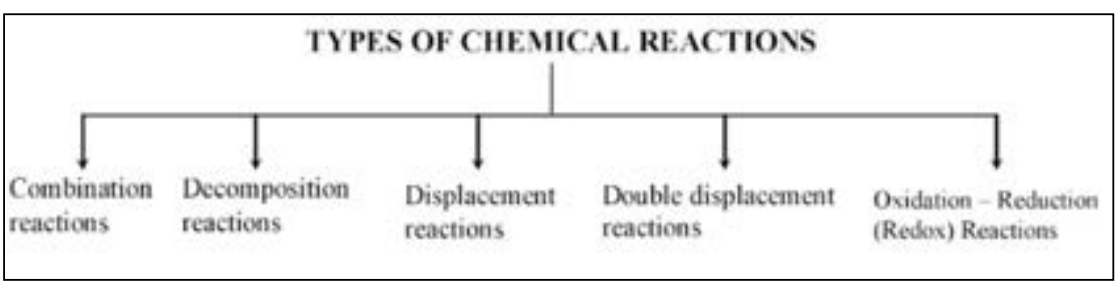
**To Make Equations More Informative:**

- Writing the symbols of physical states of substances in a chemical equation:
- By writing the physical states of substances, a chemical equation becomes more informative.
- Gaseous state is represented by symbol (g), Liquid state by symbol (l), Solid state by symbol (s) and Aqueous solution is written by symbol (aq).
- **Writing the condition in which reaction takes place:** The condition is generally written above and/or below the arrow of a chemical equation.

Thus, by writing the symbols of the physical state of substances and condition under which reaction takes place, a chemical equation can be made more informative.

## III. Types of Chemical Reactions

Chemical reactions can be classified in following types:




**(i). Combination Reaction:** Reactions in which two or more reactants combine to form oneproduct are called **Combination Reactions.**

A general combination reaction can be represented by the chemical equation given here:

$$A + B \rightarrow AB$$

**Examples:**

- When magnesium is burnt in the air (oxygen), magnesium oxide is formed. In this reaction, magnesium is combined with oxygen.Heat released in this reaction.
  **$Mg(s) + O_2(g) \rightarrow 2MgO(s)$**
  **Magnesium + Oxygen → Magnesium Oxide**
- When carbon is burnt in oxygen (air), carbon dioxide is formed. In this reaction, carbon is combined with oxygen.
  **$C(s) + O_2(g) \rightarrow CO_2(g)$**
  **Carbon + Oxygen → Carbon dioxide**
- When calcium oxide (CaO) reacts with water ($H_2O$), it forms calcium hydroxide ($Ca(OH)_2$). This reaction is also known as the **slaking of lime.**
  **$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$**

**(ii). Decomposition Reaction:** Reactions in which one compound decomposes in two or more compounds or elements are known as Decomposition Reaction. A decomposition reaction is just the opposite of combination reaction.

A general decomposition reaction can be represented as follows :

**$AB \longrightarrow A + B$**

**Examples:** (a) When calcium carbonate is heated, it decomposes into calcium oxide and carbon dioxide.

**$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$**

**Calcium carbonate → Calcium oxide + Carbon dioxide**

(b) When ferric hydroxide is heated, it decomposes into ferric oxide and water

**$2Fe(OH)_3(s) \longrightarrow Fe_2O_3(s) + 3H_2O(l)$**

**Ferric Hydroxide ⟶ Ferric Oxide + Water**

- **<u>Thermal Decomposition</u>:** The decomposition of a substance on heating is known as **Thermal Decomposition**.

  **Ex. (a) :** Leadnitrate decomposes into led oxide, nitrogen dioxide and Oxygen.

  **$2Pb(NO_3)_2(s) + heat \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$**

  **(b) :** Ferrous sulfate ($FeSO_4$) decomposes into ferric oxide ($Fe_2O_3$), sulfur dioxide ($SO_2$), and sulfurtrioxide ($SO_3$) when heated.

  **$2\ FeSO_4(s) + heat \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$**

**Ferrous sulfate crystals lose water and turn from light green to white.The decomposition produces a gas with a characteristic odor of burning sulfur.**

- **<u>Electrolytic Decomposition</u>:** Reactions in which compounds decompose into simpler compounds because of passing of electricity, are known as **Electrolytic Decomposition**. This is also known as **Electrolysis**.

  **Example:** When electricity is passed in water, it decomposes into hydrogen and oxygen.

  **$2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$**

- **<u>Photolysis (or) Photo Decomposition Reaction</u>:** Reactions in which a compound decomposes because of sunlight are known as **Photolysis or Photo Decomposition Reaction.**

  **Example:** When silver chloride is put in sunlight, it decomposes into silver metal and chlorine gas.

$$2AgCl(s)\ (white) + Sunlight \longrightarrow 2Ag(s)\ (grey) + Cl_2(g)$$

**Photographic paper has a coat of silver chloride, which turns into grey when exposed to sunlight. It happens because silver chloride is colourless while silver is a grey metal.**

**(iii). Displacement Reaction:** The chemical reactions in which a more reactive element displaces a less reactive element from a compound is known as **Displacement Reactions**.

**Displacement reactions are also known as Substitution Reaction or Single Displacement / Replacement reactions.**

A general displacement reaction can be represented by using a chemical equation as follows :

$$A + BC \rightarrow AC + B$$

Displacement reaction takes place only when 'A' is more reactive than B. If 'B' is more reactive than 'A', then 'A' will not displace 'C' from 'BC' and reaction will not be taking place.

**Examples:**

(a) When zinc reacts with hydrochloric acid, it gives hydrogen gas and zinc chloride.

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

(b) When zinc reacts with copper sulphate, it forms zinc sulphate and copper metal.

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

**(iv). Double Displacement Reaction:** Reactions in which ions are exchanged between two reactants forming new compounds are called **Double Displacement Reactions**.

$$AB + CD \rightarrow AC + BD$$

**Examples:**

(a) When the solution of barium chloride ($BaCl_2(aq)$) reacts with the solution of sodium sulphate ($Na_2SO_4(aq)$), white precipitate of barium sulphate ($BaSO_4(s)$) is formed along with sodium chloride ($NaCl(aq)$)

$$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s)\ (Precipitate) + 2NaCl(aq)$$

(b) When sodium hydroxide ($NaOH(aq)$) (a base) reacts with hydrochloric acid ($HCl(aq)$), sodium chloride ($NaCl(aq)$) and water ($H_2O(l)$) are formed.

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

- **Double Displacement Reaction, in which precipitate is formed, is also known as precipitation reaction. Neutralisation reactions are also examples of double displacement reaction.**
- **Precipitation Reaction:** The reaction in which precipitate is formed by the mixing of the aqueous solution of two salts is called **Precipitation** Reaction.

  **Example:**

  $$AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

  **Silver Nitrate + Sodium Chloride → Silver Chloride + Sodium Nitrate**

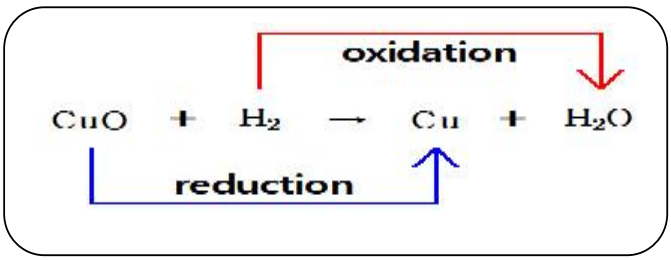
**Neutralization Reaction:** The reaction in which an acid reacts with a base to form salt and water by an exchange of ions is called **Neutralization** Reaction.

**Example:**

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

**(v). Oxidation and Reduction Reactions:**

- **Oxidation:** Addition of oxygen or non-metallic element or removal of hydrogen or metallic element from a compound is known as Oxidation.
  Elements or compounds in which oxygen or non-metallic element is added or hydrogen or metallic element is removed are called to be Oxidized.
- **Reduction:** Addition of hydrogen or metallic element or removal of oxygen or non-metallic element from a compound is called Reduction. The compound or element which goes under reduction in called to be Reduced.
  Oxidation and Reduction take place together.




**Oxidizing agent :** The substance being reduced is called oxidising agent.
**Reducing agent:** The substance being oxidised is called reducing agent.

**The reaction in which oxidation and reduction both take place simultaneously is called Redox reaction.**

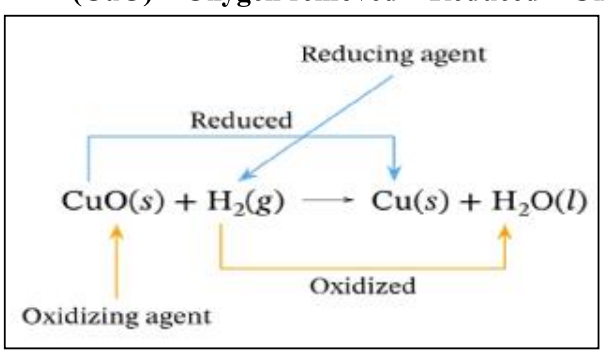
When copper oxide is heated with hydrogen, then copper metal and hydrogen are formed.

**$CuO + H_2 \rightarrow Cu + H_2O$**

**(a)** In this reaction, CuO is changing into Cu. Oxygen is being removed from copper oxide. Removal of oxygen from a substance is called Reduction, so copper oxide is being reduced to copper.

**(b)** In this reaction, $H_2$ is changing to $H_2O$. Oxygen is being added to hydrogen. Addition of oxygen to a substance is called Oxidation, so hydrogen is being oxidised to water.

- **($H_2$) - Oxygen added – Oxidised - Reducing agent**
- **(CuO) – Oxygen removed – Reduced – Oxidising agent.**




**Examples of Redox Reactions:**

**$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ (Fe – Reduced & C – oxidised)**

**$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$ (Mn – Reduced & Cl – oxidised)**

## Exothermic and Endothermic Reactions

- **Exothermic Reaction:** Reaction which produces energy is called Exothermic Reaction. Most of the decomposition reactions are exothermic.

**Examples:**

**(a)** Respiration is a decomposition reaction in which energy is released.

$$C_6H_{12}O_{6\,(aq)} + 6O_{2\,(aq)} \rightarrow 6CO_{2\,(aq)} + 6H_2O\,(l) + Energy(Q)$$

**(b)** Quick lime( CaO) reaction with water releases energy

$$CaO\,(S) + H_2O\,(l) \rightarrow Ca(OH)_2\,(aq) + Energy(Q)$$

**(c)** When slaked lime (calcium hydroxide, $Ca(OH)_2$) reacts with carbon dioxide ($CO_2$) in theair during whitewashing, it forms a thin layer of calcium carbonate ($CaCO_3$) on thewalls, giving a white, shiny finish; this is the chemical reaction responsible for thewhite appearance after whitewashing. This reaction is highly exothermic

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s)\downarrow + H_2O + Energy(Q)$$

**(d)** Decomposition of vegetable matter into compost is also an exothermic reaction

- **Endothermic Reaction:** A chemical reaction in which heat energy is absorbed .

**Examples**:

**(a)** Decomposition of calcium carbonate.

$$CaCO_3\,(s) + Heat(Q) \rightarrow CaO(s) + CO_2(g)$$

**(b)** $2AgCl\,(s) + Heat(Q) \rightarrow 2Ag\,(s) + Cl_2\,(g).$

**Decomposition of AgCl &AgBr reactions used in Black&white Photography**

| ROLE OF HEAT | DESCRIPTION |
|---|---|
| Reactants + Heat(Q) → Products | Endothermic Reaction |
| Reactants → Products + Heat(Q) | Exothermic Reaction |

**Effects of Oxidation Reactions in Everyday life: CORROSION And RANCIDITY.**

**Corrosion:** The process of slow conversion of metals into their undesirable compounds due to their reaction with oxygen, water, acids, gases etc. present in the atmosphere is called Corrosion.

**Example**: Rusting of iron.

**Rusting:** Iron when reacts with oxygen and moisture forms red substance which is called Rust.

$$4Fe\,(s) + 3O_2\,(g) + 6H_2O\,(l) \rightarrow 2\,Fe_2O_3.xH_2O\,(s)$$

**(Rust) Hydrated Ferric oxide**

**(Red brown coloured)**

**The rusting of iron is a redox reaction**. Corrosion (rusting) weakens the iron and steel objects and structures such as railings, car bodies, bridges and ships etc. and cuts short their life.

**Methods to Prevent Rusting:**

By painting, By Greasing and Oiling, By **Galvanisation (Coating with Zinc metal)**

**Corrosion of Copper:** Copper objects lose their lustre and shine after some time because the surface of these objects acquires a green coating of basic copper carbonate, $CuCO_3.Cu(OH)_2$ when exposed to air.

$$2Cu(s) + H_2O(l) + CO_2\,(g) + O_2\,(g) \rightarrow CuCO_3.Cu(OH)_2$$

**Basic Copper Carbonate (Green)**

**Corrosion of Silver Metal:** The surface of silver metal gets tarnished (becomes dull) on exposure to air, due to the formation of a coating of black silver sulphide($Ag_2S$) on its surface by the action of $H_2S$ gas present in the air.

$$2Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$$

**(Silver Sulfide-Black)**

**Rancidity:** The taste and odour of food materials containing fat and oil changes when they are left exposed to air for a long time. This is called Rancidity. It is **caused due to the oxidation of fat and oil present in food materials.**

**Methods to Prevent Rancidity** : By adding anti-oxidant, Vacuum packing,Replacing air by nitrogen.Refrigeration of foodstuff.

## EXERCISE – I

1. **Which of the following reaction can also be termed a thermal decomposition reaction?**
   (a) Combination reaction (b) Decomposition reaction
   (c) Displacement reaction (d) Double displacement reaction
2. **One of the following processes does not involve a chemical reaction, that is:**
   (a) Melting of candle wax when heated (b) Burning of candle wax when heated
   (c) Digestion of food in your stomach (d) Ripening of banana
3. **The chemical formula of magnesium oxide is _____.**
   (a) $MgO_2$ (b) $Mg_2O$ (c) MgO (d) $Mg(OH)_2$
4. **From the following, which one is an example of a chemical reaction?**
   (a) Grapes get fermented (b) Breakdown of food
   (c) Formation of curd (d) All of the above
5. **Which of the following shows an oxidation reaction?**
   (a) Gain of oxygen (b) Loss of oxygen (c) Gain of hydrogen (d) None of the above
6. **$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$**
   **The type of reaction and colour of the precipitate is….**
   (a). Double displacement & Yellow (b). Displacement & Yellow
   (c). Double displacement & Green (d). Displacement & Green
7. **Magnesium ribbon is rubbed before burning because it has a coating of**….
   (a) basic magnesium carbonate (b) basic magnesium oxide
   (c) basic magnesium sulphide (d) basic magnesium chloride
8. **What type of chemical reactions take place when electricity is passed through water?**
   (a) Displacement (b) Combination
   (c) Decomposition (d) Double displacement
9. **A substance added to food containing fats and oils is called**:
   (a) Oxidant (b) Reductant (c) Coolant (d) Antioxidant
10. **$Pb + CuCl_2 \rightarrow PbCl_2 + Cu$**
    **The above reaction is an example of:**
    (a) Combination (b) Double displacement (c) Decomposition (d) Displacement

**11. Identify the reactants in the reaction : $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$**

(a) Zn, $H_2$ (b) Zn, $ZnSO_4$ (c) Zn, $H_2SO_4$ (d) $ZnSO_4$, $H_2$

**12. Select the oxidising agent for the following reaction:**

**$H_2S + I_2 \rightarrow 2HI + S$**

(a) $I_2$ (b) $H_2S$ (C) HI (d) S

**13. When Ag is exposed to air it gets a black coating of….**

(a) $AgNO_3$ (b) $Ag_2S$ (c) $Ag_2O$ (d) $Ag_2CO_3$

**14. Two or three days after white washing …Shiny finishing of walls due to the formation of….**

(a). Calcium hydroxide [$Ca(OH)_2$] (b). Calcium Carbonate [$CaCO_3$]

