CHAPTER

3 METALS AND NON-METALS

Syllabus

Properties of metals and non-metals; Reactivity series; Formation and properties of ionic compounds; Basic metallurgical processes; Corrosion and its prevention.

Trend Analysis

List of Concept names	2018	2019		2020	
	OD/D	OD	D	OD	D
Properties of metals and Non-metals; Reactivity series, amphoteric oxides		1 Q (2 M) 1 Q (3 M)	1 Q (5 M)	1 Q (5 M)	1 Q (5 M)
Formation and properties of ionic compounds; Basic metallurgical processes; Corrosion and its prevention	1 Q (5 M)	Or 1 Q (2 M)			

TOPIC - 1
Properties of Metals and Non-Metals

Revision Notes

Introduction

- Metals are mostly solids, possessing high density. They have high melting and boiling points. They are lustrous and sonorous. They are good conductors of heat and electricity.
- Most of the metals are hard. However, some of the metals like sodium, potassium are soft metals and can be easily cut with knife.
- All metals are solids except Mercury, Caesium, Francium, Germanium and Gallium which are solids with low melting point. Gallium becomes liquid if kept on palm but Gallium has very high boiling point which makes it useful for high temperature thermometers.

➢ **Physical Properties:**

Property	Metals	Non-Metals
1. Lustre	Metals have shining surface.	They do not have shining surface. • Except Iodine.
2. Hardness	They are generally hard. • Except Sodium, Lithium and Potassium which are soft and can be easily cut with knife.	Generally soft. • Except Diamond, a form of carbon which is the hardest natural substance.
3. State	Exist as solids. • Except Mercury that exists in liquid.	Exist as solids or gases • Except Bromine that exists in liquid.
4. Malleability	Metals can be beaten into thin sheets. • Gold, Silver and Aluminium are the most malleable metals.	Non-metals are non-malleable. • They are brittle.
5. Ductility	Metals can be drawn into thin wires.	They are non-ductile.
6. Conductor of heat & electricity	Metals are good conductors of heat and electricity.	Non-metals are poor conductors of heat and electricity. • Except Graphite.
7. Density and Melting point	Generally metals have high density and high melting point. • Except Sodium and Potassium	Non metals have low density and low melting point.
8. Sonorous	Metals produce a sound on striking a hard surface.	They are not sonorous.
9. Oxides	Metallic oxides are basic in nature.	Non-metallic oxides are acidic in nature.

➢ **Chemical Properties:**

(A) Reaction with Air:

Metals combine with oxygen to form metal oxide.

$Metals + O_2 \rightarrow Metal\ oxide$

Examples:

(i) $2Cu + O_2 \rightarrow 2CuO$
Copper (II) oxide (black)

(ii) $4Al + 3O_2 \rightarrow 2Al_2O_3$
Aluminium oxide

(iii) $2Mg + O_2 \rightarrow 2MgO$
Magnesium oxide

Scan to know more about this topic

Metals and non metals

➢ Different metals show different reactivity towards O_2.

- Na and K react so vigorously with oxygen that they catch fire if kept in open. So they are kept immersed in kerosene.
- Surfaces of Mg, Al, Zn and Pb are covered with a thin layer of oxide which prevent them from further oxidation.
- Fe does not burn on heating but iron fillings burn vigorously.
- Cu does not burn but is coated with black copper (II) oxide.
- Au and Ag do not react with oxygen.

➢ **Amphoteric Oxides:** Metal oxides which react with both acids as well as bases to produce salt and water are called amphoteric oxides.

Examples: $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$
Aluminium chloride

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$
Sodium aluminate

(B) Reaction of Metals with Water:

$Metal + Water \rightarrow Metal\ oxide + Hydrogen$

$Metal\ oxide + Water \rightarrow Metal\ hydroxide$

Examples: $2Mg + 2H_2O \rightarrow 2MgO + 2H_2$
Magnesium oxide

$$MgO + H_2O \rightarrow Mg(OH)_2$$
Magnesium hydroxide

(C) Reaction of Metals with Solutions of other Metal Salts:

Metal A + Salt solution B → Salt solution A + Metal B

- Reactive metals can displace less reactive metals from their compounds in solution form.

$$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$$

- All the metals do not react with the same rate. Some react very fast, some react moderately whereas others react very slowly. The series of metals in decreasing order of reactivity is called **reactivity or activity series of metals.** The metals at the top (K at the top most) are most reactive whereas metals at the bottom (Pt at the extreme bottom) least reactive.

K > Na>Ca>Mg,> Al > Zn > Fe>Sn> Pb,>H > Cu > Hg > Ag > Au > Pt.

- Metals react with dilute acids to form salt and hydrogen gas. The metal replaces hydrogen of the acid to form salt
- **Aqua Regia** is a mixture of conc. HCl and conc. HNO_3 in the ratio of 3: 1. It can dissolve gold and platinum. Aqua Regia is a strong oxidizing agent due to the formation of NOCl (Nitrosyl chloride) and chlorine produced by reaction of two acids.
- **Alloys** are homogeneous mixtures of two or more metals. One of them can be non-metal also, *e.g.*, Brass is an alloy of copper and zinc. When a metal is alloyed with mercury, it is called an **amalgam.**
- Metals in reactivity series, if placed above hydrogen, can displace hydrogen from dilute acids (HCl and H_2SO_4).

Mnemonics

Concept: Activity series of metals

Mnemonics:
Popular **S**cientists **C**an **M**ake **A** **Z**oo **I**n**T**he **L**ow **H**umid **C**ountry **M**ore **S**atisfactorily

Interpretation:

P - Potassium
C - Calcium
A - Aluminium
I - Iron
L - Lead
C - Copper
S - Silver
S - Sodium
M - Magnesium
Z - Zinc
T - Tin
H - Hydrogen
M - Mercury

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. Which one of the following metals does not react with cold as well as hot water?

(a) Na (b) Ca
(c) Mg (d) Fe [NCERT Exemp.]

Ans. Correct option : (d)

Explanation: Metals like aluminium, zinc, iron do not react with hot/cold water. They react with water only when water is in the form of steam.

$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$. 1

Q. 2. What happens when calcium is treated with water?

(i) It does not react with water.
(ii) It reacts violently with water.
(iii) It reacts less violently with water.
(iv) Bubbles of hydrogen gas formed stick to the surface of calcium.

(a) (i) and (iv) (b) (ii) and (iii)
(c) (i) and (ii) (d) (iii) and (iv)
[NCERT Exemp.]

Ans. Correct option : (d)

Explanation: Calcium reacts slowly with water. The reaction forms calcium hydroxide, $Ca(OH)_2$, and hydrogen gas (H_2). The calcium metal sinks in water and after an hour or so bubbles of hydrogen are observed, stuck to the surface of the metal. 1

Q. 3. Generally, non-metals are not lustrous. Which of the following non-metal is lustrous?

(a) Sulphur (b) Oxygen
(c) Nitrogen (d) Iodine
[NCERT Exemp.]

