3

CHAPTER

Metals and Non-metals

Level - 1

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct.
Explanation: X (2, 8, 7): Elements with 7 electrons in their outermost shell need 1 more electron to achieve a stable noble gas configuration. Such elements are typically non-metals.
Y (2, 8, 2): With 2 electrons in its outermost shell, Y tends to lose these electrons to achieve stability. Elements with 1 or 2 outer electrons are typically metals.
Z (2, 8): Z has a completely filled outer shell, making it stable and non-reactive, indicating that it is a noble gas.
Thus, X is a non-metal, and Y is a metal.

2. Option (C) is correct.
Explanation: Mercury (Hg) is a metal that exists in a liquid state at room temperature. Bromine (Br_2) is a non-metal that exists in a liquid state at room temperature.

3. Option (C) is correct.
Explanation: Copper (Cu) is found in ores like chalcopyrite ($CuFeS_2$) and cuprite (Cu_2O) as well as in nature or free state.
Silver (Ag) is found in the free state as native silver and in the combined state in ores like argentite (Ag_2S).
Gold and platinum, being highly unreactive, are typically found in the free state only.

4. Option (B) is correct.
Explanation: Aluminium (Al) is a metal 'X' used in the thermite process because of its high reactivity and ability to reduce metal oxides to pure metals by releasing a significant amount of heat.
Oxide 'Y' is aluminium oxide (Al_2O_3), which is formed when aluminium 'X' reacts with oxygen. Aluminium oxide is amphoteric in nature because it reacts with both acids and bases.

5. Option (A) is correct.
Explanation: Lithium is the lightest metal and the least dense solid element. It is a soft, silver- white metal belonging to the alkali metal group of chemical elements.

6. Option (C) is correct.
Explanation: Non-metals typically have 5, 6, or 7 electrons in their outermost shell. This is because non-metals tend to gain electrons to complete their octet (8 electrons in the outermost shell) during chemical reactions. For example, non-metals like N_2, O_2, F_2 contain 5, 6 or 7 number of electrons in their outermost shell, respectively

7. Option (C) is correct.
Explanation: Amphoteric oxides are oxygen compounds, which show both basic and acidic characteristics. These oxides undergo a neutralisation reaction to produce water and salt.
Reaction with acid:
$ZnO + 2HCl \rightarrow ZnCl_2 + H_2O$
Reaction with base:
$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$

8. Option (B) is correct.
Explanation: Some metal oxides, such as aluminium oxide, zinc oxide shows both acidic as well as basic behaviour. Such metal oxides that react with both acids and bases to produce salt and water are known as amphoteric oxides.
Aluminium oxide reacts with base as follows:
$$Al_2O_3 + 2NaOH \rightarrow \underset{\text{(Sodium aluminate)}}{2NaAlO_2} + H_2O$$
ZnO is an oxide that can react with base, as shown by the equation given below:
$$ZnO + 2NaOH \rightarrow Na_2ZnO_2 + H_2O$$
MgO (Magnesium oxide) and CaO (Calcium oxide) are basic oxides. They react only with acids, not with bases.

9. Option (C) is correct.
Explanation: During galvanisation, metal zinc is used for coating iron and steel objects to prevent them from rusting.

10. Option (C) is correct.
Explanation: Lead is malleable, it is easily bent, soft, dense, and a poor conductor of electricity.

11. Option (B) is correct.
Explanation: For copper to deposit on a silver plate, the silver plate would need to be more reactive than copper to displace it in the solution. However, silver is less reactive than copper, so it cannot displace copper ions to form a deposit on the plate. This explains why no deposition of copper is observed on the silver plate before starting the current.

12. Option (B) is correct.

Explanation: Aluminium (Al) reacts with water (H_2O) to form aluminium oxide (Al_2O_3) and hydrogen gas (H_2). The balanced equation should include hydrogen gas on the product side.

The balanced chemical reaction is:

$2Al + 3H_2O \rightarrow Al_2O_3 + 3H_2$

Thus, X is H_2 (hydrogen gas).

13. Option (D) is correct.

Explanation: Aluminium is a highly reactive metal and is found in the combined state in ores like bauxite ($Al_2O_3.2H_2O$). It is extracted through electrolysis of molten aluminium oxide (Al_2O_3) mixed with cryolite to reduce the melting point. The process requires a significant amount of electricity.