(c). Carbon dioxide [$CO_2$] (d). Calicum Oxide [CaO]

**15. When a decomposition reaction is carried out by sunlight it is called….**

(a). Thermal decomposition (b). Photo decomposition

(c). Electrolysis (d). None of the above

**16. Name the products formed when iron filings are heated with dilute hydrochloric acid**

(a) Fe (III) chloride and water (b) Fe (II) chloride and water

(c) Fe (II) chloride and hydrogen gas (d) Fe (III) chloride and hydrogen gas

**17. The reaction of 'magnesium' with air is….**

(a) Exothermic reaction (b) Endothermic reaction

(c) Reversible reaction (d) Substitution reaction

**18. Chemically rust is …..**

(a) Hydrated ferrous oxide (b) Only ferric oxide

(c) Hydrated ferric oxide (d) None of these

**19. Consider reaction: $P(s) + O_2(g) \rightarrow P_4O_{10}(s)$. Number of Moles of $O_2(g)$ needed to balance the equation will be..**

(a) 1 (b) 3 (c) 5 (d) 7

**20. In which of the given chemical equations, the abbreviations represent the correct states of thereactants and products involved at reaction temperature?**

(a) $2H_2$ (l) + $O_2$ (l) $\rightarrow$ $2H_2O$ (g) (b) $2H_2$ (g) + $O_2$ (l) $\rightarrow$ $2H_2O$ (g)

(c) $2H_2$ (g) + $O_2$ (g) $\rightarrow$ $2H_2O$ (l) (d) $2H_2$ (g) + $O_2$ (g) $\rightarrow$ $2H_2O$ (g)

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. b** | **2. a** | **3. c** | **4. d** | **5. a** | **6. a** | **7. a** | **8. c** | **9. d** | **10. d** |
| **11. c** | **12. a** | **13. b** | **14. b** | **15. b** | **16. d** | **17. a** | **18. c** | **19. c** | **20. c** |

## EXERCISE – II

**1. Balance the following Chemical Equations.**

**(a). $NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$**

**(b). $Hg(NO_3)_2 + KI \rightarrow HgI_2 + KNO_3$**

**(c). $H_2 + O_2 \rightarrow H_2O$**

**(d). $KClO_3 \rightarrow KCl + O_2$**

**(e). $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$**

**ANSWERS:**

**(a). $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$**

**(b). $Hg(NO_3)_2 + 2KI \rightarrow HgI_2 + 2KNO_3$**

**(c). $2H_2 + O_2 \rightarrow 2H_2O$**

**(d). $2KClO_3 \rightarrow 2KCl + 3O_2$**

**(e). $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$**

**2. Write the balanced equations for the following reactions.**

**(a). Zinc + Silver nitrate → Zinc nitrate + Silver**

**(b) Aluminium + Copper chloride → Aluminium chloride + Copper**

**(c). Hydrogen + Chlorine → Hydrogen chloride**

**(d). Ammonium nitrate → Nitrogen + Oxygen + Water**

**(e). Calcium hydroxide + Nitirc acid → Water + Calcium nitrate**

**(f). Magnesium + Iodine → Magnesium iodide**

**(g). Magnesium + Hydrochloric acid → Magnesium chloride + Hydrogen**

**(h). Zinc + Calcium chloride → Zinc chloride + Calcium**

**ANSWERS:**

**(a). $Zn + 2AgNO_3 \rightarrow Zn(NO_3)_2 + 2Ag$**

**(b). $2Al + CuCl_2 \rightarrow 2AlCl_3 + 3Cu$**

**(c). $H_2 + Cl_2 \rightarrow 2HCl$**

**(d). $2NH_4NO_3 \rightarrow 2N_2 + O_2 + 4H_2O$**

**(e). $Ca(OH)_2 + 2HNO_3 \rightarrow 2H_2O + Ca(NO_3)_2$**

**(f). $Mg + I_2 \rightarrow MgI_2$**

**(g). $Mg + 2HCl \rightarrow MgCl_2 + H_2$**

**(h). $Zn + CaCl_2 \rightarrow ZnCl_2 + Ca$**

## POLYCET PREVIOUS QUESTIONS

**POLYCET – 2022:**

**1. Which of the following is NOT a chemical process**

(a). Rusting of Iron (b). Changing water into water vapour

(c). Mixing metal acid and base (d). Baking a cake

**2. What does an oxidising agent do?**

(a). It reduces other substances and itself undergoes oxidation

(b). It reduces other substances and itself undergoes reduction

(c). It oxidises other substances and itself undergoes oxidation

(d). It oxidises other substances and itself undergoes reduction

**3. Determine the nature of reaction?**

**$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + Q$**

(a). Exothermic (b).Endothermic

(c).Both Exothermic and Endothermic (d). Cant be determine

**4. $x\ H_2 + O_2 \rightarrow xH_2O$. What is the value of $x$**

(a). 4 (b). 3 (c). 2 (d). 1

**POLYCET – 2021:**

**5. which of the following methods are used to prevent corrosion?**

(a). Painting (b). Electroplating

(c). Sacrificial Electrode of another metal (d). All of these

**POLYCET – 2020:**

**6. $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$ is an example for which type of chemical reaction?**

(a) Combination (b) Double displacement

(c) Decomposition (d) Displacement

**7. A thin layer of 'X' metal is used as galvanizing on iron surface to protect from rusting of iron.The name of 'X' metal is**

(a). Tin (Sn) (b). Lead (Pb) (c). Zinc (Zn) (d). Aluminium (Al)

**POLYCET – 2019:**

**8. Lead nitrate on reaction with potassium iodide gives yellow precipitate.The yellow color is due to**

**$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s)(\downarrow) + 2KNO_3(aq)$**

(a).$Pb(NO_3)_2(aq)$ (b). KI(aq) (c). $PbI_2(s)(\downarrow)$ (d).$KNO_3(aq)$

**9. The values of x, y, zin the following chemical reaction is $C_3H_8 + x\ O_2 \rightarrow yCO_2 + zH_2O$**

(a). 5, 3, 4 (b). 4, 3, 5 (c). 3, 4, 5 (d). 5, 4, 3

**POLYCET – 2018:**

**10. $NaCl + AgNO_3 \rightarrow AgCl\downarrow + NaNO_3$ is an example for [POLYCET 2016]**

(a). Chemical Combination (b). Chemical Decomposition

(c). Displacement Reaction (d). Double Displacement Reaction

**11. $C_6H_{12}O_6 \rightarrow x\ C_2H_5OH + y\ CO_2$. In this balanced equation the x, y values respectively are**

(a). 1, 1 (b). 2, 1 (c). 1, 2 (d). 2, 2

**POLYCET – 2017:**

**12. Match the following:**

| | |
|---|---|
| (a). $Zn (s) + 2AgNO_3 (aq) \rightarrow Zn(NO_3)_2 (aq) + 2Ag (s)$ | (i). Decomposition Reaction |
| (b). $NaCl (s) + AgNO_3 (aq) \rightarrow AgCl (s) + NaNO_3 (aq)$ | (ii). Combination Reaction |
| (c). $CaCO_3 (s) \rightarrow CaO (s) + CO_2 (g)$ | (iii). Displacement Reaction |
| (d). $Mg (s) + O_2 (g) \rightarrow 2MgO (s)$ | (iv) Double Displacement Reaction |

**POLYCET – 2016:**

**13. Coating the iron metal surface with a thin layer of zinc to protect the rusting of iron is called**

(a). Greasing (b). Galvanizing (c). Tinning (d). Electroplating

**14. $x\ Na + y\ H_2O \rightarrow 2\ NaOH + H_2$. In this balanced equation, the x, y values respectively are**

(a). 1, 1 (b). 2, 1 (c). 1, 2 (d). 2, 2

**KEY:**

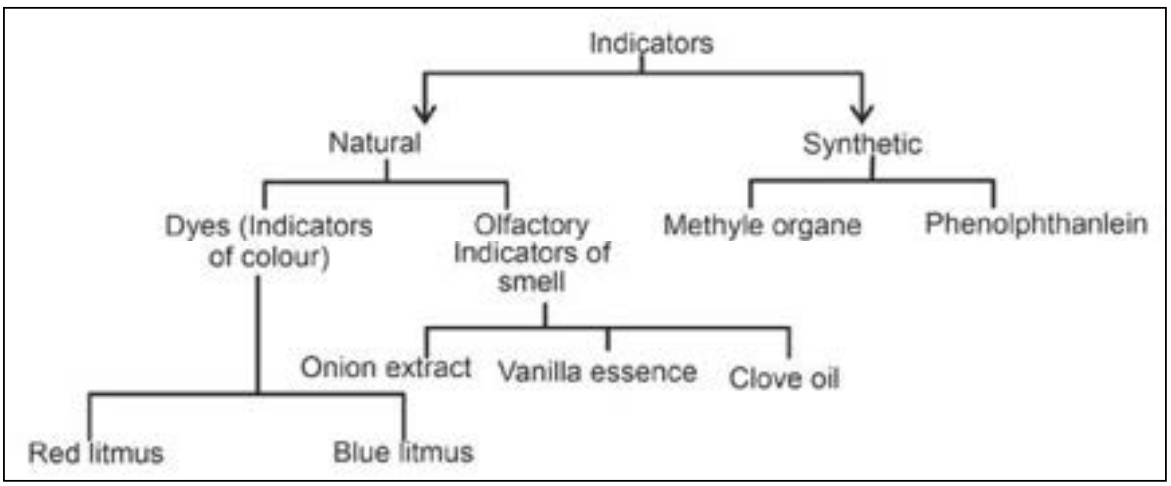
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. b** | **2. d** | **3. a** | **4. c** | **5. d** | **6. c** | **7. c** | **8. c** | **9. a** | **10. d** |
| **11. d** | **12. (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii),** | | | | | **13. b** | **14. d** | | |

* * *

# 2. ACIDS, BASES AND SALTS

**Indicators:** Indicators are substances which indicate the acidic or basic nature of the solution by the colour change .

**Types of Indicator:** There are many types of indicators. Some common types of indicators are:




- **Litmus: Litmus is obtained from lichens.** The solution of litmus is purple in colour. Litmus paper comes in two colours : blue and red.
  **An acid turns blue litmus paper red.A base turns red litmus paper blue.**
- **Turmeric:** Turmeric is another natural indicator. Turmeric is yellow in colour.
- **Turmeric solution (or) paperturns reddish brown with base**. **Turmeric does not change colour with acid.**
- **Olfactory Indicators:** **These Change smell when comes in contact with acid or base.** These are not regarded as main class of indicators **Ex :** Onion,Vanilla,Cloves
- **Synthetic Indicator:** Indicators that are synthesized in the laboratory are known as Synthetic Indicators. **Example**: Phenolphthalein, Methyl orange, etc.
- **Phenolphthalein** is a colourless liquid**. It remains colourless with acid but turns into pink with a base.**
- **Methyl orange** is originally orange in colour. **It turns into the red with acid and turns into yellow with base.**

| Indicator | Original Colour | Colour in Acid | Colour in Base |
|---|---|---|---|
| Red litmus | Red | No Change | Blue |
| Blue litmus | Blue | Red | No change |
| Turmeric | Yellow | No Change | Reddish brown |
| Phenolphthalein | Colourless | Colourless | Pink |
| Methyl Orange | Orange | Red | Yellow |

- **Acids:** Acids are sour in taste, turn blue litmus red, and dissolve in water to release $H^+$ ions. **Example:** Sulphuric acid ($H_2SO_4$), Acetic Acid ($CH_3COOH$), Nitric Acid ($HNO_3$) etc.
  **Properties of Acids:**
  - Acids have a sour taste.
  - Turns blue litmus red.
  - Acid solution conducts electricity.
  - L Release $H^+$ ions in aqueous solution.

## Types of Acids

Acids are divided into two types on the basis of their occurrence. Natural acids and Mineral acids.

**(i). Natural Acids:** Acids which are obtained from natural sources are called Natural Acids or Organic Acids.

**Examples :** Methanoic acid (HCOOH), Acetic acid ($CH_3COOH$), Oxalic acid ($C_2H_2O_4$) etc.

| **Organic Acids And Their Sources** | |
|---|---|
| **Acid** | **Source** |
| Acetic acid | Vinegar |
| Ascorbic acid | Guava, Amla |
| Citric acid | Lemon, Orange and Other Citrus Fruits |
| Lactic acid | Sour Milk, Curd |
| Methanoic acid | Ant sting, Bettle sting |
| Oxalic acid | Tomato |
| Tartaric acid | Tamarind |

**(ii) Mineral Acids :** Acids that are prepared from minerals are known as Mineral Acids Example: Inorganic acids, man-made acids or synthetic acid are also known as Mineral Acids. **Examples :** Hydrochloric acid (HCl), Sulphuric acid **($H_2SO_4$)**, Nitric acid **($HNO_3$)**, Carbonic acid **($H_2CO_3$),** Phosphoric acid **($H_3PO_4$)** etc.

## Chemical Properties of Acids

**(i) Reaction of Acids with Metal :** Acids give hydrogen gas along with respective salt when they react with a metal.

**Metal + Acid → Salt + Hydrogen**

**Examples: (a)** Hydrogen gas ($H_2$) and Zinc chloride [$ZnCl_2$] are formed when Hydrochloric acid [HCl] reacts with Zinc (Zn) metal.

**$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$**

**(b)** Hydrogen gas **[$H_2$]** and Sodium sulphate [$Na_2SO_4$] are formed when Sulphuric acid [$H_2SO_4$] reacts with sodium metal.

**$2Na + H_2SO_4 \rightarrow Na_2SO_4 + H_2$**

- **Test For Hydrogen Gas :** The gas evolved after reaction of acid with metal can be tested by bringing a lighted candle near it. If the gas bums with a pop sound, then it confirms the evolution of hydrogen gas. **Burning with pop sound is the characteristic test for hydrogen gas**.

**(ii). Reaction of Acids with Metal Carbonate :** Acids give carbon dioxide gas and respective salts along with water when they react with metal carbonates.

**Metal carbonate + Acid → Salt + Carbon dioxide + Water**

**Example:** **$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$**

**(iii) Reaction of Acid with Hydrogen Carbonates (Bicarbonates) :** Acids give carbon dioxide gas, respective salt and water when they react with metal hydrogen carbonate.

**Metal hydrogen carbonate + Acid → Salt + Carbon dioxide + Water**

**Example : $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$**

- **Test For Evolution of Carbondioxide Gas:** Carbon dioxide turns lime water milky when passed through it. This is the characteristic test for carbon dioxide gas. The gas evolved because of reaction of the acid with metal carbonate or metal hydrogen carbonate turns lime water milky. This shows that the gas is carbon dioxide gas. This happens because of the formation of a white precipitate of calcium carbonate.

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s)\downarrow + H_2O.$$
$$CaCO_3(s) + H_2O(l) + CO_2(g) \rightarrow Ca(HCO_3)_2(aq)$$

But when excess of carbon dioxide is passed through lime water, it makes milky colour of lime water disappear. This happens because of formation of calcium hydrogen carbonate. As calcium hydrogen carbonate is soluble in water, thus, the milky colour of solution mixture disappears.

**(iv). Reaction of Acid with Metal Oxides: Metal oxides are basic in nature.** Thus, when an acid reacts with a metal oxide both neutralize each other. In this reaction, the respective salt and water are formed.

**Acid + Metal Oxide → Salt + Water**

**Example :** Calcium is a metal, thus, calcium oxide is a metallic oxide which is basic in nature. When an acid, such as hydrochloric acid, reacts with calcium oxide, neutralization reaction takes place and calcium chloride, along with water is formed.

**2 HCl (g) + CaO (s) → CaCl2 (s) + H2O (l) (Neutralisation Reaction)**

**Common in Acids:** The dissociation of hydrogen ion in aqueous solution is the common property in all acids. Because of the dissociation of hydrogen ion in aqueous solution, an acid shows acidic behaviour.