Ans. Correct option : (d)
Explanation: Iodine is a non-metal but it is lustrous. 1

Q. 4. An element A is soft and can be cut with a knife. This is very reactive to air and cannot be kept open in air. It reacts vigorously with water. Identify the element from the following:
(a) Mg (b) Na
(c) P (d) Ca [NCERT Exemp.]

Ans. Correct option : (b)
Explanation: Sodium is so soft that can be cut using a knife. It reacts with oxygen or moisture present in air readily and reacts with water vigorously. Because of this sodium is stored in kerosene oil to prevent any reaction or accident. 1

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): When a piece of copper metal is added to dilute sulphuric acid, the solution turns blue.
Reason (R): Copper reacts with dilute sulphuric acid to form blue copper (II) sulphate solution.

Ans. Correct option : (a)
Explanation: When a piece of copper metal is added to dilute sulphuric acid, the solution turns blue. It is because, copper reacts with dilute sulphuric acid to form blue copper (II) sulphate solution. 1

Q. 2. Assertion (A): Metals are sonorous.
Reason (R): They are generally brittle in the solid state; they break into pieces when hammered.

Ans. Correct option :(c)
Explanation: Metals are sonorous, malleable and ductile while non-metals are brittle. 1

Q. 3. Assertion (A): Gas bubbles are observed when sodium carbonate is added to dilute hydrochloric acid.
Reason (R): Carbon dioxide is given off in the reaction.

Ans. Correct option : (a)
Explanation: Gas bubbles are observed when sodium carbonate is added to dilute hydrochloric acid as CO_2 gas is released. 1

C Very Short Answer Type Questions

Q. 1. The compound obtained on reaction of iron with steam is/are: R [CBSE Delhi 2020]

Ans. Fe_3O_4
$3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$ 1

Q. 2. An element 'X' reacts with O_2 to give a compound with a high melting point. This compound is also soluble in water. The element 'X' is likely to be: U [Delhi 2020]

Ans. Calcium reacts with oxygen and form CaO which has high melting point and is water soluble. 1

Q. 3. Name a non-metal which is lustrous and a metal which is non-lustrous. AE [DDE 2017]

Ans. Non-metal (lustrous) = Iodine (I)
Metal (non-lustrous) = Sodium (Na) ½+½

Q. 4. Why is gold a preferred metal for making jwellery? (Any two reasons) R

Ans. Due to the property of malleability, ductility and it is lustrous (Any two) ½+½

Q. 5. Which of the two, metal or non metal will form an oxide which is basic in nature? U

Ans. Metal, because metal oxides are basic in nature. 1

AI **Q. 6. How are oxides of metal different from oxides of non metals in terms of their nature?** U

Ans. Metallic oxides are basic, few are amphoteric.
Non-metallic oxides are acidic, few are neutral.
½+½

Short Answer Type Questions-I 2 marks each

Q. 1. The following observations were made by a student on treating four metals P, Q, R and S with the given salt solutions: C [CBSE 2020]

Sample	$MgSO_4$ (aq)	$Zn(NO_3)_2$ (aq)	$CaSO_4$ (aq)	Na_2SO_4 (aq)
P	No reaction	Reaction occurs	Reaction occurs	No reaction
Q	Reaction occurs	Reaction occurs	Reaction occurs	Reaction occurs
R	No reaction	Reaction occurs	No reaction	No reaction
S	No reaction	No reaction	No reaction	No reaction

Based on the above observations:
(a) Arrange the given samples in the increasing order of reactivity
(b) Write the chemical formulae of products formed when Q reacts with $CuSO_4$ solution.

Ans. (a) S>R>P>Q
(b) Cu and QSO_4 2

Q. 2. Give reasons:

(a) Platinum, gold and silver are used to make jewellery.

(b) Metals like sodium and potassium are stored under oil. AE [CBSE Outside delhi 2019]

Ans. (a) Lustre, ductile, malleable, least reactive
(Any two) ½ + ½

(b) Na & K are highly reactive (in air & moisture).
[CBSE Marking Scheme, 2019] 2

Q. 3. Silver articles become black when kept in open for some time, whereas copper vessels lose their shiny brown surfaces and gain a green coat when kept in open. Name the substances present in air with which these metals react and write the name of the products formed. A [Outside Delhi 2019]

Ans.

Silver	Sulphur in air	Silver sulphide ½+½
Copper	Moisture an carbon dioxide	Copper carbonate ½×4½=2

[CBSE Marking Scheme, 2019] 2

Q. 4. Give reasons:

(a) Carbonate and sulphide ores are usually converted into oxides during the process of extraction.

(b) Aluminium is a highly reactive metal; still it is widely used in making cooking utensils. U [Outside Delhi 2019]

Ans. (a) It is easier to obtain a metal from its oxide as compared to sulphide and carbonate ore.

(b) Aluminium forms a thicker protective oxide layer.
[CBSE Marking Scheme, 2019] 2

Q. 5. Give reasons for the following:

(i) Most metals conduct electricity well.

(ii) The reaction of iron (III) oxide [Fe_2O_3] with heated aluminium is used to join cracked machine parts. AE [CBSE Delhi 2019]

Ans. (i) Metals have loosely bound electrons / Loose electrons easily / free electrons.

(ii) Molten iron produced during reaction joins the cracked machine parts.
[CBSE Marking Scheme, 2019] 2

Short Answer Type Questions-II — 3 marks each

AI **Q. 1. What are amphoteric oxides? Give an example. Write balanced chemical equations to justify your answer.** R [CBSE Board Outside Delhi, Set-I, 2019]

Ans. Amphoteric oxides: Metal oxides showing both acidic and basic nature.

Example: Al_2O_3 / ZnO (or any other)

$Al_2O_3 + 6HCl \longrightarrow 2AlCl_3 + 3H_2O$

$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$

½ + ½ + 1 + 1
[CBSE Marking Scheme, 2019]

Detailed Answer:

Oxides of metals which have both acidic as well as basic behaviour are known as amphoteric oxides. Examples are aluminium oxide and zinc oxide. Amphoteric oxides react with acids as well as base to form salt and water. ZnO reacts with hydrochloric acid (acid) to form zinc chloride (salt) and water thus acting as basic oxide.

$$\underset{\text{Zinc oxide}}{ZnO(s)} + \underset{\text{Hydrochloric acid (Acid)}}{2HCl(aq)} \rightarrow \underset{\text{Zinc chloride (Salt)}}{ZnCl_2(aq)} + \underset{\text{Water}}{H_2O(l)}$$

ZnO reacts with sodium hydroxide (base) to form sodium zincate (salt) and water thus, acting as acidic oxide.

$$\underset{\text{Zinc oxide}}{ZnO(S)} + \underset{\text{Sodium hydroxide (Base)}}{2NaOH(aq)} \rightarrow \underset{\text{Sodium zincate (Salt)}}{Na_2ZnO_2(aq)} + \underset{\text{Water}}{H_2O(l)}$$

1 + 1 + 1

Q. 2. You are given samples of three metals: Sodium, magnesium and copper. Suggest any two activities to arrange them in order to their decreasing reactivity. U [Board Term-I, 2016]

Ans. Different metals react with oxygen at different rates. *e.g.*, Sodium (Na) and potassium (K) catch fire, if left in open. Hence, these are the most reactive metals. To prevent accidental fires, these metals are kept immersed in kerosene oil. Magnesium burns in air only by heating. So, it is less reactive than sodium and potassium. Copper (Cu) does not burn on heating but blister copper burns. Hence the order of reactivity of these metals with oxygen is:

Na > Mg > Cu.