14. Option (D) is correct.

Explanation: Q: The zinc coating prevents contact of iron with air (True): The zinc coating forms a physical barrier, preventing oxygen and moisture from coming into contact with the iron, thereby slowing rusting.

R: Zinc undergoes corrosion more easily than iron (True): Zinc is more reactive than iron (higher in the reactivity series), so if the zinc coating is scratched, zinc undergoes oxidation (corrosion) preferentially, protecting the iron underneath.

15. Option (C) is correct.

Explanation: Magnesium does not react with cold water but reacts with hot water, forming magnesium hydroxide ($Mg(OH)_2$) and releasing colourless hydrogen gas bubbles. Magnesium starts floating because of the bubbles of hydrogen gas sticking to its surface.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (B) is correct.

Explanation: Different metals have different reactivities with water and dilute acids because the chemical reactivity of metals varies based on their position in the reactivity series. Highly reactive metals (e.g., sodium) react vigorously, while less reactive metals (e.g., copper) show little to no reaction. Metal extraction methods are determined by their reactivity- electrolysis for highly reactive metals (e.g., aluminium) and reduction for less reactive ones (e.g., iron). Thus, both the assertion and reason are true, but reason does not correctly explains the assertion as the assertion is about the reactivity of metals with water and acids, whereas reason is about how metals are extracted from ores.

2. Option (C) is correct.

Explanation: When a zinc strip is placed in copper sulphate solution, the blue colour of the solution gradually fades as zinc being more reactive than copper displaces copper, forming colourless zinc sulphate. A reddish-brown layer of copper is deposited on the zinc strip because zinc is more reactive than copper. This higher reactivity of zinc also explains why copper sulphate cannot be stored in a zinc vessel. Thus, assertion is true but reason is false.

3. Option (C) is correct.

Explanation: The extraction of metals from their sulphide ores cannot take place without roasting, as this process is essential for converting sulphide ores into metal oxides by heating them in the presence of oxygen. These oxides can then be easily reduced to obtain the metal. However, the reason is incorrect because roasting does not directly convert sulphide ores into metals; it only produces the intermediate metal oxides. Thus, while the assertion is true, the reason is false.

4. Option (D) is correct.

Explanation: Sodium oxide (Na_2O) is not an amphoteric oxide; it is a basic oxide. It reacts with acids to form salts and water but does not react with bases. Amphoteric oxides are those that react with both acids and bases to form salts and water. Thus, assertion is false but reason is true.

5. Option (A) is correct.

Explanation: When a piece of lead is added to an aqueous solution of copper sulphate, a displacement reaction takes place as lead is more reactive than copper; hence, lead displaces copper from the copper sulphate solution. This results in a colourless solution ($PbSO_4$).

$$CuSO_4 + Pb \rightarrow PbsO_4 + Cu$$

Thus, both assertion and reason are true and reason is the correct explanation of assertion.

6. Option (C) is correct.

Explanation: The assertion that copper ions migrate from the anode to the cathode during electrorefining of copper is true because in electrorefining, copper metal is oxidised at the anode, releasing copper ions (Cu^{2+}) into the solution. These ions then migrate towards the cathode, where they are reduced back to solid copper. However, the reason is false, because in the electrorefining process metal ions accept electrons at the 'cathode', not the anode. At the anode, copper is oxidised (loses electrons) to form copper ions, while at the cathode, copper ions gain electrons and are deposited as pure copper. Thus, assertion is true but reason is false.

Level - 2

CASE-BASED QUESTIONS (4 Marks)

1. (i)
- The cathode is made of pure copper.
- The anode is made of impure copper.

(ii) The solution used is acidified copper sulphate solution. Its formula is $CuSO_4$.

(iii) (a) During electrolytic refining, an electric current is passed through the electrolytic cell, causing copper from the impure anode to dissolve into the solution as copper ions (Cu^{2+}). These ions migrate towards the cathode, where they gain electrons and deposit as pure copper. Impurities either settle at the bottom as anode mud or remain dissolved in the solution.

- **At the anode (oxidation):**
  Impure copper dissolves into the solution as copper ions:
  $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$
- **At the cathode (reduction):**
  Copper ions from the solution gain electrons and deposit as pure copper:
  $Cu^{2+}(aq) + 2e^- \rightarrow \underset{\text{Pure}}{Cu(s)}$

OR

(b) Observations in Beakers A and B:

- **Beaker A (Zinc strip in copper sulphate):** The blue colour of the solution fades, and a reddish- brown coating of copper forms on the zinc strip. This happens because zinc is more reactive than copper and displaces copper from its sulphate solution.
  $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
- **Beaker B (Silver strip in copper sulphate):** No change is observed. Silver does not react with copper sulphate because silver is less reactive than copper and cannot displace it from its sulphate solution.