**Examples :** Hydrochloric acid (HCl) gives hydrogen ion ($H^+$) and chloride ion ($Cl^-$) when it is dissolved in water. $\mathbf{HCl \rightarrow H^+ + Cl^-}$

Acetic acid ($CH_3COOH$) gives acetate ion ($CH_3COO^-$) and hydrogen ion ($H^+$).

$\mathbf{CH_3COOH \rightarrow CH_3COO^- + H^+}$

| **Strong acids** (Completely ionises in water and produces ($H^+$)) | **Weak Acids** [Partially ionises in water and produces a small amount of hydrogen ions ($H^+$)] |
|---|---|
| **Hydrochloric acid (HCl)** | **Acetic acid ($CH_3COOH$)** |
| **Sulphuric acid ($H_2SO_4$)** | **Carbonic acid ($H_2CO_3$)** |
| **Nitric acid ($HNO_3$)** | **Oxalic acid ($H_2C_2O_4$)** |

**When a concentrated solution of acid is diluted by mixing water, then the concentration of Hydrogen ions ($H^+$) or hydronium ion ($H_3O^+$) per unit volume decreases.**

- **Dry HCl is the gaseous form of hydrochloric acid (HCl). It's made up of only HCl molecules and doesn't contain free hydrogen ions (H+). So that it is regarded as neutral substance.**

**BASES:** Bases are bitter in taste, have soapy touch, turn red litmus blue and give hydroxide ions ($OH^-$) in aqueous solution.

**Examples:** Sodium hydroxide (Caustic Soda) – NaOH, Calcium hydroxide – $Ca(OH)_2$
Potassium hydroxide (Caustic Potash) – (KOH)

**Properties of Bases:**

- Have a bitter taste.
- Turns red litmus blue.
- Release $OH^-$ ions in Aqueous Solution
- Soapy to touch.
- Conducts electricity in solution.

**Types of Bases:** Bases can be divided in two types – Water soluble and Water-insoluble. The hydroxide of alkali and alkaline earth metals are soluble in water. These are also known as alkali.

**Example:** Sodium hydroxide, Magnesium hydroxide, Calcium hydroxide, etc. Alkali is considered a strong base.

## Chemical Properties Of Bases

**(i) Reaction of Base with Metals:**

When alkali (base) reacts with metal, it produces salt and hydrogen gas.

**Alkali + Metal → Salt + Hydrogen**

**Examples:** Sodium hydroxide gives hydrogen gas and sodium zincate when reacts with zinc metal.

$$Zn\ (s) + 2\ NaOH\ (aq) \rightarrow 2\ Na_2ZnO_2\ (aq) + H_2\ (g)$$

Sodium zincate

**(ii) Reaction of Base with Non-metalic oxide: Non-metal oxides are acidic in nature.**

**Example:** carbon dioxide is a non-metal oxide. When carbon dioxide is dissolved in water it produces carbonic acid. Therefore, when a base reacts with non-metal oxide, both neutralize each other resulting respective salt and water.

**Base + Non-metal oxide → Salt + Water**

**Examples : (a)** Sodium hydroxide [NaOH] gives Sodium carbonate [$Na_2CO_3$] and water when it reacts with carbon dioxide.

$$2\ NaOH\ (s) + CO_2\ (g) \rightarrow Na_2CO3\ (aq) + H_2O\ (l)$$

(b) Calcium hydroxide gives calcium carbonate and water when it reacts with carbon dioxide.

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

**(iii) Neutralisation Reaction:** An acid neutralizes a base when they react with each other and respective salt and water are formed.

**Acid + Base → Salt + Water**

**Examples:** (a) Sodium chloride [NaCl] and water are formed when Hydrochloric acid [HCl] reacts with Sodium hydroxide [NaOH](a strong base).

$$HCl + NaOH \rightarrow NaCl + H_2O$$

(b) calcium chloride is formed along with water when hydrochloric acid reacts with calcium hydroxide (a base).

$$2HCl + Ca(OH)_2 \rightarrow 2CaCl_2 + 2H_2O$$

- **Common in All Bases:** A base dissociates hydroxide ion ($OH^-$) in water, which is responsible for the basic behaviour of a compound.

Example: When sodium hydroxide is dissolved in water, it dissociates as hydroxide ion and sodium ion.

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

Similarly, when Potassium hydroxide [KOH] is dissolved in water, it dissociates as hydroxide [$OH^-$] and potassium ion [$K^+$].

$$KOH \rightarrow K^+ + OH^-$$

**Thus, the base shows its basic character because of dissociation of hydroxide ion.**

| **Strong Bases** (Completely ionises in water and produces $OH^-$ ions) | **Weak Bases** (Partially ionises in water and produces a small amount of $OH^-$ ions) |
|---|---|
| **Sodium hydroxide (NaOH)** | **Ammonium hydroxide ($NH_4OH$)** |
| **Potassium hydroxide (KOH)** | **Aluminium hydroxide $Al(OH)_3$** |
| **Calcium hydroxide $Ca(OH)_2$** | **Copper hydroxide $Cu(OH)_2$** |

- **Dilution of Acids and Bases :** The concentration of hydrogen ion in an acid and hydroxide ion in a base, per unit volume, shows the concentration of acid or base.

By mixing of acid to water, the concentration of hydrogen ion per unit volume decreases. Similarly, by addition of base to water, the concentration of hydroxide ion per unit volume decreases. **This process of addition of acid or base to water is called Dilution and the acid or base is called Diluted.**

**The dilution of acid or base is exothermic. Thus, acid or base is always added to water and "Water is Never Added to Acid or Base". If water is added to a concentrated acid or base, a lot of heat is** generated, which may cause splashing out of acid or base and may cause severe damage as concentrated acid and base are highly corrosive. **Add Acid to Water slowly and Not Water to Acid.**

- **Strength of Acids and Bases :**

**To Find the Strength of Acids and Bases Quantitatively, Universal Indicators and pH Scale is Used.**

Using a litmus paper, phenolphthalein, methyl orange, etc. only the acidic or basic character of a solution can be determined, but the use of these indicators does not give the idea about the strength of acid or base. So, to get the strength as well as acidic and basic nature of a given solution universal indicator is used.

**Universal Indicator:** A universal indicator is a mixture of different types of indicators that exhibits different coloration at different pH levels.

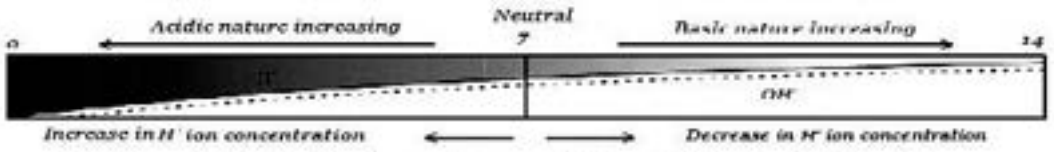
**Universal indicator shows different colours at different concentrations of hydrogen ions in a given solution.**

| S.No. | Solution | Colur of pH paper | Approximate pH value | Nature of substance |
|---|---|---|---|---|
| 1 | Saliva (before meal) | Blue | 7.4 | Basic |
| 2 | Saliva (after meal) | Yellow | 5.8 | Acidic |
| 3 | Lemon juice | Red | 2.3 | Acidic |
| 4 | Colourless aerated drink | Red-orange | 3 | Acidic |
| 5 | Carrot juice | Yellowish green | 6 | Acidic |
| 6 | Coffee | Yellow | 5 | Acidic |
| 7 | Tomato juice | Orange | 4.1 | Acidic |
| 8 | Tap water | Greenish blue | 7.4 | Basic |
| 9 | 1M NaOH | Dark violet | 14 | Acidic |
| 10 | 1M HCl | Dark red | 0 | Acidic |

**pH Scale:** It is based on hydronium ion concentration (or hydrogen ion concentration). Higher the hydronium ion ($H_3O^+$) concentration lower the pH value.

**The negative logarithmic value of hydrogen ion concentration is called pH.**

$$pH = -\log_{10}[H^+] \quad \text{(or)} \quad pH = 1/\log_{10}[H^+]$$



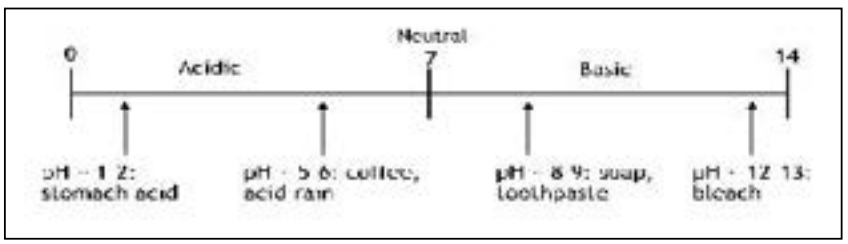

*Variation of pH with the change in concentration of $H^+(aq)$ and $OH^-(aq)$ ions*

**For water or neutral solutions : pH = 7**

**For acidic solutions : pH < 7**

**For basic solution : pH > 7**

**pH Value of Substances Used In Everyday Life**:




(i) **pH in Our Digestive System:** Dilute HCl (Hydrochloric acid) helps in digestion of food (proteins) in our stomach. Excess acid in stomach causes acidity (indigestion). Antacids like magnesium hydroxide **[$Mg(OH)_2$]**
**[$Mg(OH)_2$] also known as milk of magnesia and sodium hydrogen carbonate (baking soda) are used to neutralize excess acid.**

(ii) **Tooth Decay Caused by Acids:** The bacteria present in our mouth converts the sugar into acids. When the pH of acid formed in the mouth falls below 5.5, tooth-decaying starts. The excess acid has to be removed by cleaning the teeth with a good quality tooth paste because these kinds of **toothpaste are alkaline in nature.**

(iii) **Soil of pH and Plant Growth:** Most of the plants have a healthy growth when the soil has a specific pH (close to 7) range which should be neither alkaline nor highly acidic.

## SALTS

Salts are the ionic compounds which are produced after the neutralization reaction between acid and base. **Salts are electrically neutral**. There are number of salts but sodium chloride is the most common among them. **Sodium chloride is also known as table salt or common salt**. Sodium chloride is used to enhance the taste of food.

**The Salt (NaCl) Satyagraha was named after the salt tax imposed by the British government, which Gandhi and his followers broke by making salt from sea water.**

**Characteristics of Salt:**

- Most of the salts are crystalline soild.
- Salts may be transparent or opaque.

- Most of the salts are soluble in water.
- Solution of the salts conducts electricity in their molten state also.
- The salt may be salty, sour, sweet, bitter and umami (savoury).
- Neutral salts are odourless.
- Salts can be colourless or coloured.

- **Family of Salts :** Salts having common acidic or basic radicals are said to belong to the same family.

**Example:**

**(i)**. Sodium chloride (NaCl) and Calcium chloride ($CaCl_2$) belongs to chloride family.
**(ii)**. Calcium chloride ($CaCl_2$) and Calcium sulphate ($CaSO_4$) belongs to calcium family.
**(iii)**. Zinc chloride ($ZnCl_2$) and Zinc sulphate ($ZnSO_4$) belongs to the zinc family.

| ACID | BASE | SALT | pH value |
|---|---|---|---|
| Strong (HCl) | Strong (NaOH) | Neutral (NaCl) | = 7 |
| Strong (HCl) | Weak ($NH_4OH$) | Acidic ($NH_4Cl$) | < 7 |
| Weak ($CH_3COOH$) | Strong (NaOH) | Basic ($CH_3COONa$) | > 7 |
| Weak($CH_3COOH$) | Weak ($NH_4OH$) | Almost Neutral ($CH_3COONH_4$) | Typically 7 |

| Salt | Formed from | | pH value |
|---|---|---|---|
| | Acid - Nature | Base - Nature | |
| $Na_2CO_3$ | $H_2CO_3$ - Weak | NaOH - Strong | > 7 |
| $NaHCO_3$ | $H_2CO_3$ - Weak | NaOH - Strong | > 7 |
| $CuSO_4$ | $H_2SO_4$ - Strong | $Cu(OH)_2$ - Weak | < 7 |
| $ZnSO_4$ | $H_2SO_4$ - Strong | $Zn(OH)_2$ - Weak | < 7 |
| $KNO_3$ | $HNO_3$ - Strong | KOH - Strong | = 7 |
| $AlCl_3$ | HCl – Strong | $Al(OH)_3$ - Weak | < 7 |

## SOME IMPORTANT CHEMICAL COMPOUNDS:

| Compound | Chemical Name | Preparation &Reaction | Uses |
|---|---|---|---|
| **Common Salt/ Table Salt (NaCl)** | **Sodium Chloride** | It is formed after the reaction between sodium hydroxide and hydrochloric acid. **$HCl + NaOH \rightarrow NaCl + H_2O$** | Used in food, water softening, chemical industry, and as a preservative |
| **Caustic Soda (NaOH)** | **Sodium Hydroxide** | Produced by electrolysis of brine (chlor-alkaliprocess). **Reaction:** **$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$** * **Chlorine gas at anode and hydrogen gas at cathode released** * **Aqueous NaCl is called Brine solution** | Used in soap, paper, textiles, drain cleaners, and chemical manufacturing |
| **Baking soda ($NaHCO_3$)** | **Sodium Bicarbonate /Sodium hydrogen carbonate** | **Produced by reacting $CO_2$ with $Na_2CO_3$ or NaOH. Reaction: $Na_2CO_3 + CO_2 + H_2O \rightarrow 2NaHCO_3$** | **Used in baking, medicine (antacid), fire extinguishers, and cleaning agents** |
| **Washing soda ($Na_2CO_3.10H_2O$)** | **Sodium Carbonate. decahydrate** | **Manufactured using $NaHCO_3$ obtained from Solvay process Reaction: $2NaHCO_3$ + heat $\rightarrow$ $Na_2CO_3 + CO_2 + H_2O$ $Na_2CO_3 + 10\ H_2O \rightarrow Na_2CO_3.10H_2O$** | Used in glassmaking, detergents, water treatment, and textile processing |
| **Bleaching Powder ($CaOCl_2$)** | **Chloride of lime** | **Produced by reacting chlorine gas with dry slaked lime. Reaction: $Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$** | Used for water purification, disinfecting, bleaching fabrics and paper, and as an oxidizer in chemical industries |
| **Gypsum ($CaSO_4 \cdot 2H_2O$)** | **Calcium sulphate di hydrate** | **Found naturally or obtained as a byproduct of industrial processes. Reaction:** | Used in cement, fertilizers, plaster, and as a soil |

| | | | |
|---|---|---|---|
| | | **$CaO + H_2SO_4 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O$** | conditioner |
| **Plaster of Paris ($CaSO_4 \cdot ½H_2O$)** | **Calcium sulphate hemihydrate** | **Produced by heating gypsum to remove water.**<br>**Reaction:**<br>**$CaSO_4 \cdot 2H_2O \rightarrow$**<br>**$CaSO_4 \cdot ½H_2O + 1.5H_2O$ (on heating)** | Used in construction, sculpture, medical casts, and mold-making |

- **Baking Powder:**

Baking powder is the mixture of baking soda and a mild edible acid. Generally, tartaric acid is mixed with baking soda to make baking powder.When baking powder is heated, sodium hydrogen carbonate ($NaHCO_3$) decomposes to give $CO_2$ and sodium carbonate ($Na_2CO_3$). $CO_2$ causes bread and cake fluffy. Tartaric acid helps to remove bitter taste due to formation of $Na_2CO_3$.