Metals react with water to produce a metal oxide and hydrogen gas. Sodium (Na) and potassium (K) react violently with cold water. So the reaction is violent and exothermic. Magnesium (Mg) does not react with cold water. It reacts with hot water. Metals like lead, copper, silver do not react with water at all. The reactivity series of metals towards water is:

Na > Mg > Cu. 1½ + 1½

COMMONLY MADE ERROR

- Students usually get confused with the order of reactivity of metals.

ANSWERING TIP

- Understand the concept of reactivity of metals and how to arrange them in increasing or decreasing order.

AI **Q. 3. State reason for the following:**

(i) Non-metals cannot displace hydrogen from the acids.

(ii) Hydrogen is not a metal, yet it is placed in the activity series of metals.

(iii) Aluminium is more reactive than iron, yet its corrosion is less than that of iron.

U [Board Term-I, 2015]

Ans. (i) Non-metals are electron acceptors, they cannot supply electrons so as to convert H^+ ion to $H_2(g)$.

(ii) Like metals, hydrogen can lose an electron to form positive H^+ ion.

(iii) Aluminium reacts with oxygen in atmosphere and forms a strong protective layer of oxide which protects the metal from further corrosion. **1+1 + 1**

Long Answer Type Questions — 5 marks each

Q. 1. A metal 'M' is stored under kerosene. It vigorously catches fire, if a small piece of this metal is kept open in air. Dissolution of this metal in water releases great amount of energy and the metal catches fire. The solution so formed turns red litmus blue. C [CBSE Outside Delhi 2020]

(a) Name the metal 'M'.

(b) Write formula of the compound formed when this metal is exposed to air.

(c) Why is metal 'M' stored under kerosene ?

(d) If oxide of this metal in treated with hydrochloric acid, what would be the products?

(e) Write balanced equations for:

(i) Reaction of 'M' with air.

(ii) Reaction of 'M' with water.

(iii) Reaction of metal oxide with hydrochloric acid.

Ans. (a) Metal M is sodium (Na).

(b) Formula of the compound formed is Na_2O.

(c) Metals like sodium and potassium react with oxygen so fast that they can catch fire if kept open. Since, they are most reactive metals; they are always kept immersed in kerosene oil to prevent accidental fire.

(d) Sodium oxide reacts with hydrochloric acid to produce sodium chloride and water.

(e) (i) Reaction with air:

$4Na + O_2 \rightarrow 2Na_2O$

(ii) Reaction with water:

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

(iii) Reaction of sodium oxide with HCl:

$Na_2O(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l)$

1 × 5 = 5

Q. 2. (a) List in tabular form any three chemical properties on the basis of which metals and non-metals are differentiated.

(b) State two ways to prevent the rusting of iron.

R+U [Compartment Set 1, 2,3 , 2018]

Ans. (a)

S. No.	Metals	Non-Metals
1.	Lose electrons to form positive ions/ are electropositive in nature.	Gain electrons to form negative ions/ are electronegative in nature.
2.	React with dilute acids to liberate hydrogen gas.	Do not react with dilute acids .
3.	Generally metal oxides are basic in nature.	Generally non-metal oxides are acidic in nature.

(b) (i) Painting

(ii) Oiling

(iii) Galvanization

(vi) Alloying **(or any other)**

[CBSE Marking Scheme, 2018]5

COMMONLY MADE ERROR

- Students get confused and interchange the properties of metals and non metals.

ANSWERING TIP

- Don't get confused between acceptor and gainer of electron concept.
- Learn and understand the properties of both metals and non metals with examples.

TOPIC - 2
Ionic compounds, Metallurgy and Corrosion

Revision Notes

➤ **Ionic Compounds**

The compounds formed by the transfer of electrons from a metal to a non-metal are called ionic compounds or electrovalent compounds.

➤ **Properties of Ionic Compounds**

(i) **Physical nature:** They are solid and hard, generally brittle.
(ii) **Melting and Boiling Point:** They have high melting and boiling points.
(iii) **Solubility:** Generally soluble in water and insoluble in solvents such as kerosene, petrol etc.
(iv) **Conduction of electricity:** Ionic compounds conduct electricity in molten and solution form but not in solid state.

➤ **Occurrence of Metals**

- **Minerals:** The elements or compounds which occur naturally in the earth's crust are called minerals.
- **Ores:** Minerals that contain very high percentage of particular metal and the metal can be profitably extracted from it, such minerals are called ores.

➤ **Extraction of metals**

- It is the process of obtaining pure metal from its ore.
- Extraction of metal can be classified into three steps:
  1. Enrichment of ores or concentration of ores
  2. Extraction of metal from the concentrated ores.
  3. Refining of metal

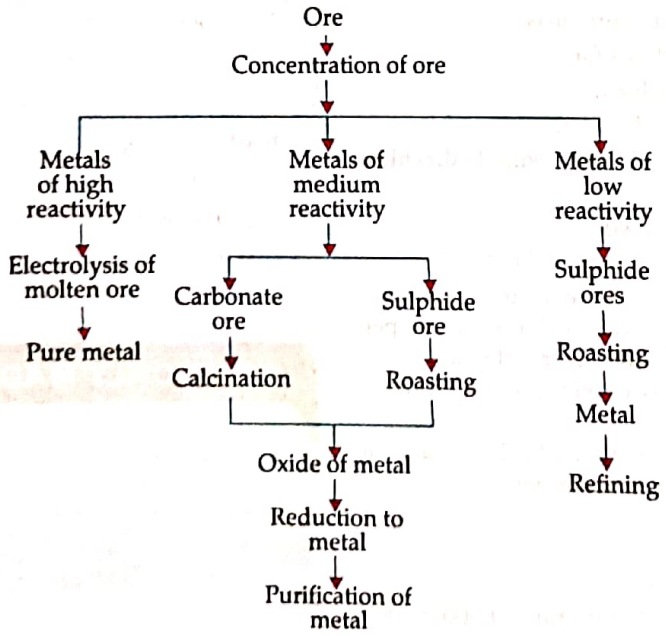


Fig: Steps involved in the extraction of metals from ores.

Scan to know more about this topic

Difference between metals and non-metals

➤ **Alloys**

- An alloy is a homogeneous mixture of two or more metals or a metal and non-metal. It is prepared by mixing the molten metals in definite proportions and then cooling the mixture at the room temperature.