2. (i) The metal sample that reacted the fastest with dilute hydrochloric acid and caused the highest temperature rise was likely magnesium. Magnesium is highly reactive with hydrochloric acid, producing hydrogen gas rapidly and releasing a significant amount of heat, making its reaction more vigorous compared to aluminium and iron.

(ii) All three metals, i.e., magnesium, aluminium and iron react with dilute hydrochloric acid (HCl) because they are more reactive than hydrogen.

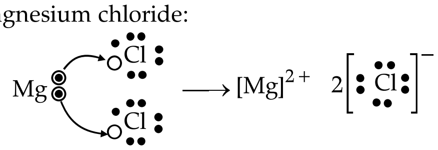
$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$
$$2Al + 6HCl \rightarrow 2AlCl_2 + 3H_2$$
$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

(iii) (a) Hydrogen gas is not evolved when a metal reacts with dilute nitric acid because nitric acid is a strong oxidising agent. Instead of releasing hydrogen gas, the hydrogen is oxidised to form water, and the reaction produces the corresponding nitrate salt along with nitrogen oxides (e.g., nitrogen dioxide, NO_2) as the products.

OR

(b) The type of reaction on the basis of which reactivity of metals is decided is a displacement reaction. In a displacement reaction, a more reactive metal displaces a less reactive metal from its compound in aqueous solution. To determine which metal is more reactive, you can carry out displacement reactions between metals X and Y with solutions of salts containing the ions of both metals. If metal X displaces metal Y from its salt solution, then metal X is more reactive than metal Y and vice versa.

3. (i) Transfer of electrons during the creation of magnesium chloride:



(ii) **Properties of Ionic Compounds:**

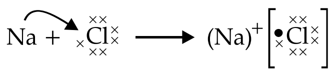
(1) Solubility: Ionic (electrovalent) compounds are generally soluble in water but remain insoluble in non-polar solvents like kerosene, petrol, and similar substances.

(2) Electrical Conductivity: Ionic compounds do not conduct electricity in their solid state because the ions are fixed in position within the crystal lattice. However, they conduct electricity when dissolved in water or in their molten state, as the ions become free to move and carry charge in these conditions.

(iii) (a) Sodium (Na) atom has one electron in its outermost shell. It loses this electron, achieving a stable octet configuration and forms a positively charged sodium ion (Na^+). On the other hand, chlorine (Cl) atom has seven electrons in its outermost shell and needs one more to complete its octet. It gains the electron lost by sodium, forming a negatively charged chloride ion (Cl^-). These oppositely charged ions attract each other due to electrostatic forces, resulting in the formation of the ionic compound sodium chloride (NaCl).

$$\underset{2,8,1}{Na} \rightarrow \underset{\substack{2,\,8 \\ \text{(Sodium cation)}}}{Na^+} + e^-$$

$$\underset{2,8,7}{Cl} + e^- \rightarrow \underset{\substack{2,\,8,\,8 \\ \text{(chloride anion)}}}{Cl^-}$$



OR

(b) (1) The conduction of electricity through a solution involves the movement of charged particles. A solution of an ionic compound in water contains ions, which move to the opposite electrodes when electricity is passed through the solution. Ionic compounds in the solid state do not conduct electricity because movement of ions in the solid is not possible due to their rigid structure. But ionic compounds conduct electricity in the molten state. This is possible in the molten state since the elecrostatic forces of attraction between the oppositely charged ions are overcome due to the heat. Thus, the ions move freely and conduct electricity.

(2) When electricity is passed through a solution of sodium chloride in water, hydrogen gas is released twice as much as oxygen gas is released at the anode.

4. (i) **Electronic Configuration of Sodium (Na):** 2, 8, 1
Sodium can lose 1 electron from its 3s orbital to achieve the stable octet configuration of neon (Ne), its nearest noble gas. Thus, sodium loses 1 electron to have a stable octet.

(ii) **Electronic Configuration of Chlorine (Cl):** 2, 8, 7
Chlorine can gain 1 electron to complete its 3p orbital, achieving the stable octet configuration of argon (Ar), its nearest noble gas. Thus, after gaining one electron, chlorine will attain the octet configuration of argon.