**$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O$ + Sodium salt of acid**

**The Water of Crystallization:**

Many salts contain water molecule and are known as Hydrated Salts**.**

**The water molecule present in salt is known as Water of crystallization.**

Salts containing water of crystallisation do not appear wet because the water molecules are trapped within the crystal lattice and are not free liquid water, meaning they are chemically bound and not readily available to moisten anything; therefore, the salt appears dry despite having water molecules present

**Examples:**

**Copper sulphate pentahydrate ($CuSO_4.5H_2O$): Blue colour of copper sulphate is due to presence of 5 molecules of water.** When copper sulphate is heated, it loses water molecules and turns: into grey – white colour, which is known as anhydrous copper sulphate. After adding water, anhydrous copper sulphate becomes blue again.

| Name of the salt Hydrated | Formulae | Number of Water Molecules |
|---|---|---|
| Copper Sulphate (Blue vitriol) | **$CuSO_4.5H_2O$** | 5 |
| Sodium Carbonate (Washing soda) | **$Na_2CO_3.10H_2O$** | 10 |
| Gypsum | **$CaSO_4 . 2 H_2O$** | 2 |
| Plaster of Paris | **$CaSO_4 . ½ H_2O$** | 1/2 |

# MULTIPLE CHOICE QUESTIONS

**1. The pH of the gastric juices released during digestion is …**

(a) less than 7 (b) more than 7 (c) equal to 7 (d) equal to 0

**2. Which of the following is acidic in nature?**

(a) Lime juice (b) Human blood (c) Lime water (d) Antacid

**3. Which of the following is not a mineral acid?**

(a) Hydrochloric acid (b) Citric acid

(c) Sulphuric acid (d) Nitric acid

**4. Which of the following statements is true for acids?**

(a) Bitter and change red litmus to blue (b) Sour and change red litmus to blue

(c) Sour and change blue litmus to red (d) Bitter and change blue litmus to red

**5. What happens when a solution of an acid is mixed with a solution of a base in a test tube?**

**(i) The temperature of the solution increases**

**(ii) The temperature of the solution decreases**

**(iii) The temperature of the solution remains the same**

**(iv) Salt formation takes place**

(a) (i) only (b) (i) and (iii) (c) (ii) and (iii) (d) (i) and (iv)

**6. Sodium carbonate is a basic salt because it is a salt of…**

(a) Strong acid and Strong base (b) Weak acid and Weak base

(c) Strong acid and Weak base (d) Weak acid and Strong base

**7. Which of the following gives the correct increasing order of acidic strength?**

(a) Water < Acetic acid < Hydrochloric acid

(b) Water < Hydrochloric acid < Acetic acid

(c) Acetic acid < Water < Hydrochloric acid

(d) Hydrochloric acid < Water < Acetic acid

**8. To protect tooth decay we are advised to brush our teeth regularly.**

**The nature of the tooth paste commonly used is…..**

(a) Acidic (b) Neutral (c) Basic (d) Corrosive

**9. Which of the following phenomena occur, when a small amount ofacid is added to water?**

**(i) Ionisation (ii) Neutralisation (iii) Dilution (iv) Salt formation**

(a) (i) and (ii) (b) (i) and (iii) (c) (ii) and (iii) (d) (ii) and (iv)

**10. Identify the correct representation of reaction occurring duringChlor-alkali process?**

(a) $2NaCl(l) + 2H_2O(l) \rightarrow 2NaOH(l) + Cl_2(g) + H_2(g)$

(b) $2NaCl(aq) + 2H_2O(aq) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$

(c) $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(aq) + H_2(aq)$

(d) $2NaCl\ (aq) + 2H_2O\ (l) \rightarrow 2NaOH\ (aq) + Cl_2(g) + H_2(g)$

**11. Which one of the following salts does not contain water of crystallisation?**

(a) Blue vitriol (b) Baking soda (c) Washing soda (d) Gypsum

**12. Tomato is a natural source of which acid?**

(a) Acetic acid (b) Citric acid (c) Tartaric acid (d) Oxalic acid

**13. Brine is an……**

(a) Aqueous solution of sodium hydroxide (b) Aqueous solution of sodium carbonate

(c) Aqueous solution of sodium chloride (d) Aqueous solution of sodium bicarbonate

**14. $Na_2CO_3 . 10H_2O$ is**

(a) Washing soda (b) Baking soda (c) Bleaching powder (d) Tartaric acid

**15. Alkalis are**….

(a) Acids, which are soluble in water (b) Acids, which are insoluble in water

(c) Bases, which are insoluble in water (d) Bases, which are soluble in water

**16. Lime water reacts with chlorine to give…**

(a) Bleaching powder (b) Baking powder

(c) Baking soda (d) Washing soda

**17. Rain is called acid rain when its…**

(a) pH falls below 7 (b) pH falls below 6

(c) pH falls below 5.6 (d) pH is above 7

**18. Dry HCl nature?**

(a) Basic (b) Neutral (c) Strong acid (d) Weak acid

**19. Which of the following are present in a dilute Aqueous solution of hydrochloric acid?**

(a) $H_3O^+ + Cl^-$ (b) $H_3O^+ + OH^-$ (c) $Cl^- + OH^-$ (d) Unionised HCl

**20. Sodium carbonate reacts with hydrochloric acid and produces –**

(a) NaCl (b) $CO_2$ (c) $H_2O$ (d) All of the above

**21. Match the chemical substances givenin column (A) with their appropriateapplication given in column (B)**

| **Column (A)** | **Column (B)** |
|---|---|
| **A. Bleachingpowder** | **(i) Preparation of glass** |
| **B. Baking soda** | **(ii) Production of $H_2$ and $Cl_2$** |
| **C. Washing soda** | **(iii) Decolorization** |
| **D. Sodium chloride** | **(iv) Antacid** |

(a). A - (ii), B - (i), C - (iv), D - (iii) (b). A - (iii), B - (ii), C - (iv), D - (i)

(c). A - (iii), B - (iv), C - (i), D - (ii) (d). A - (ii), B - (iv), C - (i), D - (iii)

**22. Which of the following are correctly matched?**

**1. Acid + salt → metal + hydrogen**

**2. Acid + metal carbonate → salt + carbon dioxide + water**

**3. Metal oxide + acid → salt + water**

(a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3

**23. A solution in test tube 'A' turns red litmus blue, evolves hydrogen gas on reaction with zinc and does not react with sodium carbonate. Whereas, solution in test tube ' ' B turns blue litmus red, liberates hydrogen gas on reaction with zinc and evolves carbon dioxide gas with sodium carbonate. Identify 'A' and 'B' .**

(a) 'A' is an acid, 'B' is a base. (b) 'A' is a base, 'B' is an acid.

(c) Both 'A' and 'B' are bases. (d) Both 'A' and 'B' are acids.

**24. $ZnSO_4$ salt is formed from the combination of**

(a). Strong acid - Srtong base (b). Strong acid-Weak base

(c). Weak acid- Strong base (d). Weak acid- Weak base

**25. 1M HCl shows which Colour in pH paper that impregnated with universal indicator.**

(a). Red (b). Orange (c). Yellow (d). Blue

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. a** | **2. a** | **3. b** | **4. c** | **5. d** | **6. d** | **7. a** | **8. c** | **9. b** | **10. d** |
| **11. b** | **12. d** | **13. c** | **14. a** | **15. d** | **16. a** | **17. c** | **18. b** | **19. a** | **20. d** |
| **21. c** | **22. b** | **23. b** | **24. b** | **25. a** | | | | | |

## POLYCET PREVIOUS QUESTIONS

**POLYCET – 2024:**

**1. Which of the following can be used as acid-base indicator to detect acidic or basic nature of solution**

(a). Turmeric solution (b). Litmus

(c). a & b (d). None of these

**2. If pH of rain water is less than _____, then it is called acid rain.**

(a). 5.6 (b). 7.6 (c). 6.6 (d). 8.6

**3. What do you observe on pouring potassium hydroxide on red and blue litmus papers?**

(a). Red litmus remains red ad blue litmus turns to red

(b). Red litmus turns to blue and blue litmus remains like

(c). Red litmus becomes colorless and blue litmus remains blue

(d).Red litmus turns to blue and blue litmus turns to red

**POLYCET – 2023:**

**4. $CH_3COOH$ solution turns red litmus into**

(a). Blue (b). Remains red (c). Colourless (d). None of these

**5. $2HCl + Zn \rightarrow$?**

(a). $ZnCl_2$ (b). $ZnCl_2 + Cl_2$ (c). $H_2$ (d). $ZnCl_2 + H_2$

**6. Methyl orange shows _____ colour in acidic solution.**

(a). Yellow (b). Red (c). Green (d). Blue

**POLYCET – 2022:**

**7. Which of the following is / are used to detect acidic or basic nature of a solution?**

(a). Phenolphthalein (b). Metals

(c). Universal Indicator (d). All of these

**8. Which of the following can't be used as X in the following equation?**
**Acid + X → Salt + $CO_2$ + Water**

(a). Metal Hydrogen Carbonates (b). Metal Carbonates

(c). a & b (d). Metal hydroxides

**9. Which of the following metal liberates Hydrogen gas on reaction with NaOH**

(a). Zn (b). Ca (c). Mg (d). Na

**10. What is the pH of salt formed from weak acid and strong base?**

(a). 3 (b). 9 (c). 7 (d). 5

**POLYCET - 2021:**

**11. Which of the following character is used in olfactory indicator?**

(a). Colour Change (b). Odour (c). Taste (d). None

**12. What happens when litmus paper test is performed with an acid?**

(a). Red litmus turns to blue (b). Red litmus turns to yellow

(c). Blue litmus turns to red (d). Blue litmus turns to yellow

**13. When $Na_2CO_3$ reacts with an acid, which of the following gases is evolved?**

(a). $H_2$ (b). $N_2$ (c). $O_2$ (d). $CO_2$

**14. An antacid is**

(a). A salt (b). An acid (c). A base (d). An acid (or) base

**POLYCET – 2020:**

**15. The chemical name of baking soda is**

(a). Sodium carbonate (b). Calcium hydrogen carbonate

(c). Calcium carbonate (d). Sodium hydrogen carbonate

**16. The colour of methyl orange in alkaline medium (basic) is**

(a). orange (b). Yellow (c). Red (d). Blue

**17. Which one of the following types of medicine is used for treating indigestion?**

(a). Antibiotuic (b). Analgesic (c). Antacid (d). Antiseptic

**18. The number of water molecules present in one formula unit of gypsum is**

(a). Two (b). Half (½) (c). Five (d). One

**POLYCET – 2019:**

**19. The colour of methyl orange indicator in HCl is**

(a). Pink (b). Colourless (c). Yellow (d). Blue

**20. The Chemical name of Plaster of Paris is**

(a). Calcium sulphate monohydrate (b). Calcium sulphate

(c). Calcium sulphate dihdrate (d). calcium sulphate hemihydrate

**21. Which of the following is an example of acid?**

(a). Dry HCl (b). Aqueous HCl

(c). NaOH (d). $NH_4OH$

**22. Which of the following is an example for neutralization reaction?**

(a). Base + Salt → Acid + Water (b). Acid + Salt → Base + Water

(c). Acid + Base → Salt + Water (d). Base + Water → Acid + Salt

**POLYCET – 2018**:

**23. The Chemical Formula of Bleaching powder is**

(a). $CaOCl_2$ (b). $Ca(OH)_2$ (c). CaO (d). $Ca(HCO_3)_2$

**24. Which of the following solutions converts blue litmus paper to red?**

(a). HCl or $HNO_3$ (b). KOH (c). NaOH (d). $Na_2CO_3$

**25. The pH of blood is in between**

(a). 7 – 8 (b). 6 – 7 (c). 4 – 5 (d). 13 – 14

**26. Match the following [POLYCET – 2016]**

| | |
|---|---|
| **a. Caustic soda** | **(i) $NaHCO_3$** |
| **b. Baking soda** | **(ii) $CaSO_4 . 2H_2O$** |
| **c. Gypsum** | **(iii) $CaSO_4 . ½ H_2O$** |
| **d. Plaster of Paris** | **(iv) NaOH** |

(a). a – (i), b – (ii), c – (iii), d – (iv) (b). a – (i), b – (iv), c – (iii), d – (ii)

(c). a – (iv), b – (i), c – (iii), d – (ii) (d). a – (iv), b – (i), c – (ii), d – (iii)

**POLYCET – 2017:**

**27. The pH of milk of magnesia is**

(a). 7 – 8 (b). 6 – 7 (c). 10 – 11 (d). 4 – 5

**28. Which of the following salt solutions is basic in nautre?**

(a). NaCl (b). $NH_4Cl$ (c). $Na_2CO_3$ (d). KCl

**POLYCET – 2016:**

**29. Which of the following salt solutions has pH greater than seven?**

**(a).** $CH_3COOH$ (b). $NH_4Cl$ (c). NaCl (d). $CH_3COONa$

**30. $HCl + H_2O \rightarrow X + Cl^-$. The X may be**

(a). $H_3O^+$ (b). $OH^-$ (c). HOCl (d). $H_2O^+$

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. c** | **2. a** | **3. b** | **4. b** | **5. d** | **6. b** | **7. d** | **8. d** | **9. a** | **10. b** |
| **11. b** | **12. c** | **13. d** | **14. c** | **15. d** | **16. b** | **17. c** | **18. a** | **19. a** | **20. d** |
| **21. b** | **22. c** | **23. a** | **24. a** | **25. a** | **26. d** | **27. c** | **28. c** | **29. d** | **30. a** |

* * *

# 3. METALS AND NON-METALS

## Properties of Metals:

- These are hard solids except Mercury (Hg) at room temperature. Mercury is in liquid state at room temperature.
- They have high melting & boiling point and density. Gallium and Caesium will have very low melting point.
- Metals have Lustre, Malleable, ductile and sonority.
  Metallic Lustre means shiny surface.
  Malleability means ability to form thin sheets. **Most malleable metals are Gold and Silver.**
  Ductility means ability to drawn into thin wires.
  **Sonority means ability to produce sound. The metals that produce a sound on striking a hard surface are said to be 'sonorous.**
  **Ex.:** School bells are made of metals. Because, they are sonorous.
- Metals are good conductors of heat and electricity due to free mobile electrons.
- The best first conductor is silver (Ag). The second best conductor is copper (Cu). Merucry (Hg) and Lead (Pb) are poor conductors of heat.
- The current carrying metallic wires are coated with PVC (Polyvinylchloride) or rubber like material. Because they are non-conductors (Insulators).
- Graphite and Diamond are allotrope of carbon (non-metal). Graphite [Carbon] conducts electricity. Diamond is the hardest substance and have high melting and boiling point.
- Iodine is a non-metal, but it is lustrous.
- Alkali metals (Lithium (Li), Sodium (Na) and Potassium (K) are soft and they can be cut with knife. They have low densities and low melting points.
- Metal oxides are basic nature. Metals combine with oxygen to form metal oxides.

  **Metal + Oxygen → Metal Oxide**

  **Ex.:1.** $2Cu + O_2 \rightarrow 2CuO$
  **(Copper) (Copper(II)oxide)**

  **Ex.:2** $4Al + 3O_2 \rightarrow 2Al_2O_3$
  **(Aluminium) (Aluminium oxide)**
- Aluminium oxide ($Al_2O_3$) and Zinc oxide (ZnO) show both acidic nature and basic nature. They are amphoteric oxides**. Metal oxides which react with both acids and bases to produce salts and water are known as "Amphoteric oxides"**.

  $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
  **(Aluminium chloride)**

  $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$
  **(Sodium aluminate)**

  **Gold and Silver do not react with oxygen even at high temperature.**
- **Metal oxides react with water to form alkalies (Bases).** Sodium oxide **($Na_2O$)** dissolve in water to form Sodium hydroxide (**NaOH**). Potassium oxide**($K_2O$)** dissolve in water to form Potassium hydroxide. **(KOH)**

  $Na_2O(s) + H_2O(l) \rightarrow 2NaOH(aq)$
  $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

- **Anodising** is a process of forming a thick oxide layer of aluminium. Aluminium develops a **thin oxide layer** when exposed to air. This **aluminium oxide coat** makes it **resistant** to further **corrosion.**
- Magnesium is less reactive than Sodium. **Potassium and Sodium are kept in Kerosene, petrol to prevent fire accidents.**
- When copper is heated it does not burn. But the surface is coated with black colour layer of Copper(II)oxide. Iron does not burn on heating but iron filings burn vigorously when sprinkled in the flame.
- Metals react with water and produce metal oxide and hydrogen gas. Metal oxides dissolve in water to form metal hydroxides.