- Examples include:

Alloys	Constituents
Stainless steel	Iron, carbon, nickel, chromium
Brass	Copper and zinc
Bronze	Copper and tin
Solder	Lead and tin

➢ **Amalgam:** An alloy in which mercury is present as one of the constituents is known as amalgam. e.g. Sodium amalgam and Silver amalgam

Mnemonics

Concept:	Concept:
Mnemonics: Long Route, Short Route, Medium Route	**Mnemonics : Cold Coffee Should Rearranged**
Interpretation: **L**ow **R**eactivity **S**ulphide **O**res **R**oasting **M**etal **R**efining	**Interpretation:** **C**arbonate Ores **C**alcination **S**ulphide ores **R**oasting

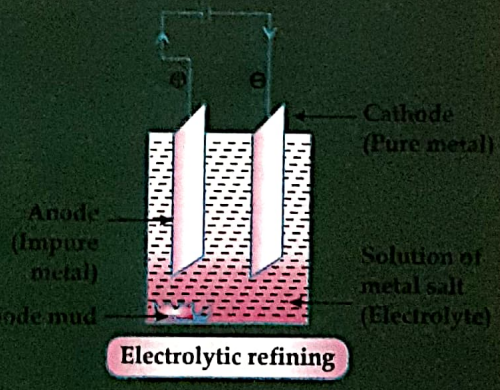
How is it done on the GREENBOARD?

Q. Describe electrolytic refining of copper with chemical equations. Draw a well labelled diagram for it.

Ans. Step I: Electrolytic Refining: This method is widely used as purification of metals like zinc (Zn), copper (Cu), aluminium (Al), chromium (Cr), tin (Sn), lead (Pb), nickel (Ni) and gold (Au).

Step II: In this process, impure metal is used as anode, a strip of pure metal is used as cathode and soluble salt of metal is used as electrolyte. On passing electric current through the electrolyte, cations move towards cathode, gain electrons and pure metal gets deposited on cathode.

Step III: In electrolytic refining of copper, the impurities left behind at anode called anode mud contains valuable metals such as gold and silver which can be recovered in the native state.



Electrolytic refining

3

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. Which of the following metals exist in their native state in nature?

(i) Cu (ii) Au
(iii) Zn (iv) Ag
(a) (i) and (ii) (b) (ii) and (iii)
(c) (ii) and (iv) (d) (iii) and (iv)
[NCERT Exemp.]

Ans. Correct option : (c)
Explanation: Metals such as gold and silver are found as native metals.

Q. 2. Galvanization is a method of protecting iron from rusting by coating with a thin layer of

(a) Gallium (b) Aluminium
(c) Zinc (d) Silver
[NCERT Exemp.]

Ans. Correct option : (c)
Explanation: In the process of galvanization, iron is covered by a coat of zinc. This layer of zinc prevents iron from getting rusted.

Q. 3. Which of the following metals are obtained by electrolysis of their chlorides in molten state?

(i) Na (ii) Ca
(iii) Fe (iv) Cu
(a) (i) and (iv) (b) (iii) and (iv)
(c) (i) and (iii) (d) (i) and (ii)
[NCERT Exemp.]

Ans. Correct option : (d)
Explanation: Sodium and calcium fall towards the top of reactivity series. Since, sodium and calcium are very reactive these metals cannot be reduced to pure form from their oxides or carbonates.
Thus, sodium and calcium are obtained by the process of electrolysis of their chlorides.

Q. 4. An electrolytic cell consists of

(i) positively charged cathode
(ii) negatively charged anode
(iii) positively charged anode
(iv) negatively charged cathode
(a) (i) and (ii) (b) (iii) and (iv)
(c) (i) and (iii) (d) (ii) and (iv)
[NCERT Exemp.]

Ans. Correct option: (b)
Explanation: Positively charged ions are called cations as they are deposited at negatively charged pole. Negatively charged ions are called anions as these are deposited at positively charged pole. That's why the negatively charged pole is called cathode and positively charged pole is called anode.

Q. 5. Alloys are homogeneous mixtures of a metal with a metal or non-metal. Which among the following alloys contain non-metal as one of its constituents?

(a) Brass (b) Bronze
(c) Amalgam (d) Steel
[NCERT Exemp.]

Ans. Correct option: (d)
Explanation: Steel is an alloy of iron and carbon. Mixing of carbon gives strength to iron.

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): A mineral is called ore, when metal is extracted from it conveniently and economically.
Reason (R): All ores are minerals but all minerals are not ores.

Ans. Correct option : (b)
Explanation: Minerals are naturally occurring chemical substances in the earth's crust obtained by mining. But a mineral is called an ore only when the metal can be extracted from it conveniently and economically. Thus, all ores are minerals but all minerals are not ores.

Q. 2. Assertion (A): In the metallurgy of Al, purified Al_2O_3 is mixed with Na_3AlF_6 or CaF_2.
Reason (R): It lowers the melting point of the mixture and brings conductivity.

Ans. Correct option: (a)
Explanation: In the metallurgy of aluminium, purified Al_2O_3 is mixed with Na_3AlF_6 or CaF_2 which lowers the melting point of the mixture and brings conductivity.

Q. 3. Assertion (A): Usually the sulphide ore is converted to oxide before reduction.
Reason (R): Reduction of oxides occurs easier.

Ans. Correct option: (a)
Explanation: Usually the sulphide ore is converted to oxide before reduction as oxides are easier to reduce.

Q. 4. Assertion (A): While the extraction of copper, one of the steps involved is
$Cu_2S + 2Cu_2O \longrightarrow 6Cu + SO_2$

Reason (R): In this reaction Cu_2S is the reducing agent whereas Cu_2O is the oxidising agent.

Ans. Correct option : (c)

Explanation: The Cu^{2+} ion in both the compounds gets reduced while sulphur gets oxidised.

Q. 5. Assertion (A): In alumino thermite process, the metals like iron melts due to the heat evolved in the reaction.

Reason (R): The reaction is:

$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$

Ans. Correct option: (a)

Explanation: Large amount of heat is evolved which melts iron and can be used for welding.

C Very Short Answer Type Questions

Q. 1. Why do ionic compounds not conduct electricity in solid state but conduct electricity in molten and aqueous state? U [CBSE SQP-2020]

Ans. Ionic compound do not conduct electricity in solid state due to absence of free ions but they conduct electricity in molten and aqueous state due to presence of free ions. **1**

Q. 2. State thermite reaction giving the reaction involved. R [Board Term-1] [Set (B1), 2010]

Ans. Reduction of iron oxide to iron by aluminium is called thermite reaction. **1**

$$Fe_2O_3 + 2Al \longrightarrow 2Fe + Al_2O_3 + Heat.$$

AI **Q. 3. Why is painting on iron articles necessary?** AE

Ans. Paint forms a protective coating on the surface of iron. So, oxygen and moisture present in the air cannot have a direct contact with the metal. Therefore, surface gets protected against rusting. **1**

Q. 4. Why carbon is not considered as a good reducing agent while reducing alumina? U

Ans. Because aluminium has greater affinity for oxygen than for carbon, therefore carbon cannot reduce alumina (Al_2O_3) to aluminium. **1**

Q. 5. Show by equation, the product formed when zinc carbonate is heated in absence of oxygen. U

Ans. ZnO(s) and $CO_2(g)$ are formed.