(iii) (a)
$$\underset{[2,8,2]}{Mg} \longrightarrow \underset{[2,8]}{Mg^{2+}} + 2e^-$$
$$\underset{[2,6]}{O} + 2e^- \longrightarrow \underset{[2,8]}{O^{2-}}$$
$$Mg{:} + \overset{\times\times}{\underset{\times\times}{Cl}}{\times} \longrightarrow [Mg^{2+}]\,[O^{2-}]$$
$$Mg^{2+} + O^{2-} \longrightarrow MgO$$

OR

(b) (1) **Sodium chloride (NaCl):**
- **Cation:** Sodium ion (Na^+).
- **Anion:** Chloride ion (Cl^-)

(2) **Potassium nitrate (KNO_3)**
- **Cation:** Potassium ion (K^+).
- **Anion:** Nitrate ion (NO_3^-)

5. (i) Iron is placed in the middle of the reactivity series of metals. It is less reactive than metals like sodium and calcium but more reactive than metals like copper and gold.

Forms in which iron ores are found in nature:
- Hematite (Fe_2O_3)
- Magnetite (Fe_3O_4)
- Limonite ($FeO(OH).nH_2O$)
- Siderite ($FeCO_3$)

(ii)

	Roasting	Calcination
1.	Roasting is done in case of sulphide ores.	Calcination is done in case of carbonate ores.
2.	In this, the ore is heated in the presence of excess air to convert it into its oxide compound.	The carbonate ore is heated in the absence of air (limited supply of air) to convert into its oxide.
3.	The gas given out is SO_2 (sulphur dioxide) gas.	The gas given out is CO_2 (carbon dioxide) gas.
4.	Example: $2ZnS + 3O_2 \xrightarrow{\text{Heat}} 2ZnO + 2SO_2\uparrow$	Example: $ZnCO_3 \xrightarrow{\text{Heat}} ZnO + CO_2\uparrow$

(iii) (a) Rusting of iron can be prevented by the following two ways:
(1) By coating the surface of iron with paint, air and moisture cannot come in contact with it, and hence, no rusting takes place.
(2) Applying grease or oil on the surface of the iron: This method also prevents air and moisture from coming in contact with the iron, and hence, no rusting takes place.

OR

(b) Aluminium is used in thermite welding to join railway tracks or cracked machine parts because it reacts exothermically with iron oxide to produce molten iron, which fuses the parts together. This process is known as the thermite reaction.
$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3$$
This reaction produces a significant amount of heat, melting the iron and allowing it to flow and fill the gaps in the broken parts, creating a strong, welded joint.

6. (i) The ore of Mercury is Cinnabar (HgS), and Mercury is present in it as mercuric sulphide.

(ii) When zinc carbonate ($ZnCO_3$) is heated strongly in a limited supply of air, it undergoes thermal decomposition to form zinc oxide (ZnO) and carbon dioxide (CO_2). The reaction is as follows:
$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$

(iii) (a) (I) The metal A is aluminium (Al). The reaction taking place is the thermit reaction.
(II) The chemical equation for the thermit reaction is:
$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3 + \text{Heat}$$

OR

(b) We cannot use carbon to obtain sodium from sodium oxide because sodium is more reactive than carbon, and thus carbon cannot reduce sodium oxide.
Reactions during electrolytic reduction of sodium chloride:
- At the cathode (reduction): $Na^+ + e^- \longrightarrow Na$
- At the anode (oxidation): $2Cl^- \longrightarrow Cl_2 + 2e^-$

Level - 3

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Some metals react with acids to produce a salt and hydrogen gas. For example, when magnesium reacts with hydrochloric acid, magnesium chloride (a salt) and hydrogen gas are produced. The chemical equation for this reaction is:
$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$
To detect the presence of hydrogen gas, bring a burning match or candle near the mouth of the test tube, where the reaction is occurring. If hydrogen gas is present, it will ignite and produce a characteristic 'pop' sound. This is due to hydrogen's high

flammability, which causes it to react with oxygen in the air and form water vapour when ignited, creating a popping sound.

2. **Ductility** can be defined as the property of a metal by virtue of which it can be stretched or drawn into a thin wire without breaking.

Malleability can be defined as the property of a metal by virtue of which it can be beaten, rolled, or pressed into thin sheets without breaking.