  **Metal + Water → Metal oxide + Hydrogen**

  **Metal oxide + Water → Metal hydroxide**
- Sodium and Potassium are more reactive with cold water. Calcium is less reactive with cold water. Magnesium does not react with cold water. It reacts with hot water.

  **$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g) +$ heat energy [Reaction of K with water]**

  **$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) +$ heat energy**

  **$Ca(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + H_2(g)$ [Reaction of Ca with water]**

  **$Mg(s) + Hot\ 2H_2O(l) \rightarrow Mg(OH)_2(aq) + H_2(g)$**
- Aluminium, Iron and Zinc do not react with either cold water or hot water. They react with steam to form metal oxide and hydrogen.

  **$2Al(s) + 3H_2O(g) \rightarrow Al_2O_3(s) + 3H_2(g)$**

  **$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$ [Reaction of Iron with steam]**

  **Lead, copper, silver and gold do not react with water (Cold & Hot, steam).**
- **Metals react with acids to give a salt and hydrogen gas.**

  **Metal + Dilute acid → Salt + Hydrogen**

  **$Mg + 2HCl \rightarrow MgCl_2 + H_2$**

  **$2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$**

  **$Zn + 2HCl \rightarrow ZnCl_2 + H_2$**

  **$Fe + 2HCl \rightarrow FeCl_2 + H_2$**

  **$Fe + H2SO4 \rightarrow FeSO_4 + H_2$**

  **The decreasing order of reactivity with dilute acids: Mg > Al > Zn > Fe.**

  Copper [Cu] does not react with dilute HCl.
- **Aqua Regia [Royal Water] : 3:1** ratio of concentrated hydrochloric acid and concentrated nitric acid. **[3:1 HCl & $HNO_3$]**. It can dissolve gold and platinum. It is a highly corrosive, fuming liquid.

## Reactivity / Electrochemical Series

- **Electro chemical Series/Reactivity Series:** A series of metals which are arranged in the decreasing order of reactivity is called electrochemical series (or) Activity series.

  **Descending order of reactivity: K > Na > Ca > Mg > Al > Zn > Fe > Pb > Cu > Ag > Au**
- Based on reactivity metals are divided into three groups. They are

**Electrochemical / Activity Series**:

| **K, Na, Ca, Mg, Al** | **Zn, Fe, Pb, Cu** | **Ag, Au** |
|---|---|---|
| **High Reactivity** | **Moderate Reactivity** | **Low Reactivity** |

**(i). High Reactive Metals**: K, Na, Ca, Mg, Al. They never found in Free State.

**(ii). Moderate Reactive Metals**: Zn, Fe, Pb, Cu; they found as sulphides, carbonates.
**(iii). Less Reactive Metals:** Au & Ag: They found in free state.

- **Reactive metals can displace less reactive metals from their compounds in solution.**
  **Ex. 1 :** Iron (Fe) displaces Copper (Cu) from Copper sulphate ($CuSO_4$) Solution and forms Iron sulphate ($FeSO_4$) and Copper (Cu). It is a displacement reaction. **Iron is more reactive than Copper.**

  **$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$.**

  **Ex. 2 :** Zinc (Zn) displaces Iron (Fe) from Iron (II) sulphate ($FeSO_4$) Solution and forms Zinc sulphate ($ZnSO_4$) and Iron (Fe). It is a displacement reaction. **Zinc is more reactive than Iron.**

  **$Zn\ (s) + FeSO_4\ (aq) \rightarrow ZnSO_4\ (aq) + Fe\ (s)$**

## Reactions of Metal & Non-metals

- Noble gases belongs to 'O' group or 18th group (VIIIA) have negligible reactivity compared to other elements. He, Ne, Ar, Kr, Xe, Rn are inert gases (Noble gases) and are available in air. **All the noble gases have 8 electrons in the valency shell except Helium. This is the reason for less reactivity of noble gases**
- **Bond formed between two dissimilar atoms due to transfer of electrons is called Ionic bond [Electrostatic bond (or)Electrovalent bond].**
- Ionic bond is formed between Highly reactive metals (IA & IIA) and highly reactive non-metals (VIIA). NaCl, $MgCl_2$, $Na_2O$, $AlCl_3$, KI, $BaCl_2$ etc are examples for ionic compounds.

**Formation of Sodium chloride [NaCl]:**

Metal: Sodium (Na) and Non-metal : Chlorine (Cl)

$Na \rightarrow Na^+ + e^-$ [oxidation reaction] **$Na^+$ : Sodium cation**

[2, 8, 1] [2, 8]

$Cl \rightarrow Cl^- + e^-$ [Reduction reaction] **$Cl^-$ : Chloride anion**

[2, 8, 7] [2, 8, 8]

**$Na^+ + Cl^- \rightarrow NaCl$**

**Formation of Magnesium chloride [$MgCl_2$]:**

Metal: Magnesium (Mg) and Non-metal: Chlorine (Cl)

$Mg \rightarrow Mg^{+2} + 2e^-$ [oxidation reaction] **$Mg^{+2}$ : Magnesium cation**

[2, 8, 2] [2, 8]

$Cl \rightarrow Cl^- + e^-$ [Reduction reaction] **$Cl^-$ : Chloride anion**

[2, 8, 7] [2, 8, 8]

**$Mg^{+2} + 2Cl^- \rightarrow MgCl_2$**

**Formation of Sodium oxide [$Na_2O$]:**

Metal: Sodium (Na) and Non-metal: Oxygen (O)

$Na \rightarrow Na^+ + e^-$ [oxidation reaction] **$Na^+$ : Sodium cation**

[2, 8, 1] [2, 8]

$O \rightarrow O^{-2} + 2e^-$ [Reduction reaction] **$O^{-2}$ : Oxide anion**

[2, 6] [2, 8, 8]

**$2Na^+ + O^{-2} \rightarrow Na_2O$**

**Formation of Aluminium chloride [$AlCl_3$]:**

Metal: Aluminium (Al) and Non-metal: Chlorine (Cl)

$Al \rightarrow Al^{+3} + 3e^-$ [oxidation reaction] **$Al^{+3}$ : Aluminiumcation**

[2, 8, 3] [2, 8]

$Cl \rightarrow Cl^- + e^-$ [Reduction reaction] **$Cl^-$ : Chloride anion**

[2, 8, 7] [2, 8, 8]

**$Al^{+3} + 3Cl^- \rightarrow AlCl_3$**

**Properties of Ionic Compounds:**

1. **Ionic Compounds are solids and hard**. Because of **strong electrostatic force of attraction** between cation and anion.
2. Ionic compounds have **High melting and boiling points**. Because of **strong inter-ionic attraction**.
3. Ionic compounds **are soluble in water (Polar solvent**). **Insoluble in Kerosene, petrol.**
4. Ionic compounds are **good electric conductors in aqueous state or molten state**. Because of **freely moving ions**.

## Enrichment of ores

- Sea water contains soluble salts such as sodium chloride [NaCl] and magnesium chloride [$MgCl_2$] etc.
- Gold (Au), Silver (Ag), Platinum (Pt) and Copper (Cu) are available in nature in Free State (native) as they are least reactive. Silver (Ag) and Copper (Cu) are also found in the combined state as their Sulphide (or) Oxide ores.
- **The elements or compounds of the metals which occur in nature in the earth crust are called *Minerals*.**
- **The minerals from which the metals are extracted without economical loss are called *Ores*.**

  Aluminium, is the most abundant metal in the Earth's crust.
- **Gangue (Matrix): The earthy impurities such as soil, sand associated with mineral (or) ore is called *Gangue*.**
- **Extraction of the Metals at The Top of the Activity Series:**

  Metals of high reactivity like K, Na, Ca, Mg, Al etc are obtained by **Electrolysis of their molten (or) fused ore**, but not with their aqueous solution compounds (Aqueous NaCl - Brine).

  Fused NaCl as an electrolyte on electrolysis, liberates **$Cl_2$ gas at anode and deposits Na metal at cathode.**

  **At cathode: $Na^+ + e \rightarrow Na$ [Oxidation reaction]**

  **At anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ [Reduction reaction]**

- Aluminium is obtained by the electrolytic reduction of aluminium oxide [$Al_2O_3$]
- **Extraction Of The Metals At The Bottom Of The Activity Series:**
  Less active metals like Hg, Ag & Au are obtained by heating (or) by chemical displacement from aqueous solutions.
  - HgS (Cinnabar – ore of Mercury) is heated in air. HgO (Mercuric oxide) is formed and it is then reduced to Mercury(Hg) further heating.

$$\mathbf{2HgS\ (s) + 3O_2\ (g) \xrightarrow[Air]{Heat} 2HgO\ (s) + 2SO_2\ (g).}$$

$$\mathbf{2HgO\ (s) \xrightarrow{Heat} 2Hg(l) + O_2\ (g).}$$

**Copper is obtained from $Cu_2S$ by heating in air.Auto reduction of $Cu_2O$ into Cu metal by using $Cu_2S$ by partial roasting.**

$$\mathbf{2Cu_2S\ (s) + 3O_2\ (g) \xrightarrow[Air]{Heat} 2Cu_2O\ (s) + 2SO_2\ (g).}$$

$$\mathbf{2Cu_2O + Cu_2S \xrightarrow{Heat} 6Cu\ (s) + SO_2\ (g).}$$

**• Extraction of Metals in the Middle of the Activity Series:**

Moderate Reactive Metals: Zn, Fe, Pb, Cu; they found as Sulphides or Carbonates.

- **Calcination**: lt is a process in which the ore is **heated in the absence of air** below its melting point without fusion. During calcination **carbonate ores** are converted into oxides.

**Examples:**

$$\underset{\text{(Zinc carbonate)}}{\mathbf{ZnCO_3\ (s)}} \rightarrow \underset{\text{(Zinc oxide)}}{\mathbf{ZnO\ (s)}} + \mathbf{CO_2\ (g)\uparrow}$$

$$\underset{\text{(Calcium carbonate)}}{\mathbf{CaCO_3\ (s)}} \rightarrow \underset{\text{(Calcium oxide)}}{\mathbf{CaO\ (s)}} + \mathbf{CO_2\ (g)\uparrow}$$

- **Roasting :** lt is a process in which the ore is **heated in presence of oxygen (or) air** below its melting point without fusion. During roasting **Sulphide ores** are converted into oxides

**Examples:**

$$\underset{\text{(Zinc sulphide)}}{\mathbf{2\ ZnS\ (s)}} + \mathbf{3O_2\ (g)} \rightarrow \underset{\text{(Zinc oxide)}}{\mathbf{2\ ZnO(s)}} + \mathbf{2SO_2\ (g)}$$

$$\underset{\text{Lead sulphide}}{\mathbf{2\ PbS\ (s)}} + \mathbf{3O_2\ (g)} \rightarrow \underset{\text{Lead Oxide}}{\mathbf{2\ PbO\ (s)}} + \mathbf{2\ SO_2\ (g)}$$

- **Reduction by Coke:**
  Metal oxides obtained from Calcination and Roasting are reduced to the corresponding metals by using **carbon [COKE] as reducing agent.**

$$\mathbf{ZnO\ (s) + C\ (s) \rightarrow Zn\ (s) + CO\ (g)}$$

$$\mathbf{PbO\ (s) + C\ (s) \rightarrow Pb\ (s) + CO\ (g)}$$

- **Reduction by More Active Metals [Na, Ca, Al]:**
- The displacement of less active metal like lron from its ore [$Fe_2O_3$ – Hematite] by a more active metal like Aluminium [Al] is called **Gold Schmidt Alumino Thermite Process (or) Thermite process**. lt is an **exothermic** process.

$$\mathbf{Fe_2O_3(s) + 2\ Al\ (s) \rightarrow Al_2O_3\ (s) + 2\ Fe\ (l) + Heat}$$

- ln thermite process **Al is used as reducing agent** and molten metal is obtained. This process is used in **welding of railway tracks or cracked machine parts**.

- Manganese dioxide [$MnO_2$] is reduced to Manganese [Mn] when it is heated with Aluminium [Al].

$$3MnO_2\,(s) + 4Al\,(s) \rightarrow 3Mn\,(l) + 2Al_2O_3\,(s) + Heat$$

- **Electro refining :**

• It is process that uses electrolysis to purify metals like Copper (Cu), Zinc (Zn), Tin (Sn), Nickel (Ni), Silver (Ag), Gold (Au) etc**.**

**Electrolytic refining:** ln this process **impure metal** is used as **anode**, **pure metal** is used **cathode** and **acidified salt solution** is used as **electrolyte**. During electrolysis **pure metal** is deposited at **cathode** and **impurities** are settle down as **anode mud.**

**Example:** Copper Refining

**Anode:** Impure Copper Metal**; Cathode:** Thin strip of pure Copper

**Electrolyte:** Acidified Copper sulphate [$CuSO_4$] solution**.**

Pure Copper is deposited at the cathode.

Insoluble impurities settle down at the bottom of the anode is known as **"Anode Mud"**

**Corrosion :** Silver articles become **black** when exposed to air. Because silver reacts with sulphur in the air to form **Silver sulphide (AgS).** Copper reacts with moist carbon dioxide [$CO_2$] in the air and get coated with **green coat of basic copper carbonate [$CuCO_3$].** Iron articles get rusted when they are exposed both **air and water.**

**Galvanisation of Iron :** The coating of zinc on lron/Steel metal surface to protect it from corrosion is called Galvanisation.