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$ **1**

Short Answer Type Questions-I — 2 marks each

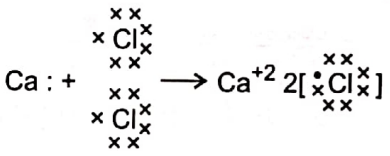
Q. 1. Name a metal of medium reactivity and write three main steps in the extraction of this metal from its sulphide ore. [CBSE Outside Delhi 2019]

Ans. (i) Iron / Zinc / Lead (any one) ½
(ii) Concentration of ore Enrichment of ore ½
(iii) Roasting / conversion of sulphide into oxide on heating in air ½
(iv) Reduction of metallic oxide to metal ½
[CBSE Marking Scheme, 2019]

Q. 2. Explain the formation of Calcium Chloride with the help of electron dot structure. (At numbers: Ca = 20; Cl = 17) [CBSE SQP-2020]

Ans.

	Z	E.C.
Ca	20	2, 8, 8, 1
Cl	17	2, 8, 7,



Ca^{+2} $2Cl^-$
$CaCl_2$

Q. 3. (a) Where does the metal aluminium, used in the process, occurs in the reactivity series of metals?

(b) Name the substances that are getting oxidised and reduced in the process. [CBSE Delhi 2020]

Ans. **(a)** As aluminium is more reactive than iron, so it is placed above iron in the reactivity series.

(b) Aluminium is getting oxidised to aluminium oxide and iron oxide is getting reduced to iron.

Short Answer Type Questions-II — 3 marks each

Q. 1. What is thermit process? Where is this process used? Write balanced chemical equation for the reaction involved. [CBSE Delhi 2020]

Ans. **Thermite reaction:** Reaction in which iron oxide reacts with aluminium to produce molten iron.

The thermite reaction is used to join railway tracks or cracked machine parts.

This process is called thermite welding.

It is an exothermic process.

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

Q. 2. An ore on treatment with dil. HCl gives the smell of rotten egg. Name the type of this ore. How can the metal be obtained from its concentrated ore? [CBSE OD 2019]

Topper Answer, 2019

Ans.

Smell of rotten eggs is usually produced by Sulphur.

∴ It must be a sulphide ore.

Let us suppose that the ore is Zinc Blende (ZnS).

Concentration of ore

First of all, the ore is concentrated by the method of Froth floatation.

Conversion into metal oxide

Then it is roasted converted into its metal oxide via Roasting in supply of excess air.

For eg: $ZnS + O_2 \xrightarrow[\Delta]{\text{Roasting}} ZnO + SO_2 \uparrow$

Zinc sulphide ore; (excess air); zinc oxide; sulphur dioxide (pungent smell)

Conversion into metal

It is then converted into its metal form by using a reducing agent like Carbon, Aluminium etc.

for eg: $ZnO + C \xrightarrow{\text{reduction}} Zn + CO$

zinc oxide; (reducing agent) Carbon; zinc metal (contaminated); Carbon monoxide

It is further refined to get it in its pure form.

Q. 3. Explain the following:

(a) Sodium chloride is an ionic compound which does not conduct electricity in solid state, whereas it conducts electricity in molten state as well as in its aqueous solution.

(b) Reactivity of aluminium decreases if it is dipped in nitric acid.

(c) Metals like calcium and magnesium are never found in their free state in nature.

A [CBSE Board Delhi, Set- III, 2019]

Ans. (a) In molten state, due to heat the electrostatic forces of attraction between the oppositely charged ions are overcome. So ions move freely and conduct electricity. In aqueous solutions ions are free and conduct electricity.

(b) Due to the formation of a coating of aluminium oxide / Al_2O_3.

(c) Reactive metals like calcium and magnesium react easily with different elements and occur in the form of ores. 1 + 1 + 1

[CBSE Marking Scheme, 2019]

Detailed Answer:

(a) Sodium chloride is an ionic compound formed by ions of sodium (Na^+) and chlorine (Cl^-). In solid state, ions are fixed in position so no free electrons are available to conduct electricity. Whereas in molten state and aqueous solution of sodium chloride, free electrons are available to conduct electricity.

(b) On dipping aluminium in nitric acid, a layer of aluminium oxide is formed as nitric acid is a strong oxidizing agent. The layer of aluminium oxide prevents further reaction of aluminium due to which the reactivity of aluminium decreases.

(c) Because these metals are highly reactive and readily react with atmospheric oxygen and other gas. **1+1+1**

Q. 4. Given below are the steps for the extraction of copper from its ore. Write the chemical equation of the reactions involved in each case.

(i) Roasting of copper (I) sulphide

(ii) Reduction of copper (I) oxide with copper (I) sulphide

(iii) Electrolytic refining

R [CBSE Board Outside Delhi, Set- III, 2019]

Ans. (i) $2Cu_2S + 3O_2 \xrightarrow{\text{Heat}} 2Cu_2O + 2SO_2$

(ii) $2Cu_2O + Cu_2S \xrightarrow{\text{Heat}} 6Cu + SO_2$

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

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

(1 + 1+ (½ + ½)) [CBSE Marking Scheme, 2019]

Detailed Answer:

(i) Roasting of copper (I) sulphide:

$$\underset{\text{Copper sulphide}}{2Cu_2S(s)} + 3O_2(g) \xrightarrow{\text{Heat}} \underset{\text{Copper oxide}}{2Cu_2O(s)} + 2SO_2(g)$$

(ii) Reduction of copper (I) oxide from copper (I) sulphide:

$$\underset{\text{Copper oxide}}{2Cu_2O(s)} + \underset{\text{Copper sulphide}}{Cu_2S(s)} \xrightarrow{\text{Heat}} 6Cu(s) + SO_2(g)$$

(iii) Electrolytic refining:

At anode: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

At cathode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ **1+1+1**

Q. 5. What is Cinnabar ? How is a metal extracted from cinnabar ? Explain briefly.

R [CBSE Board Term-I, 2016]

Ans. Cinnabar (HgS) is an ore of mercury.