Gold (Au) is an element that exhibits both ductility and malleability. Gold's ability to exhibit both ductility and malleability is due to the nature of its metallic bonding, where the atoms are arranged in a close-packed structure and can slide over each other with relative ease, allowing the metal to deform without breaking.

3. (i) (a) When zinc metal is placed in copper(II) sulphate ($CuSO_4$) solution, zinc displaces copper from the solution. The copper(II) sulphate solution, which is blue due to the presence of Cu^{2+} ions, changes to colourless as $ZnSO_4$ forms in the solution. Copper metal is deposited as a reddish-brown solid.

$$\underset{}{Zn(s)} + \underset{\text{Copper sulphate (Blue)}}{CuSO_4(aq)} \longrightarrow \underset{\text{Zinc Sulphate (Colourless)}}{ZnSO_4(aq)} + \underset{\text{Copper (Reddish-brown Solid)}}{Cu(s)}$$

(b) In the reaction between sodium chloride and silver nitrate ($AgNO_3$), a white ppt of silver chloride (AgCl) is formed.

$$\underset{\text{Silver nitrate}}{AgNO_3(aq)} + \underset{\text{Sodium chloride}}{NaCl(aq)} \longrightarrow \underset{\text{Silver chloride (White ppt.)}}{AgCl(s)(\downarrow)} + \underset{\text{Sodium nitrate}}{NaNO_3(aq)}$$

(ii) (a) When a zinc plate is dipped in ferrous sulphate ($FeSO_4$) solution, zinc displaces iron from the solution. This causes the pale green colour of the ferrous sulphate solution to disappear as zinc sulphate, which is colourless, is formed. Iron is deposited as a solid on the zinc plate.

(b) $$Zn(s) + \underset{\text{Ferrous sulphate (Pale green)}}{FeSO_4(aq)} \rightarrow \underset{\text{Zinc Sulphate (Colourless)}}{ZnSO_4(aq)} + Fe(s)$$

4. **Metal 'A':** Reacts violently with cold water and the gas evolved catches fire: Sodium reacts vigorously with cold water, producing hydrogen gas that often catches fire.

Metal 'B': When dipped in water, starts floating. Calcium reacts with water, forming calcium hydroxide and hydrogen gas. The hydrogen gas formed makes the calcium float on the water.

Metal 'C': Does not react either with cold or hot water, but reacts with steam. Zinc does not react with cold or hot water but reacts with steam to form zinc oxide and hydrogen gas.

Metal 'D': Does not react with water at all. Gold is a noble metal and does not react with water.

So, the identified metals are:

Metal 'A': Sodium (Na)

Metal 'B': Calcium (Ca)

Metal 'C': Zinc (Zn)

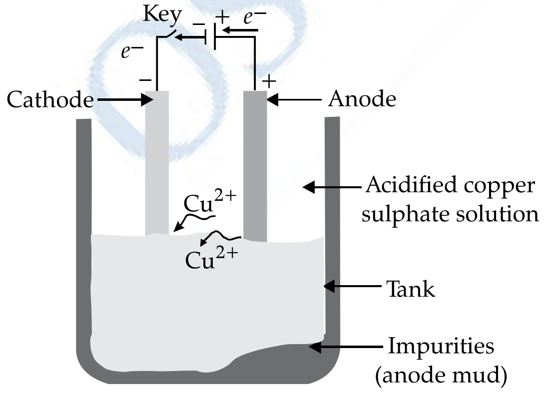
Metal 'D': Gold (Au)

5. (i) (1) Sodium chloride imparts a yellow colour to the flame. This is due to the excitation of sodium ions, which emit a characteristic bright yellow light when heated.

(2) Calcium chloride imparts an orange-red colour to the flame. This is due to the excitation of calcium ions, which emit an orange-red light when heated.

(ii) No, these compounds are not soluble in organic solvents such as kerosene or petrol. Sodium chloride and calcium chloride are both ionic compounds, and ionic compounds are generally soluble in polar solvents like water. Kerosene and petrol are non-polar solvents, and non-polar solvents do not effectively dissolve ionic compounds due to the lack of strong interactions between the solvent molecules and the ions. Therefore, sodium chloride and calcium chloride are insoluble in non-polar solvents like kerosene and petrol.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. 