**Alloy:** Metals have ability to form Alloys. A homogenous mixture of two (or) more metals (or) non- metal having metallic property is called **Alloy.**

**Examples : Bronze :** [ Copper (Cu) + Tin (Sn)]; **Brass:** [Copper (Cu) + Zinc (Zn)]

**Solde**r: [Leas (Pb) + Tin (Sn)];

**Stainless Steel :** [Iron (Fe) + Nickel (Ni) + Chromium (Cr) + Carbon (C)],

- **Common metal present in the alloy known as amalgam** is **Mercury (Hg).**
- Pure gold is know is as 24 carat gold. It is very soft and suitable for making jewellery.
- **22 carat gold is known as ornament gold. 22 parts of pure gold is alloyed with 2 parts of copper (or) silver.**
- Non-metals have properties opposite to that of metals. They are neither malleable nor ductile. They are bad conductors of heat and electricity, except for graphite, which conducts electricity.
- Non-metals form negatively charged ions by gaining electrons when reacting with metals.
- Non-metals form oxides which are either acidic or neutral **Ex**. $CO_2$, $SO_2$, $SO_3$, $NO_x$.
- Non-metals do not displace hydrogen from dilute acids. They react with hydrogen to form hydrides

## EXERCISE– I

1. **Which of the following is a non-metal?**
   (a). Potassium (b) Chlorine (c) Silicon (d)) Sodium
2. **Which of the following is not the property of Ionic compounds**
   (a). Crystalline solids (b). High melting points
   (c). Insoluble in water (d). Soluble in water
3. **In which of the following ionic bond is present?**
   (a). $MgCl_2$ (b) $Na_2O$ (c) $AlCl_3$ (d) All the above
4. **How many electrons are transferred in the formation of $MgCl_2$ from Magnesium to Chlorine**.
   (a). 1 (b). 2 (c).3 (d).4
5. **The number of electrons transferred during the formation of MgO is**
   (a). 1 (b). 2 (c).3 (d).4
6. **Aqua Regia [Royal Water] is**
   (a). 3 : 1 $HCl + HNO_3$ (b). 1 : 1 $HNO_3 + HCl$
   (c). 3: 1 $HNO_3 + HCl$ (d). 3 : 3 $HNO_3 + HCl$
7. **Which of the following is correct**.
   (a). $Zn + HCl \rightarrow ZnCl_2 + H_2$ (b). $2Zn + HCl \rightarrow ZnCl_2 + H_2$
   (c). $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ (d). $2Zn + 2HCl \rightarrow ZnCl_2 + H_2$
8. **$Fe_2O_3 + 2Al \rightarrow 2Fe +$ _____**
   (a). Al (b). $2AlO_3$ (c). $Al_2O_3$ (d). $Al(O_3)_2$
9. **Which process is used in welding of railway tracks or cracked machine parts.**
   (a). Electro refining (b). Calcination (c). Roasting (d). Thermite
10. **Which metal is present in the alloy known as amalgam?**
    (a). Hg (c). Ag (c). Al (d). Au
11. **In Copper refining the anode is**
    (a). Pure Copper (b). Acidified $CuSO_4$
    (c). Impure Copper (d). Graphite
12. **Alloy containing (Pb) + (Sn)**
    (a). Solder (b). Brass (c). Bronze (d). Stainless steel
13. **The decreasing order of reactivity of Mg, Al, Zn, Fe with dilute acids:**
    (a). Mg > Al > Zn > Fe (b). Mg < Al < Zn < Fe
    (c). Mg > Al < Zn > Fe (d). Mg < Al > Zn > Fe
14. **Write the reaction of Iron with steam**
    (a). $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$
    (b). $5Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$
    (c). $3Fe(s) + 2H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$
    (d). $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 2H_2(g)$
15. **_____ is a process of forming a thick oxide layer of aluminium.**
(a). Galvanizing (b). Anodising (c) Tinning (d). Electrolysis.
16. **Which is the amphoteric oxide**
    (a). $CO_2$ (b). CaO (c). $Al_2O_3$ (d). $Na_2O$

**17. Iron is more reactive than Copper.**
(a). True (b). False (c). Both a & b (d). None

**18. Which of the following method is suitable for preventing an iron frying pan from rusting.**
(a). Applying Grease (b). Applying paint
(c). Applying coating of zinc (d). All of the above

**19. Food cans are coated with tin and not with zinc because**
(a). Zn is costlier than Sn (b). Zn is less reactive than Sn
(c). Sn is less reactive than Zn (d). Zn has higher melting point than Sn

**20. Which of the following pairs will give displacement reactions.**
(a). NaCl solution and Cu metal (b). $MgCl_2$ solution and Al metal
(c). $FeSO_4$ solution and Ag metal (d). $AgNO_3$ solution and Cu metal

**21. Example for Corrosion**
(a). Rusting of Iron (b). Tarnishing of Silver
(c). Development of Green coating on Copper (d). All the above.

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. b** | **2. c** | **3. d** | **4. b** | **5. b** | **6. c** | **7. c** | **8. c** | **9. d** | **10. a** |
| **11. c** | **12. a** | **13. a** | **14. a** | **15. b** | **16. c** | **17. a** | **18. c** | **19.c** | **20. d** |
| **21. d** | | | | | | | | | |

## EXERCISE – II

**1. Corrosion occurs in**
(a). Air (b). Water (c). Only Water (d). a & b

**2. The of the ore strongly in absence of air without fusion is known as**
(a). Roasting (b). Calcination (c).Smelting (d). None.

**3. The heating of the ore strongly in presence of air without fusion is called**
(a). Smelting (b). Roasting (c). Calcination (d). Thermite process

**4. The impurities associated with the mineral is called**
(a). Flux (b). Gangue (c). Slag (d). Mineral

**5. The metal that occurs in native form is**
(a). Pb (b). Au (c). Fe (d). Hg

**6. The most abundant metal in the earth's crust is**
(a). Oxygen (b). Aluminium (c). Zinc (d). Iron

**7. The reducing agent used in the Thermite process is**
(a). Al (b). Mg (c). Fe (d). Si

**8. Arrange the K, Zn, Hg metals in the decreaing order of their reactivity.**
(a). K > Zn > Hg (b). Zn < K < Hg (c). K > Zn < Hg (d). K< Zn > Hg

**9. During corrosion which reaction takes place at Anode**
(a). Reduction (b). Oxidation (c). Redox Reaction (d). None

**10. Stainless steel contains**

(a). Iron (b). Nickle (c). Chromium (d). All the Above

**11. Liquid metal at room temperature**

(a). Mercury (b). Bromine (c). Galium (d). Carbon

**12. The non-metal that conducts electricity is**

(a). Copper (b). Silver (c). Bromine (d). Graphite

**13. The metal which is not available in free state in nature**

(a). Gold (b). Platinum (c). Silver (d). Copper

**14. Which of the following is calcination reaction.**

(a). $2ZnS + O_2 \rightarrow 2ZnO + 2SO_2$ (b). $ZnCO_3 \rightarrow ZnO + CO_2$

(c). $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$ (d). All the Above

**15. The property of ability of an atom can be beaten into thin sheets is called**

(a). Lustre (b). Malleability (c). Ductility (d). Sonority

**16. The metallic compound from which a metal can be extracted easily and economically is called**

(a). Mineral (b). Ore (c). Gangue (d). Flux

**17. The ability of metals can be drawn into thin wires is called**

(a). Conductivity (b). Ductility (c). Sonority (d). Malleability

**18. Auto reduction is used in the extraction of which metal sulphide ore**

(a). Zn (b). Fe (c). Al (d). Cu

**19. The electrolysis of fused NaCl the products formed at Anode and Cathode**

(a). $Cl_2$ gas & Na metal (b). NaOH & $H_2$ gas

(c). Na metal & $Cl_2$ gas (d). $Cl_2$ gas & $H_2$ gas

**20. During electrolytic refining of metal the pure metal used as**

(a). Anode (b). Cathode (c). Electrolyte (d). All the Above

**21. Corrosion of copper causes**

(a). Copper oxide (CuO) (b). Copper carbonate ($CuCO_3$)

(c). Copper sulphate ($CuSO_4$) (d). Pure copper (Cu).

**22. 22 carat Gold contains**

(a). 22 parts of Gold + 2parts of Nickel (b). 22 parts of Gold + 2parts of Copper/Silver

(c). 22 parts of Gold + 2parts of Iron (d). 22 parts of Gold + 2parts of Chromium

**23. Which pairs of metals are moderate reactive**

(a). K & Zn (b). Zn & Fe (c). Hg & Au (d). K & Pb

**KEY:**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. d** | **2. b** | **3. b** | **4. b** | **5. b** | **6. b** | **7. a** | **8. a** | **9. b** | **10. d** | **11. a** | **12. d** | **13. d** |
| **14. b** | **15. b** | **16. b** | **17. b** | **18. d** | **19. a** | **20. b** | **21. b** | **22. b** | **23. b** | | | |

## PREVIOUS POLYCET QUESTIONS

**POLYCET – 2024:**

1. **Strong Ionic bond is formed between ____ and _____ group elements.**
   (a). I A & II A (b). II a & VIII A **(c).** I A & VII A (d). I A & VIIIA
2. **Corrosion of silver results in the formation of**
   (a). Silver chloride (AgCl) (b). Pure Silver (Ag)
   (b). Silver nitrate ($AgNO_3$) **(d).** Silver sulphide ($Ag_2S$)
3. **During corrosion, a metal will**
   (a). Be oxidized (b). Lose electrons (c) Be reduced **(d)**. a& b
4. **Reactivity increasing order of the following metals will be**
   (a). K, Na, Ca (b). K, Ca, Na **(c).** Ca, Na, K (d). Na, K, C

**POLYCET – 2023:**

5 **$2HCl + Zn \rightarrow$ _____**
   (a). $ZnCl_2$ (b). $ZnCl_2 + Cl_2$ (c). $H_2$ **(d)** $ZnCl_2 + H_2$
6. **Electronic configuration of $Mg^{+2}$ ion and $Cl^-$ ion are**
   **(a).** 2, 8 and 2, 8, 8 (b). 2, 8, 2 and 2, 8, 8 (c).2, 8, 8 and 2, 8 (d). 2, 8, 2 and 2, 8, 8
7. **Corrosion of copper produces**
   (a). Copper oxide **(b).** Copper carbonate
   (c). Copper sulphate (d). Pure copper
8. **22 carat Gold contains**
   (a). 22 parts of Gold + 2 parts of Nickel **(b).** 22 parts of Gold + 2 parts of Copper
   (c). 22 parts of Gold + 22 parts of Silver **(d).** 22 parts of Gold + 2 parts of Chromium
9. **Formula of Rust is**
   **(a).** $Fe_2O_3$. x $H_2O$ (b). $Fe_2O_4$ x $H_2O$ (c). $Fe(OH)_2$ (d). $Fe(OH)_3$

**POLYCET – 2022:**

10. **Highest abundant metal in earth's crust is**
    **(a).** Al (b). Au (c). $N_2$ (d). Fe
11. **Which of the following ores undergoes roasting.**
    (a). Carbonate ores (b). Oxide ores **(c)**. Sulphide ores (d). All of these
12. **Which of the following metals liberates $H_2$ on reaction with steam but not with cold water.**
    (a). Lead (Pb) (b). Sodium (Na). **(c).** Iron (Fe) (d). Potassium (K)
13. **Which of the following is not a conductor**.
    (a). Graphite (b). Carbon nanotubes **(c)**. Diamond (d). All of these
14. **Which of the following metals liberates $H_2$ gas on reaction with NaOH**
    **(a).** Zn & Al (b). Ca & Mg (c). Zn & Na (d). Ca & Na

**15. Which type of bond is formed due to transfer of electrons between two dissimilar atoms.**

(a). Electrovalent bond (b). Electrostatic bond

(c). Ionic bond **(d).** All of these.

**POLYCET – 2021:**

**16. Ionic bond is formed due to which of the following.**

(a). Transfer of electrons from one atom to another atom

(b). Electrostatic attraction between two oppositely charged ions

(c). Sharing of electrons between two atoms

**(d).** Both (a) and (b).

**17. When a metal atom forms ionic bond with a non-metal atom, the metal atom will.**

(a). Gain electrons **(b).** Lose electrons

(c). Share electrons (d). Neither lose nor gain electrons.

**18. In nature, gold metal is available in free state (native), because**

**(a).** It is less reactive (b). It is more reactive

(c). It is independent of reactivity (d). None of these.

**19. The impurities such as soil and sand associated with ore are called**

(a). Slag (b). Flux (c). Mineral **(d).** Gangue.

**20. The spot at which corrosion occurs on the surface of an iron material, behaves as**

(a). Cathode **(b).** Anode

(c). Either Cathode or Anode (d). It has no relation with electrode

**21. The nature of non-metal oxide is**

**(a)**. Acidic (b). Basic (c). Neutral (d). Acidic or Basic

**POLYCET – 2020:**

**22. Which one of the following layers of a metallic compound can be formed on electric. Wire as insulator during rainy season and causes the power supply to our home from the electric pole to be interrupted.**

(a). Metal sulphide **(b).** Metal oxide (c). Metal carbonate (d). Metal peroxide

**23. A thin layer of 'X' metal is used as galvanizing on iron surface to protect from rusting of iron. The name of 'X' metal is.**

(a). Tin (Sn) (b). Lead (Pb) **(c).** Zinc (Zn) (d). Aluminium (Al)

**POLYCET – 2019:**

**24. Electrolysis of aqueous NaCl solution [Brine Solution] producers**

**(a).** $H_2$ at Cathode & $Cl_2$ gas at Anode (b). $O_2$ at Cathode & $Cl_2$ gas at Anode

(c). $H_2$ at Cathode & $O_2$ gas at Anode (d). $Cl_2$ at Cathode & $H_2$ gas at Anode

**25. Which of the following metals is least reactive**.

(a). Mg **(b).** Au (c). K (d). Fe

**26. Heating of carbonate ore in absence of air is called**

**(a).** Calcination (b). Roasting (c). Smelting (d). Refining

**27. The tarnishing of silver spoon in presence of moisture is due to formation of**

(a). $Ag_2O$ **(b).** $Ag_2S$ (c). $AgNO_3$ (d). AgCl

**POLYCET – 2018:**

**28. The low reactivity in the following is**

**(a).** Au (b). Mg (c). Zn (d). Cu

**29. $CaCO_3 \rightarrow CaO + CO_2$. This reaction is an example for**

(a). Smelting **(b).** Calcination (c). Reduction (d). Roasting

**POLYCET – 2017:**

**30. Stainless Steel is an alloy of**

**(a).** Fe + Cr + Ni + C (b). Fe + Cu + Ni + Zn

(c). Fe + Mn + C + Cu (d). Fe + C + Pb + Mn

**31. $Fe_2O_3 + Al \rightarrow Al_2O_3 + 2Fe$. In this reaction, which statement is correct.**

(a). $Fe_2O_3$ is oxidized (b). Al is reduced

(c). Al is Oxidized **(d).** Fe is reduced

**32. The low reactivity in the following is**

**(a).** Na (b). Al **(c).** Au (d). Cu

**POLYCET – 2016:**

**33. Coating of iron metal surface with thin layer of Zinc to protect the rusting of iron is Called**

**(a).** Greasing **(b).** Galvanizing (c). Tinning (d). Electroplating

**34. $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$. This reaction is an example for**

(a). Smelting (b). Calcination (c). Reduction **(d).** Roasting

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. c** | **2. d** | **3. d** | **4. c** | **5. d** | **6. a** | **7. b** | **8. b** | **9. a** | **10. a** |
| **11. c** | **12. c** | **13. c** | **14. a** | **15. d** | **16. d** | **17. b** | **18. a** | **19.d** | **20. b** |
| **21. a** | **22. b** | **23. c** | **24. a** | **25. b** | **26. a** | **27. b** | **28. a** | **29. b** | **30. a** |
| **31. d** | **32. a** | **33. b** | **34. d** | | | | | | |

# 4. CARBON AND ITS COMPOUNDS

- Carbon is a non-metal, belongs to IV A group and contain four valency electrons in the valency shell **(Tetra (4) valency)**
- Carbon forms covalent bonds (single or double or Triple bonds) with same or other atoms. Due to its small size carbon forms strong bonds.
- Electronic configuration of Carbon in **ground state is $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^0$**. In the **excited state the electronic configuration of Carbon is $1s^2 2s^1 2p_x^1\ 2p_y^1\ 2p_z^1$. 4 electrons are involved in bond formation**. The energy required to excite the electron is obtained from the energy released in the formation of bonds
- **Covalent Bond:**Bond formed between atoms by sharing of electron pair/pairs is called Covalent Bond. Denoted with hyphen [-]. Shared electrons belong to valency shell [Outermost shell]. $H_2$, $F_2$, $Cl_2$, $O_2$, $CH_4$, $NH_3$, $H_2O$ etc., contain covalent bond.
- Covalent compounds have low melting and boiling points**.** They are poor conductors of electricity.
- **Hydrogen Molecule ($H_2$) :** Pair of electrons is shared between two hydrogen atoms. A single Covalent bond is formed between two hydrogen atoms **[H – H].** Nearest inert gas to hydrogen is Helium.
- **Chlorine Molecule ($Cl_2$):** Pair of electrons is shared between two chlorine atoms. A single Covalent bond is formed between two chlorine atoms [**Cl – Cl**]. Nearest inert gas to Chlorine is Argon.
- **Oxygen Molecule ($O_2$):** Two Pairs of electrons are shared between two oxygen atoms. A Double Covalent bond is formed between two Oxygen atoms [**O = O**]. Nearest inert gas to oxygen is Neon.
- **Nitrogen Molecule ($N_2$):** Three Pairs of electrons are shared between two nitrogen atoms. A Triple Covalent bond is formed between two nitrogen atoms [**N ≡ N**]. Nearest inert gas to nitrogen is Neon.
- **Ammonia Molecule ($NH_3$) :** Three pairs of electrons are shared between Nitrogen atom and 3 Hydrogen atoms. 3 single covalent bonds are formed between Nitrogen and Hydrogen atoms.
- **Methane ($CH_4$)**: Carbon shares four valence electrons with four atoms of hydrogen and forms 4 covalent bonds.
- **Methane** is the major component in **Bio-gas** and **CNG** (Compressed Natural Gas), which are used as fuel.
- The property of element to exist in different physical forms is called **"Allotropy".**
- **Diamond, Graphite and Buckminster Fullerene [$C_{60}$] etc.** are crystalline allotropes of carbon.
- Physical properties of graphite and diamond are different but their chemical properties are same.