When Cinnabar, HgS is heated in air, it is first converted into HgO, HgO is then reduced to Hg on further heating.

$$2HgS + 3O_2 \xrightarrow{\Delta} 2HgO + 2SO_2$$

$$2HgO \xrightarrow{\Delta} 2Hg + O_2$$

[CBSE Marking Scheme, 2016]

Detailed Answer:

- Cinnabar (HgS) is an ore of Mercury.
- The metals being less reactive can be obtained by reducing their oxides to metals by heating alone. So, when Cinnabar is heated in air, it first changes into its oxide and then into mercury metal.

$$\underset{\text{(Cinnabar)}}{2HgS(s)} + \underset{\text{(Air)}}{3O_2(g)} \xrightarrow{\text{Heat}} \underset{\text{Mercury oxide}}{2HgO(s)} + \underset{\text{Sulphur dioxide}}{2SO_2(g)}$$

$$\underset{\text{mercuric (II) oxide}}{2HgO(s)} \xrightarrow{\Delta} \underset{\text{mercury metal}}{2Hg(l)} + \underset{\text{oxygen}}{O_2(g)}$$

Long Answer Type Questions — 5 marks each

Q. 1. Carbon cannot reduce the oxides of sodium, magnesium and aluminium to their respective metals. Why? Where are these metals placed in the reactivity series? How are these metals obtained from their ores? Take an example to explain the process of extraction along with chemical equations. U [CBSE Delhi 2020]

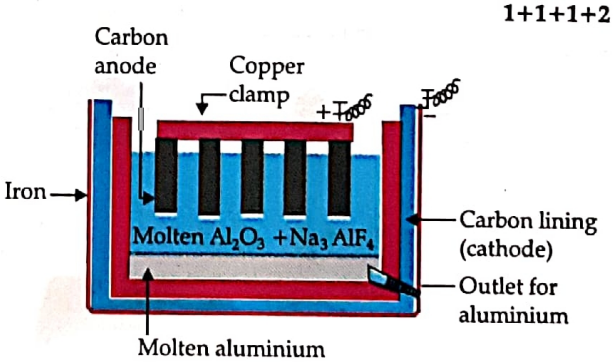
Ans. Metals which are placed high in the reactivity series such as sodium, calcium, magnesium, aluminium etc. are very reactive. These metals have high affinity for oxygen than carbon. Therefore, these metals cannot be obtained by reduction with carbon. For such metals, electrolytic reduction process is used for obtaining metal.

Electrolytic reduction of aluminium: Molten aluminium oxide is electrolysed to produce pure aluminium at the cathode while oxygen gas is produced at the anode.

$Al^{3+} + 3e^- \rightarrow Al$ (aluminium metal at the (–) cathode)

$2O^{2-} - 4e^- \rightarrow O_2$ (oxygen gas at the (+)anode)

1+1+1+2



Electrolytic reduction of aluminium

Q. 2. Write balanced chemical equations to explain what happens, when

(i) Mercuric oxide is heated.
(ii) Mixture of cuprous oxide and cuprous sulphide is heated.
(iii) Aluminium is reacted with manganese dioxide.
(iv) Ferric oxide is reduced with aluminium.
(v) Zinc carbonate undergoes calcination.

AE **[CBSE Outside Delhi 2020]**

Ans. (i) When mercury oxide is heated strongly, it reduces to mercury metal.

$$2HgO \xrightarrow{heat} 2Hg + O_2$$

(ii) When a mixture of copper oxide and copper sulphide is heated, pure copper is obtained.

$$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$$

(iii) When aluminium powder is heated with manganese dioxide, the following reaction takes place:

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

(iv) Reaction of ferric oxide with aluminium: In this reaction, a lot of heat is produced along with molten iron. This process of metal oxide to form metal by using aluminium powder as a reducing agent is known as thermite reaction.

$$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s) + Heat:$$

(v) Heating of carbonate ores in the limited supply of air is known as calcination. During the process, carbon dioxide gas is released and metal oxide is obtained.

$$ZnCO_3 \xrightarrow{heat} ZnO + CO_2$$ **1×5=5**

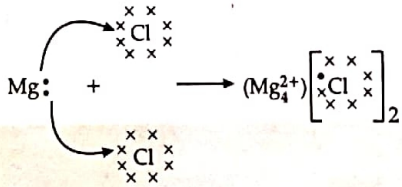
Q. 3. (i) By the transfer of electrons, illustrate the formation of bond in magnesium chloride and identify the ions present in this compound.
(ii) Ionic compounds are solids. Give reasons.
(iii) With the help of a labelled diagram show the experimental set up of action of steam on a metal.

U **[Outside Delhi 2020]**

Ans. (i) Formation of magnesium chloride:

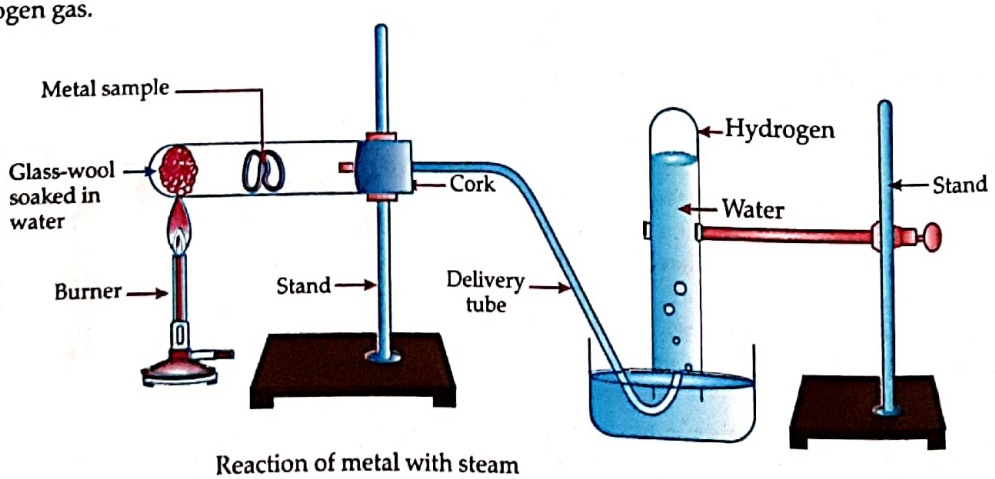
Here, magnesium is a metal and chlorine is a non-metal. Magnesium atom loses two electrons to attain noble gas configuration and results in the formation of magnesium cation Mg^{2+}. Similarly, chlorine atom gains electron to complete its octet and results in the formation of chloride anion Cl^-. When magnesium reacts with chlorine, two electrons lost by magnesium atom are gained by two chlorine atoms. Mg^{2+} and Cl^- being oppositely charged, attract each other and held by strong electrostatic forces of attraction to exist as $MgCl_2$.

$Mg \rightarrow Mg^{2+} + 2e^-$
2,8,2 2,8
(Magnesium cation)
$Cl \rightarrow Cl^-$
2,8,7 2,8,8
(Chloride anion)



(ii) Due to the strong force of attraction between the positive and negative ions, ionic compounds are solid.

(iii) Reaction with steam: Metals like iron, zinc and aluminium react with steam to form corresponding oxide and hydrogen gas.



Reaction of metal with steam

$2 + 1 + 2$

Q. 4. (a) Write electron dot structures of Ca (Atomic no. 20) and O (Atomic no. 8).

(b) Show the formation of calcium oxide by transfer of electrons.

(c) Name the ions present in this compound.

(d) List four important characteristics of this compound. AE [Outside Delhi 2020]

Ans. (a) Ca = 2, 8, 8, 2 O = 2, 6

(b) Ca ⁚ + ⁚Ö⁚ → Ca^{2+} [⁚Ö⁚]$^{2-}$

(c) Calcium ions (Ca^{2+}) and oxygen ions (O^{2-})

(d) Characteristics of calcium oxide (CaO):

(i) Quick lime is an amorphous white solid with a high melting point of about.