Electrolytic refining of copper

When electric current passes through the electrolyte (acidified copper sulphate solution), the impure copper anode releases copper ions (Cu^{2+}) into the solution. These positive copper ions migrate towards the pure copper cathode, where they gain electrons and are deposited as pure copper. Simultaneously, the impurities from the anode either dissolve into the electrolyte or settle as sludge (anode mud) at the bottom of the tank. This process results in the purification of copper, where the cathode grows with deposited pure copper.

At anode: $Cu \rightarrow Cu^{2+} + 2e^-$

At cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

2. (i) **Mercury (Hg):** Mercury is obtained by the reduction of its ore, cinnabar (HgS), through roasting in the presence of air. Mercury lies low

in the reactivity series, so it can be easily reduced by heating its sulphide ore in air. The sulphur in cinnabar combines with oxygen to form sulphur dioxide (SO_2), leaving behind pure mercury.

$$HgS + O_2 \longrightarrow Hg + SO_2$$

(ii) Copper (Cu): Copper is extracted by the reduction of its oxide ores, such as cuprite (Cu_2O), or directly from sulphide ores like chalcopyrite ($CuFeS_2$) through roasting and smelting. Copper is moderately reactive and does not require very strong reducing agents. It can be obtained by heating its oxide with carbon or through self-reduction of sulphides.

$$2Cu_2O + C \longrightarrow 4Cu + CO_2$$

OR

$$2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$$
$$2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$$

(iii) Sodium (Na): Sodium is extracted by the electrolysis of molten sodium chloride (NaCl). Sodium is highly reactive and cannot be reduced using carbon or other chemical reducing agents. Hence, it requires a strong method like electrolysis. During electrolysis, sodium ions are reduced at the cathode to form sodium metal.

3. (i) Silver (Ag): When silver is exposed to atmospheric air for some time, it undergoes a chemical reaction with sulphur compounds (i.e., hydrogen sulphide) present in the air, leading to the formation of silver sulphide (Ag_2S). As silver sulphide is a black compound, so the change in appearance observed on the surface of silver objects is the formation of a black tarnish layer. Change:

$$4Ag + 2H_2S + O_2 \longrightarrow 2Ag_2S + 2H_2O$$

(ii) **Copper (Cu):** When copper is exposed to the atmosphere, it undergoes corrosion and turns green in colour. This happens because the metal reacts with moisture and atmospheric gases such as carbon dioxide (CO_2) and oxygen (O_2). As a result, a mixture of copper carbonate ($CuCO_3$) and copper hydroxide [$Cu(OH)_2$] forms on the surface of the copper. This green layer, known as patina, acts as a protective coating that prevents further corrosion of the metal.

$$2Cu + H_2O + CO_2 + O_2 \longrightarrow Cu(OH)_2 + CuCO_3$$

(iii) Iron (Fe): When iron is exposed to atmospheric air for some time, it undergoes oxidation reactions with oxygen and moisture to form hydrated iron(III) oxide [$Fe_2O_3.xH_2O$] (rust). Rust appears as a reddish-brown flaky layer on the surface of iron objects. The formation of rust is a common example of corrosion, which weakens the structure of iron and eventually leads to its deterioration if not prevented.

$$4Fe + xH_2O + 3O_2 \longrightarrow 2Fe_2O_3.xH_2O$$

4. The ore of mercury is Cinnabar (HgS). It is found in nature as mercuric sulphide (HgS).

The extraction of mercury from cinnabar ore involves two steps.

(1) The concentrated mercury (II) sulphide ore is roasted in the air to form mercuric oxide (HgO).

(2) This mercuric oxide formed is then reduced to mercury on further heating to about 300°C.

$$2\,HgS_{(s)} + 3O_{2(g)} \xrightarrow{\Delta} 2\,HgO_{(s)} + 2\,SO_{2(g)}$$
$$2\,HgO_{(s)} \xrightarrow{\Delta} 2\,Hg_{(l)} + O_{2(g)}$$

Conditions Required:

- The roasting is carried out in a controlled furnace at a high temperature.
- Sufficient oxygen supply is essential for the reaction to occur efficiently.

Through this process, mercury is obtained in its liquid metallic state, which is then purified further if needed.

5. Roasting and calcination are two different processes used in metallurgy to extract metals from their ores. Here are the main differences between roasting and calcination:

(1) Temperature: Roasting is carried out at a high temperature, typically above 600°C, whereas calcination is conducted at a relatively lower temperature, usually below 600°C.