- **Diamond is hardest substance** and its hardness is due to strong C – C bonds. Each carbon atom is bonded to four other carbon atoms forming a three dimensional structure.
- **Graphite is smooth and slippery. It is good conductor.** Graphite has layered structure. Each carbon atom is bonded to three other carbon atoms in the same giving a hexagonal array.
- **In $C_{60}$, carbon atoms are arranged in the shape of a football.**
- **Urea [$NH_2CONH_2$] is the first organic compound prepared in the laboratory from heating of Ammonium cyanate [$NH_4CNO$]** by **Friedrich Wohler**.
- **Catenation:** Carbon has the ability to form bonds with other atoms of carbon to form large molecules. This property is called **"Catenation'.** Carbon is the element with highest catenation ability.
- Compounds containing Carbon and Hydrogen are called **"Hydrocarbons".**
- **Saturated Hydrocarbons:** Compounds of carbon which are linked by only single bonds between the carbon atoms are called Saturated Hydrocarbons**.**These compounds are not very reactive**.** Saturated hydrocarbons are called **Alkanes.**They are also known paraffins**.**
- **General Formula : $C_nH_{(2n+2)}$**

  **Ex.: Methane [$CH_4$], Ethane [$C_2H_6$], Propane [$C_3H_8$], Butane [$C_4H_{10}$],**

  **Pentane [$C_5H_{10}$], Hexane [$C_6H_{12}$]**

  **Unsaturated Hydrocarbons:** Compounds of carbon having double (or) triple bonds between their carbon atoms are called Unsaturated Hydrocarbons. These compounds are more reactive than saturated hydrocarbons.

  Unsaturated Hydrocarbons which contain one (or) more double bonds [C = C] are called

  **Alkenes. General Formula: $C_nH_{2n}$.**

  **Ex.:** Ethylene (Ethene) [**$C_2H_4$: $H_2C = CH_2$**],

  Unsaturated Hydrocarbons which contain one (or)more triple bonds C ≡ C**]** are called **Alkynes. General Formula: $C_nH_{(2n-2)}$**

  **Ex. :** Ethyne (Acetylene) [**$C_2H_2$: $H_2C \equiv CH_2$**]

  **Cyclic carbon compounds**: **Ex. : Cyclopentane [$C_5H_{10}$]**

  **Cyclohexane[$C_6H_{12}$] – Saturated Compound.**

  **Benzene: [$C_6H_6$] – Unsaturated compound.**
- Carbon forms bonds with Halogens [F, Cl, Br, I], Nitrogen, Oxygen and Sulphur. The element replacing Hydrogen in Hydrocarbons is known as **Heteroatom.**
- **Isomerism :** Compounds having same molecular formula but different properties due to different structures are called **Isomers** and the phenomenon is called **Isomerism.**
- **Structural Isomers :** Compounds with identical molecular formula but different structures are called **structural isomers.**
- **Functional Groups :** The characteristics properties of an organic compound depend mainly on an atom (or) group of atoms in its compound is known as **Functional Group.**

- **Homologous Series:** The series of carbon compounds in which two successive compounds differ by **$-CH_2$ unit** is called Homologous series**.**

  **Ex.: Alkanes:** $CH_4$, $C_2H_6$, $C_3H_8$, $C_4H_{10}$, $C_5H_{12}$**:** These successive compounds differ by $-CH_2$ unit.

  **Alcohols:** $CH_3OH$, $C_2H_5OH$, $C_3H_7OH$, $C_4H_9OH$: These successive compounds differ by $-CH_2$ Unit.

  Increase in molecular mass in a homologous series is **14**.

  **Melting points and boiling points of hydrocarbons increase with increase in molecular mass.**
- **<u>Nomenclature of Carbon Compounds</u>:**
- **Root Word:** The number of carbon atoms present in continous longest possible carbon chain as main chain in the compound**.**
- **$C_1$ – Meth; $C_2$ – Eth; $C_3$ – Prop; $C_4$ – But; $C_5$ – Pent; $C_6$ – Hex; $C_7$ –Hept; $C_8$ – Oct; $C_9$ – Non; $C_{10}$– Dec.**

  **Prefix:** To indicate substituents/side chains. It has different part as

  # Number prefix [1, 2, 3, . . . . . substituent attached to which carbon atom in the chain).

  # Numerical prefix [di, tri, -- for same substituent repeated twice or thrice**).**

  # Primary prefix used for cyclic compounds only [Cyclo].

  # Secondary prefix tells about the substituents/secondary grade functional group.

  [***Viz.,*** **Cl – Chloro, $CH_3$ – methyl, $C_2H_5$ – ethyl, $NO_2$ – nitro, -OH – hydroxyl, -CHO – formyl, -OR – alkoxy etc**.]

  **Suffix: (i).** Primary suffix indicates saturation / unsaturation in the compound.

  (a). For Saturated **[C – C]**: Primary suffix is **'ane'**,

  (b). For Unsaturated **[C = C]**: Primary Suffix is **'ene'**

  (c). For Unsaturated **[C ≡ C]**: Primary Suffix is **'yne'.**

  **(ii).** Secondary suffix indicates functional group in the compound.

  (a). For alcohol **[-OH]: 'ol'**;

  (b). For aldehydes **[-CHO]: 'al'**

  (c). For ketones **[=C=O]: one**; (d). For carboxylic acids **[-COOH]: 'oic acid'**.
- **If the carbon chain is unsaturated, then the final 'ane' in the name of the carbon chain is substituted by 'ene' or 'yne.**
- **In case functional group is present, then the name of the carbon chain is modified by deleting the final 'e' in 'ane' and adding the appropriate suffix.**

| Class of Compounds | Functional Group | As Prefix | As Suffix |
|---|---|---|---|
| Alcohol | -OH | hydroxy | ol |
| Aldehyde | -CHO | formyl | al |
| Ketone | -C = O | oxo | one |

| Carboxylic acid | -COOH | carboxy | oic acid |
|---|---|---|---|
| Halo alkane | | chloro, bromo etc., | |
| Alkane | [C – C] | | ane |
| Alkene | [C = C] | | ene |
| Alkyne | [C ≡ C] | | yne |

**Examples**:

$CH_3CH_2CH_2Cl$: Choropropane;
**$CH_3COCH_3$: Propanone [Acetone]**;
$CH_3CH_2COOH$: Propanoic acid;
$CH_3C{\equiv}CH$: Propyne.
$CH_3CH_2CH_2OH$: Propanol
$CH_3CH_2CHO$: Propanal
$CH_3CH{=}CH_2$: Propene;
$CH_3 – CH_2 – Br$: Bromoethane

- **HCHO: Methanal [Formaldehyde]**
- $CH_3CH_2CH_2CH_2C{\equiv}CH$: Hexyne.
- **$CH_3CH_2OH$ [$C_2H_5OH$]: Ethanol [Ethylalcohol]**
- **$CH_3COOH$: Ethanoic acid [Acetic acid]**
- $CH_3CH_2CH_2CH_2CH_2Br$: Bromopentane
- $CH_3CH_2COCH_3$: Butanone
- $CH_3CH_2CH_2CH_2CH_2CHO$: Hexanal
- **Number of structural isomers for Pentane: 3** [n-pentane, isopentane & neopentane]
- **Number of structural isomers for Bromopentane : 3**
  [1-Bromopentane, 2-Bromopentane, 3-Bromopentane]
- **<u>Combustion:</u>**
  Carbon in all its allotropic forms, burns in oxygen to give carbondioxide [$CO_2$].
  **$C + O_2 \rightarrow CO_2$ + Heat & Light**
  **Combustion of organic compounds is exothermic and produces Water ($H_2O$), $CO_2$ and Heat & Light.**
  **$CH_4$ [Methane] + $O_2 \rightarrow CO_2 + H_2O$ + Heat & Light**
  **$CH_3CH_2OH$ [Ethyl alcohol] + $3O_2 \rightarrow 2CO_2 + 3H_2O$ + Heat & Light**
- Saturated hydrocarbons will give clean flame [Non-sooty flame]. While unsaturated hydrocarbons give yellow flame with lots of black smoke [sooty flame].
- The gas/kerosene stoves used at home has inlets in air so that sufficiently oxygen rich mixture is burnt to give a clean blue flame.
- The bottoms of cooking vessels getting blackened because the air holes are blocked and fuel is getting wasted.
- **Coal and petroleum are called fossil fuels**.
- **<u>Oxidation Reaction</u>**:

Ethanol [Ethyl alcohol] on oxidation by strong oxidizing agents like Alkaline Potassium permangante[$KMnO_4$] (or) Acidified Potassium dichromate [$K_2Cr_2O_7$] gets oxidized to give Ethanoic acid [Acetic acid].

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{Acidified } K_2Cr_2O_7]{\text{Alkaline } KMnO_4 \text{ (or)}} \underset{\text{Ethanoic Acid}}{CH_3COOH}$$

**The colour of $KMnO_4$ not disappear when excess is added to ethanol, because, there is no more ethanol for reaction.**

- **Addition Reaction:**

  **Unsaturated hydrocarbons [Alkenes & Alkynes] mainly undergoes addition reaction.**

  Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium [Pd] (or) Nickel [Ni] to give saturated hydrocarbons.

$$\underset{\text{Unsaturated Hydrocarbon}}{R_2C=CR_2} \xrightarrow[H_2]{Ni\,(or)\,Pd\ Catalyst} \underset{\text{Saturated Hydrocarbon}}{R_2HC-CHR_2}$$

- **Catalyst:** catalysts are substances that cause a chemical reaction to proceed at a different rate [increase/decrease] without undergoing any chemical changes is called Catalyst.
- **Nickel [Ni] is used as a catalyst in hydrogenation of vegetable oils.**

  **Animal fats contain saturated fatty acids. These are harmful for health. Oils containing unsaturated fatty acids are good for cooking.**
- **Substitution Reaction:**
- **Saturated hydrocarbons [Alkanes] are inert/less reactive and mainly undergo substitution reactions.**

  In presence of sunlight chlorine is added to saturated hydrocarbons in a reaction. Chlorine replaces the hydrogen atoms one by one. It is called **substitution reaction**.

$$CH_4 + Cl_2 \xrightarrow{Sunlight} CH_3Cl + HCl$$

$$CH_3Cl + Cl_2 \xrightarrow{Sunlight} CH_2Cl_2 + HCl$$

$$CH_2Cl_2 + Cl_2 \xrightarrow{Sunlight} CHCl_3 + HCl \quad [CHCl_3: \text{Chloroform}]$$

$$CHCl_3 + Cl_2 \xrightarrow{Sunlight} CCl_4 + HCl$$

- **Ethanol [Ethyl alcohol] And Ethanoic Acid [Acetic acid]:**

  Pure ethanol [Pure Ethyl alcohol] is called **"Absolute Alcohol".**

- **Reactions of Ethanol:**

  1. **Reaction with Sodium metal:**

     Ethanol reacts with sodium metal and liberates hydrogen gas and sodium ethoxide is formed. **(or)**

     **When a small piece of sodium is dropped into ethanol hydrogen gas is liberated.**

$$\underset{\text{Ethanol}}{2C_2H_5OH} + \underset{\text{Sodium}}{2Na} \rightarrow \underset{\text{Sodium Ethoxide}}{2C_2H_5ONa} + \underset{\text{Hydrogen gas}}{H_2\uparrow}$$

  2. **Reaction to give Unsaturated Hydrocarbon:**

     Ethanol on heating at $443^0K$ [$170^0C$] with Concentrated Sulphuric acid [$H_2SO_4$] in excess undergoes **dehydration** to form Ethene. This is a unsaturated hydrocarbon.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[443^\circ K\,(or)\,170^\circ C]{Conc.\,H_2SO_4} \underset{\text{Ethene}}{H_2C=CH_2} + H_2O$$

**Concentrated $H_2SO_4$ is dehydrating agent. It removes water from ethanol.**

- Methanol [$CH_3OH$] added ethanol is called "**Denatured alcohol'. [poisonous]**
- Methanol is oxidized to Methanal [HCHO] in the liver.

- Molasses from sugarcane juice on fermentation gives alcohol. Alcohol is added to petrol to give cleaner fuel. This on burning with oxygen (air) gives only $CO_2$ and Water.
- **Properties of Ethanoic Acid [Acetic Acid:$CH_3COOH$ (or) $C_2H_4O_2$]:**
- **5 – 8% solution of acetic acid in water is called "Vinegar".** It is used as a preservative in pickles.
- The melting point of pure ethanoic acid is $290^0K$ [$17^0C$]. It freezes during winter in cold climates. This is known as **Glacial Acetic Acid**.
- **$CH_3COOH$ is weak organic acid than HCl**. HCl is completely ionized. $CH_3COOH$ is weakly ionized.
- **Reactions of Ethanoic acid:**

  **Esterificaton:**The reaction between carboxylic acid and alcohol in presence of concentrated $H_2SO_4$ to form ester is called **Esterification.**

  **Ethanoic acid [Acetic acid]** reacts with **ethanol [Ethyl alcohol]** in the presence of an **acid [$H_2SO_4$] catalyst** to give an **Ester [Ethyl acetate]**. **Esters are sweet smelling substance**

$$\underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{CH_3CH_2OH} \xrightleftharpoons{H_2SO_4} \underset{\text{Ethyl acetate (Ester)}}{CH_3COOC_2H_5} + H_2O$$

- **Saponification**: Ester [Ethyl acetate] on treating with a base/alkali [NaOH], the ester is converted to alcohol [Ethyl alcohol] and Sodium salt of Carboxylic acid [$CH_3COONa$]. This reaction is known as **Saponification**.
- **Alkaline hydrolysis of fats producing soaps is called saponification**. Saponification is used in the preparation of Soaps. **Soaps are sodium (or) potassium salts of long chain carboxylic acids.**

$$\underset{\text{Ethyl acetate (Ester)}}{CH_3COOC_2H_5} \xrightarrow{NaOH} \underset{\text{Ethanol}}{C_2H_5OH} + \underset{\text{Sodium acetate}}{CH_3COONa}$$

- **Reaction with base [NaOH]**: Ethanoic acid [$CH_3COOH$] reacts with a base [NaOH] to give a salt [Sodium acetate] and water [$H_2O$]

$$\underset{\text{Sodium acetate}}{NaOH} + \underset{\text{Acetic acid}}{CH_3COOH} \longrightarrow \underset{\text{Sodium acetate}}{CH_3COONa} + H_2O$$

- **Reaction with Carbonates [$Na_2CO_3$] & Hydrogencarbonates [Bicarbonates] [$NaHCO_3$]**: Ethanoic acid [$CH_3COOH$] reacts with Sodium carbonate [$Na_2CO_3$] and Sodium bicarbonate [$NaHCO_3$] to give a Salt, Carbon dioxide and Water.

$$\underset{\text{Acetic acid}}{2CH_3COOH} + \underset{\text{Sodium carbonate}}{Na_2CO_3} \rightarrow \underset{\text{Sodium acetate}}{2CH_3COONa} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbondioxide}}{CO_2}$$

$$\underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Sodium bicarbonate}}{NaHCO_3} \rightarrow \underset{\text{Sodium acetate}}{CH_3COONa} + \underset{\text{Water}}{H_2O} + \underset{\text{Carbondioxide}}{CO_2}$$

- **Sodium bicarbonate Test**: **This test is used to distinguish between Ethyl alcohol and Carboxylic acid.** Ethanol [$C_2H_5OH$] doesn't react with Sodium bicarbonate. But Ethanoic acid [$CH_3COOH$] produces $CO_2$ gas.