(ii) It is a very stable compound and withstands high temperatures.

(iii) In the presence of water, it forms slaked lime. This process is called the slaking of lime.

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

(iv) It is an oxide that is basic in nature and forms salts when it comes in contact with an acid.

$$CaO + H_2SO_4 \rightarrow CaSO_4 + H_2O$$

AT **Q. 5. (a) Define the terms 'alloy' and 'amalgam'. Name the alloy used for welding electric wires together. What are its constituents ?**

(b) Name the constituents of the following alloys:

(i) Brass (ii) Stainless steel (iii) Bronze,

State one property in each of these alloys, which is different from its main constituents.

R [DDE 2017]

Ans. (a) An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal, mixed in the molten state. Amalgam is an alloy of a metal with mercury.

Solder is the alloy used for the welding of electric wires. Tin and Lead are its constituents.

(b) (i) Brass – copper and zinc

(ii) Stainless steel – Iron, carbon, nickel, chromium

(iii) Bronze – copper and tin.

Brass and bronze have lower electrical conductivity than their constituents. Stainless steel does not corrode easily as iron does. 1 + 3 + 1

COMMONLY MADE ERROR

- Students get confused with metals involved in forming alloys and their name.

ANSWERING TIP

- Make a list and learn the mixture of metals of alloys with their names.

Q. 6. Metal X is found in nature as its sulphide XS. It is used in the galvanisation of iron articles. Identify the metal X. How will you convert this sulphide ore into the metal? Explain with equations.

A [CBSE SQP, 2020]

Ans. Metal X is Zinc

The sulphide ore is first heated strongly in supply of oxygen and changed into its oxide. This process is called roasting.

$$2ZnS + 3O_2 \xrightarrow{heat} 2ZnO + 2SO_2$$

Zinc oxide is then reduced to zinc metal by heating it with carbon. This process is called reduction.

$$2ZnO + C \rightarrow 2Zn + CO_2$$

[CBSE Marking Scheme, 2020] 1 + 1 + 1 + 1 + 1

Q. 7. State the reason for the following:

(i) Aluminium oxide is called an amphoteric oxide.

(ii) An iron strip dipped in a blue copper sulphate solution turns blue pale green solution.

(iii) Hydrogen gas is not evolved when most metals react with nitric acid.

(iv) Calcium does not occur in free state in nature.

(v) Sodium and potassium metals are kept immersed under kerosene. A [Board SQP, 2020]

Ans. (i) As it reacts with both acids as well as bases to form salts.

(ii) Iron being more reactive than copper displaces copper from copper sulphate to form green ferrous sulphate solution.

(iii) Nitric acid is a strong oxidising agent. Hydrogen gas produced gets oxidised to H_2O.

(iv) Calcium is a very reactive metal. It reacts with the chemicals in surroundings and occurs in combined state.

(v) Sodium and potassium are highly reactive metals and react vigorously with oxygen in air and may even catch fire. They do not react with kerosene.

[CBSE Marking Scheme, 2020] 1 + 1 + 1 + 1 + 1

AT **Q. 8. (a) Write chemical equations for the following reactions:**

(i) Calcium metal reacts with water.

(ii) Cinnabar is heated in the presence of air.

(iii) Manganese dioxide is heated with aluminium powder.

(b) What are alloys ? List two properties of alloys.

R [CBSE Board Delhi, Set- II, 2019]

Ans. (a) (i) $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

(ii) $2HgS + 3O_2 \xrightarrow{Heat} 2HgO + 2SO_2$

(iii) $3MnO_2 + 4Al \longrightarrow 2Al_2O_3 + 3Mn$

(b) Alloys are homogeneous mixture of two or more metals or a metal and a non metal.

Properties:

Alloys are stronger / harder / have low melting point / more resistant to corrosion / some are magnetic in nature. **(Any two)**

[CBSE Marking Scheme, 2019] 3 + 2

Q. 9. (i) How will you show experimentally that metals are good conductors of heat.

(ii) Describe the extraction of Mercury metal from its ore Cinnabar (HgS). R + U [SQP, 2018]

Ans. (i) Diagrams (consider from detailed answer)

Procedure

Observation: Heat is transferred from one end of metal wire to the free end of wire which melts the wax and pin falls shows metals conduct heat.

(ii) Ore: HgS – cinnabar

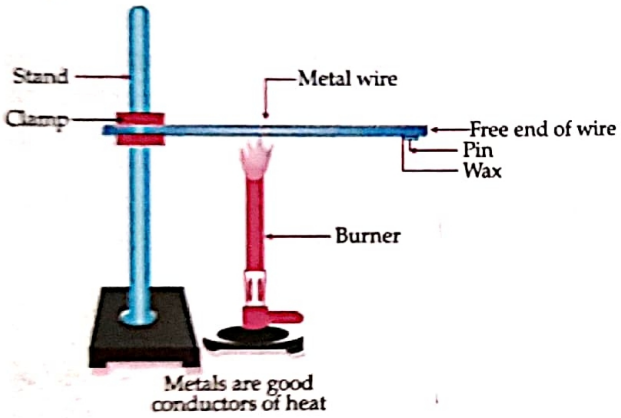
Roasting: $2HgS(s) + 3O_2(g) \rightarrow 2HgO(s) + 2SO_2(g)$

Reduction: $2HgO(s) \xrightarrow{\Delta} 2Hg(l) + O_2(g)$

[CBSE Marking Scheme, 2018] 5

Detailed Answer:

(i)



Procedure: Take an aluminium or copper wire and fix this wire on a stand as shown in the figure above. Attach pin to the free end of the wire with the help of wax. Heat the wire with the help of burner, candle or spirit lamp whatever available near the place where it is fixed.

Observation: Heat is transferred from one end of the metal wire to the free end of the wire, which melts the wax and the pin falls.

Inference: This experiment shows that metals are good conductors of heat and have high melting points.

(ii) Refer SAQ, Q5 Short Answer Type-II.

COMMONLY MADE ERROR

- Students often give incorrect experimental procedure and set-up. Students also get confused with the techniques and equations involved in the extraction of mercury metal.

ANSWERING TIP

- Practise the diagrams thoroughly and learn the extraction methods of mercury, copper and aluminium properly.

AI **Q. 10. (i) Write the steps involved in the extraction of pure metals in the middle of the activity series from their carbonate ores.**

(ii) How is copper extracted from its sulphide ore ? Explain the various steps supported by chemical equations. Draw labelled diagram for the electrolytic refining of copper.