(2) Gas Environment: Roasting is performed in the presence of excess oxygen or air, while calcination is usually carried out in the absence or limited supply of air, resulting in a reducing or inert atmosphere.

In both roasting and calcination, metal reduction occurs as part of the process to obtain the desired metal. The reduction is accomplished by using a reducing agent, which reacts with the metal oxide present in the roasted or calcined ore.

Let's take an example of the roasting of a sulfide ore to extract copper:

Roasting of copper iron sulphide ore ($CuFeS_2$):

$$2CuFeS_2(s) + 3O_2(g) \rightarrow 2CuS(s) + 2FeO(s) + 2SO_2(g)$$

In this case, the ore, copper iron sulphide ($CuFeS_2$), is heated in the presence of oxygen (O_2). The sulphur in the ore combines with oxygen to form sulphur dioxide (SO_2) gas, which escapes into the atmosphere. The copper sulfide (Cu_2S) is left behind as a solid, and the iron in the ore is converted to iron oxide (FeO).

LONG ANSWER TYPE QUESTIONS (5 Marks)

1.
- **Element X (At. No. 12):** Electronic configuration: 2, 8, 2
- **Element Y (At. No. 17):** Electronic configuration: 2, 8, 7

Formation of Ionic Compound:

- Element X loses two electrons to form a X^{2+} ion:

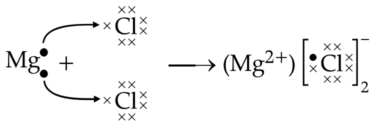
$$X \longrightarrow X^{2+} + 2e^-$$

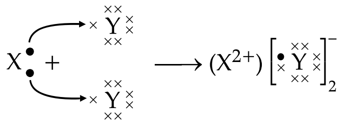
- Element Y gains one electron to form a Y^- ion:

$$Y + e^- \longrightarrow Y^-$$

- Since X^{2+} requires two Y^- ions to balance its charge, the formula of the compound is XY_2.

Thus, the ionic compound XY_2 formed above is Magnesium chloride ($MgCl_2$).





Effect of Passing Electric Current through Aqueous Solution of $MgCl_2$:

When $MgCl_2$ is dissolved in water, it dissociates into its constituent ions:

$$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$$

At Cathode: The Mg^{2+} ions migrate to the cathode. At the cathode, these ions gain electrons and are reduced to form magnesium metal.

$Mg^{2+} + 2e^- \longrightarrow Mg$ (Metal deposited at cathode)

At Anode: The Cl^- ions migrate to the anode. At the anode, these ions lose electrons and are oxidised to form chlorine gas.

$2Cl^- \longrightarrow Cl_2 + 2e^-$ (Chlorine gas released at anode)

Ions Reaching Electrodes:

(i) **Cathode (Negative Electrode):** Mg^{2+} ions are reduced to magnesium metal.

(ii) **Anode (Positive Electrode):** Cl^- ions are oxidised to chlorine gas.

2. (i) **Two metals of moderate reactivity:**

- Two metals of moderate reactivity are iron (Fe) and zinc (Zn).
- Zinc is more reactive than iron.

Experimental Demonstration in School Laboratory: The reactivity of these metals can be demonstrated using a displacement reaction:

- Take solutions of zinc sulphate ($ZnSO_4$) and iron sulphate ($FeSO_4$) in separate test tubes.
- Add a strip of iron to the zinc sulphate solution and observe. There will be no reaction as iron is less reactive than zinc.
- Add a strip of zinc to the iron sulphate solution. Zinc will displace iron from its solution because zinc is more reactive than iron.

  $Zn + FeSO_4 \longrightarrow ZnSO_4 + Fe$

  This confirms that zinc is more reactive than iron.

(ii) Some metals of moderate reactivity, such as zinc and iron, are found in the Earth's crust as carbonates. The extraction involves the following processes:

(1) Conversion of Carbonates to Oxides (Calcination):

- The carbonate ore is heated in the absence of air (calcination) to convert it into metal oxide.
- Example for zinc carbonate ($ZnCO_3$):

  $ZnCO_3 \xrightarrow{\text{Heat}} ZnO + CO_2$

(2) Reduction of Oxides to Metals:

- The metal oxide is reduced using a suitable reducing agent, such as carbon (coke), to obtain the pure metal.
- Example for zinc oxide (ZnO):

  $ZnO + C \xrightarrow{\text{Heat}} Zn + CO$