- **Micelle**: **A spherical aggregate of soap molecules of colloidal size in water is called Micelle.**
  In the cleaning action of soap, a micelle is formed as the ionic end **[hydrophilic end (-$COO^-$ group of soap)]** of soap interacts with water and the carbon chain **[hydrophobic end (alkyl group of soap)]** interacts with oil.

**Micelle forms an emulsion in water.**

- The insoluble **'scum'** is caused by the reaction of soap with the calcium and magnesium salts. **The calcium and magnesium salts causes hardness to water.**
- Detergents are sodium salts of sulphonic acids or ammonium salts with chlorides or bromides ions**.**

## EXERCISE

**1. Which of the following is true.**

(a). Carbon is non-metal (b). Carbon has highest catenation ability

(c). Carbon forms 4 bonds with other atoms. **(d)**. All are correct.

**2. The first organic compound prepared in the laboratory**

(a). $NH_4CNO$ [Ammonium cyanate] **(b).** $NH_2CONH_2$ [Urea]

(c). $CH_4$ [Methane] (d). CH3COOH [Acetic acid]

**3. The element with highest catenation ability is**

**(a).** Carbon (b). Nitrogen (c). Oxygen (d). Sulphur

**4. Which of the following is not hydrocarbon**

(a). $C_2H_6$ (b). $C_6H_6$ **(c).** $C_2H_5OH$ (d). $C_2H_2$

**5. Different members in homologous series is differ by**

(a). $CH_3$ (b). $C_2H_5$ (c). $CH_4$ **(d).** $CH_2$

**6. Functional group present in Aldehydes**

(a). –OH **(b).** –CHO (c). –COOH (d). –COOR

**7. Suffix used to indicate the functional group in ketone is**

(a). al **(b).**one (c). oate (d). oic acid

**8. Organic compounds containing –COOH functional group are called**

(a). Alcohols (b). Ethers **(c).** Carboxylic acids (d). Esters

9. $\mathbf{2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + Heat + Light}$

(a). Combustion reaction (b). Addition reaction

(c). Hydration (d). Substitution reaction

**10. Which of the following is a saturated hydrocarbon**

(a). Ethane [$C_2H_6$] (b). Methane [$CH_4$] (c). Propane [$C_3H_8$] **(d).** All the above

**11. oxidation of ethyl alcohol [$C_2H_5OH$] with acidified $K_2Cr_2O_7$ on heating gives**

(a). $CH_3CHO$ (b). $CH_3COOH$ (c). $CH_3$-$CH_3$ (d). $CH_3CH_2COOH$

**12. Combustion reaction is**

(a). Endothermic (b). Exothermic
(c). Both (a) & (b) (d). None of the above

**13. Unsaturated hydrocarbons [Alkenes & Alkynes] mainly undergoes**
(a). Oxidation reactions. (b). Substitution reactions
(c). Reduction reactions (d). Addition reactions

**14. The catalyst used in hydrogenation of oils is**
(a). $H_2$ **(b).** Ni (c). Fe (d). Cu

**15.** $CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$
(a). Addition reaction **(b).** Substitution reaction
(c). Elimination reaction (d). Oxidation reaction

**16. Which of the following match is incorrect.**
(a). $C_2H_5OH$ – Ethanol (b). $CH_3COOH$ – Ethanoic acid
(c). $CH_3CHO$ – Ethanal **(d).** $CH_3COOCH_3$ – Ethyl acetate

**17. Alkanes mainly under goes**
(a). Addition reaction **(b). Substitution reaction**
(c). Elimination reaction (d). Oxidation reaction

**18. When ethyl alcohol is treated with 'Na' metal the gas liberated is**
(a). $O_2$ (b). $CH_4$ **(c).** $H_2$ (d). $N_2$

**19. The percentage of acetic acid in vinegar is**
(a). 5 – 10% (b). 5 – 8% (c). 10 – 12% (d). 20 – 25%

**20. Which of the following compound has sweet odour**
(a). Aldehydes (b). Esters (c). Ether (d). Acids

**21. A Spherical aggregate of soap molecules in water is called**
(a). Coagulant (b). Solution **(c).** Micelle (d). Phase

**22. The process of obtaining of soap from oils or fats by hydrolysis in presence of base is called**
(a). Defecation (b). Saponification (c). Carbonation (d). Sulphitation

**23. Which of the following gas is liberated when ethanoic acid [$CH_3COOH$] reacts with Sodium carbonate [$Na_2CO_3$].**
(a). $H_2$ (b). $O_2$ **(c).** $CO_2$ (d). $N_2$

**24.** $CH_3COOH + CH_3CH_2OH \xrightarrow{H_2SO_4} CH_3COOC_2H_5 + H_2O.$
**This reaction is called**
(a). Substitution reaction (b). Addition reaction
(c). Hydrolysis reaction **(d).** Esterification

**25. Sodium (or) Potassium salts of higher fatty acids are called**
(a). Saponification (b). Detergent **(c).** Soap (d). Micelle

**26. Which of the following is formed in the cleaning of action of soap.**

**(a).** Micelle (b). True solution (c). Emulsion (d). None of the above

**27. The ability of carbon to form longest chains with its own atoms is called**

(a). Isomerism (b). Tetravalency **(c).** Catenation (d). Allotropy

**28. Which of the following is a ring compound**

(a). n-Pentane (b). Isopentane **(c).** Cyclopentane (d).Isobutane

**29. The prefix used for aldehyde group in nomenclature is**

(a). Hydroxy **(b).** Formyl (c). Oxo (d). Amino

**30. Urea [$NH_2CONH_2$] is the first organic compound synthesized in the laboratory. This compound Is formed by heating**

(a). $CH_3COONH_4$ (b). $NH_4NO_3$ **(c).** $NH_4CNO$ (d). $NH_4NCO$

**31. How many structural isomers are possible for bromopentane & pentane.**

**(a).** 3 & 3 (b). 2 & 3 (c) 2 & 2 (d). 3 & 2

**32. Coal and Petroleum are called**

(a). Nuclear Fuels **(b).** Fossil Fuels

(c). Artificial Fuels (d). None of the above.

**33. Combustion of hydrocarbon is generally accomplished by evolution of**

(a). Heat (b). Light

**(c)** Both Heat & Light (d). Electric current.

**34. The IUPAC name of Acetylene [HC ≡ CH] is**

(a). Ethane (b). Ethene **(c).** Ethyne (d). Ethyl

**35. Which of the following compounds burn with yellow and sooty flame during combustion?**

(a). Saturated Hydrocarbons **(b).** Unsaturated Hydrocarbons

(c). Compounds contain hydrogen (d). Compounds contain oxygen

**36. The major component of biogas and CNG is**

(a). Ethane (b). Acetylene **(c).** Methane (d). $CO_2$

**37. The General formula of Alkene**

(a). $C_nH_{2n}$ (b). $C_nH_{2n-2}$ (c). $C_nH_{2n+2}$ (d). $C_nH_{2n-6}$

**38.** $CH_3COOH + CH_3CH_2OH \xrightarrow{Conc.H_2SO_4} CH_3COOC_2H_5 + H_2O.$

**In this reaction concentrated $H_2SO_4$ is**

(a). Oxidizing agent (b). Dehydrating agent

(c). Reducing agent (d). None of the above

**39. 1ml of glacial acetic acid and 1ml of ethanol are mixed together in a test tube. Few drops of Conc. $H_2SO_4$ is added in the mixture and warmed in a water bath for 5 min. What is the resultant compound**

**(a).** Ethylacetate (b). Sodium acetate (c). $CO_2$ (d). $CH_4$

**40. The next homology of $C_2H_5OH$ is**

(a). $CH_3OH$ (b). $CH_4OH$ (c).$C_2H_3OH$ **(d).** $C_3H_7OH$

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. d** | **2. b** | **3. a** | **4. c** | **5. d** | **6. b** | **7. b** | **8. c** | **9. a** | **10. d** |
| **11. b** | **12.b** | **13. d** | **14. b** | **15. b** | **16. d** | **17. b** | **18. c** | **19. b** | **20. b** |
| **21. c** | **22. b** | **23. c** | **24. d** | **25. c** | **26. a** | **27. c** | **28. c** | **29. b** | **30. c** |
| **31. a** | **32. b** | **33.c** | **34. c** | **35. b** | **36. c** | **37. a** | **38. b** | **39. a** | **40. d** |

## PREVIOUS POLYCET QUESTIONS

**POLYCET – 2024**

**1. IVA Group elements are called**

**(a).** Carbon Family (b). Chalcogen Family

(c). Nitrogen Family (d). Boron Family

**2. What is the Structural formula of simplest ketone.**

(a). $CH_3 – O – CH_3$ (b). $CH_3 – NH_2$

**(c)**. $CH_3 – CO – CH_3$ (d). $CH_3 – COOH$

**3. Ethene and Ethyne differ in the** **[Polycet – 2023]**

(a). Number of carbons (b). Number of bonds

(c). Number of hydrogens **(d).** (b) & (c)

**4. Saturated hydrocarbons contain**

(a). At least one double bond (b). At least one triple bond

**(c)**. All single bonds (d). At least one ionic bond.

**POLYCET - 2023**

**5. R – CO – R functional group indicates**

(a). Aldehyde (b). Ester (c). Alcohol **(d).** Ketone

**6. Ethyl alcohol upon oxidation produces**

(a). Ester **(b).** Carboxylic acid (c). Ether (d). Alkane

**7. Which of the following are called paraffins**

**(a).** Alkanes (b). Alkenes (c). Alkynes (d). Alkyls

**8. Cough Syrup contains**

**(a).** Ethanol (b). Ethanoic acid (c). Ethanal (d). Ethyl acetate

**9. Identify the structure of propyne?**

(a). HC ≡ CH (b).$H_3C - C \equiv CH$ (c). $H_2C = CH - CH_3$ (d). $H_2C = CH_2$

**POLYCET – 2022**

**10. If Q is the heat energy, determine the nature of the reaction in the following equation**

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + Q$

(a). Exothermic (b). Endothermic

(c). Both (a) & (b) (d). Can't be determined

**11. The number of sigma and pi bonds in $C_2H_2$ molecule is**

(a). 3 sigma and 0 pi (b). 3 sigma and 2 pi (c). 2 sigma and 3 pi (d). 4 sigma and 1 pi

**12. Which of the following is not a conductor**

(a). Graphite (b). Carbon nanotube

**(c)**. Diamond (d). All of these

**13. Which of the following is an unsaturated hydrocarbon.**

(a). Butane (b). Butyne (c). Isobutane (d). Cyclobutane

**14. What does an oxidizing agent do**

(a). It reduces other substances and itself undergoes oxidation

(b). It reduces other substance and itself undergoes reduction

(c). It oxidizes other substance and itself undergoes oxidation

(d). It oxidizes other substance and itself undergoes reduction.

**POLYCET – 2021:**

**15. The ability of an atom to form the longest chain with its own atoms is called as**

(a). Allotropy (b). Hybridization **(c)**. Catenation (d). Isomerism

**16. Hydrocarbons that contain only single bonds between the carbon atoms are called**

**(a).** Alkanes (b). Alkenes (c). Alkynes (d). All of these

**17. For hydrocarbons, if the molecular formula increases, then melting point**

**(a).** Increases (b). Decreases (c). Either Increase or Decrease (d). No relation

**18. In hydrocarbons, which type of bonds does carbon form**

(a). Four single bonds (b). Two double bonds

(c). One single bond and one triple bond (d). All of these

**POLYCET – 2020**

**19. Graphite is a good conductor of electricity because of**

(a). It has localized pi electron system

(b). It has declocalized pi electron system

(c). It has localized sigma electron system

(d). It has declocalized sigma electron system

**20. The molecular formula of cyclopentane is**

**(a).** $C_5H_{10}$ (b). $C_5H_{12}$ (c).$C_5H_8$ (d). $C_5H_{11}$

**21. The IUPAC name of the compound $CH_3 - CH_2 - CH = CH_2$ is**

(a). But – 3 – ene **(b).** But – 1 – ene (c). But – 3 – yne (d). But – 1 – yne

**22. $C_2H_5OH$ on oxidation with alkaline $KMnO_4$ gives the compound 'A', ehich on further oxidation gives the compound 'B'. The names of A, B respectively are [Polycet – 2017]**

(a). Methanal&Methanoic acid **(b).**Ethanal&Ethanoic acid

(c). Ethene&Propanoic acid (d). Ethyne&Ethanoic acid

**23. Which of the following compound hydrocarbons can show isomerism.**

(a). $C_2H_4$ (b). $C_2H_6$ (c).$C_3H_8$ **(d).** $C_4H_{10}$

**24. $CH_3COOH$ is an organic**

**(a).** Weak base (b). Weak acid (c). Strong acid (d). Strong base

**POLYCET – 2019**

**25. Electronic configuration of 'C' in its exited state [Polycet – 2017]**

(a). $1s^2 2s_2 2p_x^0 2p_y^2 2p_z^o$ (b). $1s^2 2s_2 2p_x^2 2p_y^0 2p_z^o$

(c). $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^o$ **(d).** $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$

**26. The first synthesized organic compound in laboratory is**

(a). Methane **(b).** Urea (c).Acetic acid (d). Ammonia

**27. The organic compound with R – COO – R' functional group is prepared from**

**(a).** RCOOH & R'OH (b). R'COOH & ROH

(c). RCHO & R'OH (d). R'CHO & ROH

**28. The values of x, y, z in the following chemical reaction is**

**$C_3H_8 + x\ O_2 \rightarrow\ y\ CO_2 + z\ H_2O$**

**(a).** 5, 3, 4 (b). 4, 3, 5 (c).3, 5, 4 (d). 5, 4, 3

**29. The molecule that contains only sigma bonds in the following is**

(a). $C_2H_4$ (b). $O_2$ (c). $N_2$ **(d).** $NH_3$

**POLYCET - 2018**

**30. Which of the following is an unsaturated hydrocarbon. [Polycet – 2016]**

(a). $CH_4$ **(b).**$C_2H_2$ (c). $C_3H_8$ (d). $C_2H_6$

**31. Successive compounds in a homologous series possess a difference of**

(a). (-CH) unit **(b).** ($-CH_2$) unit (c). ($-CH_3$) unit (d). ($-C_2H_2$) unit

**32. Ethanol on heating with acidified $KMnO_4$ to form ethanal and acetic acid. This reaction is an example of**

(a). Addition reaction (b). Substituton reaction

(c). Reduction reaction **(d).** Oxidation reaction

**33. 5 – 8% solution of acetic acid in water is called as**

**(a).** Vinegar (b). Formalin (c). Gasohol (d). Cough syrup

**34. The general formula of ketone is**

(a). R – O – R (b). R – CO – R (c). R – COOR (d). R – CHO

**POLYCET – 2017**

**35. But – 2 – yne reacts with $H_2$ in Ni catalyst to form But – 2 – ene. This reaction is an example for**

(a). Substitution reaction (b). Addition reaction
(c). Elimination reaction (d). Rearrangement reaction

**36. The hardest material among the allotropes of carbon is**

**(a).** Diamond (b). Graphite (c).Coke (d). Coal

**POLYCET – 2016**

**37. Which of the following substituted products is not formed when methane reacts with chlorine in sunlight.**

(a). Chloroform (b). Carbon tetrachloride
(c). Methyl chloride (d). Ethyl chloride

**38. The general formula of ester is**

**(a).** R – O – R (b). R – CO – R (c). R – COOR (d). R – CHO

**KEY:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. a** | **2. c** | **3. d** | **4. c** | **5. d** | **6. b** | **7. a** | **8. a** | **9. b** | **10. a** |
| **11. b** | **12. c** | **13. b** | **14. d** | **15. c** | **16. a** | **17. a** | **18. d** | **19. b** | **20. a** |
| **21. b** | **22. b** | **23. d** | **24. a** | **25. d** | **26. b** | **27. a** | **28. a** | **29. d** | **30. b** |
| **31. b** | **32. d** | **33. a** | **34. b** | **35. b** | **36. b** | **37. d** | **38. c** | | |

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