R + U [Delhi/Outside Delhi, 2018]

Ans. (i) (a) Calcination, (b) Reduction, (c) Purification (in the given sequence only)

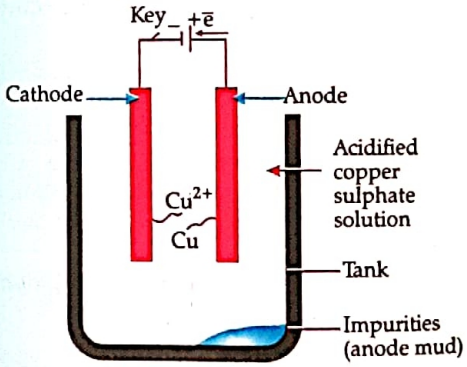
(ii) Sulphide ore of copper is heated in air.

$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$

$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

(Note: Full marks to be awarded even when only equations are written).

Labelled diagram of electrolytic refining of copper.



Electrolytic refining of copper

[CBSE Marking Scheme, 2018] 5

COMMONLY MADE ERROR

- Students usually write vague answers. It seems they are confused about the extraction methods involved.

ANSWERING TIP

- Understand the concept of ore extraction and the order of the steps involved in the extraction and the equation separately for sulphide and oxide ores. Diagrams are equally important.

Topper Answer, 2018

Ans. (a) Extraction of pure metals from 'CO₃' ores :-

(i) Concentration of ore

↳ Gangue or matrix must be removed from ore by processes taking in mind differences in physical & chemical properties of gangue & ore.

(ii) Calcination :

The carbonate ores must be heated strongly in absence of air to convert them into metal ores.

$$ZnCO_3(s) \xrightarrow{\Delta} ZnO(s) + CO_2(g)$$

(iii) Reduction by a more reactive metal or carbon :-

$$ZnO(s) + C \longrightarrow Zn + Co$$

This will happen as Carbon has higher affinity for oxygen than zinc.

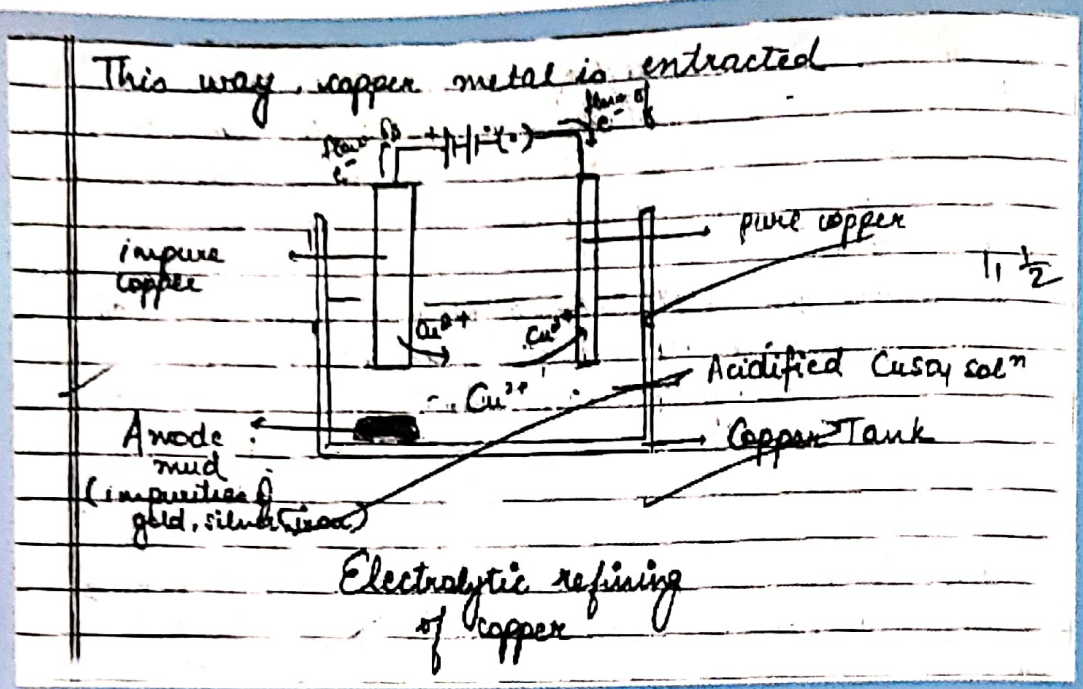
(iv) Finally, the obtained metal can be refined by electrolysis of their salt solution.

(b) Copper glance [Cu_2S] is copper's sulphide ore. It is first roasted & then reduced by the remaining Cu_2S in tank.

$$2Cu_2S(s) + 3O_2(g) \xrightarrow{\Delta} 2Cu_2O(s) + 2SO_2(g)$$

[Copper(I) sulphide] [Copper(I) oxide]

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



Visual Case-based Questions — 4 marks each

Q. 1. Study the given table and answer any four questions from (a) to (e):

A student took the samples of four metals A, B, C and D and added following solutions one by one. The results obtained have been tabulated as follows:

Metal	Iron (II) Sulphate	Copper (II) Sulphate	Zinc Sulphate	Silver Nitrate
A	No reaction	Displacement	-	-
B	Displacement	-	No reaction	-
C	No reaction	No reaction	No reaction	Displacement
D	No reaction	No reaction	No reaction	No reaction

(a) Choose the most reactive metal:
(i) A **(ii) B**
(iii) C **(iv) D**

(b) Which of the following will displace Cu from its solution of sulphate:
(i) A only **(ii) B only**
(iii) Both A and B **(iv) None of the above**

(c) Which is the correct decreasing order of reactivity?
(i) B > A > C > D **(ii) A > B > D > C**
(iii) D > B > A > C **(iv) B > A > D > C**

(d) The gas produced when dil. HCl is added to a reactive metal:
(i) Oxygen **(ii) nitrogen**
(iii) hydrogen **(iv) none of the above**

(e) On the basis of sequence of reactions, identify the most and least reactive elements.
$A + BX \rightarrow AX + B$
$C + AY \rightarrow CY + A$
(i) Most reactive: C; Least reactive: B
(ii) Most reactive: B; Least reactive: C
(iii) Most reactive: A; Least reactive: B
(iv) Most reactive: B; Least reactive: A

Ans. (a) (i) B is the most reactive metal as it displaces iron from its salt solution.

(b) (ii) B only
B will displace Cu from $CuSO_4$ solution because B is more reactive than copper.

(c) (i) B > A > C > D

(d) (iv) Hydrogen

(e) (i) Most reactive: C; Least reactive: B 1+1+1+1

Q. 2. When a silvery grey powder of a solid (A) is mixed with a powder of solid (B) no reaction occurs. But if the mixture is ignited and lighted using magnesium ribbon a reaction occurs with evolution of large amount of heat forming product (C) which settles down as liquid metal and the solid product (D) formed floats on the liquid (C). (C) in solid form reacts with moisture to form rust. The amount of heat generated during the reaction is so high that the reaction is used in welding of electric conductors, joints in railway tracks. Based on this information, answer any four questions from (a) to (e).

(a) Identify A and C?
(i) A – Al and C – Fe (ii) A – Fe and C – Al
(iii) A – Mg and C- Al (iv) A – Al and C - Cu
(b) Identify B and D which are oxides of:
(i) B – Fe , D – Al (ii) B – Mg , D – Al
(iii) B – Al D - Cu (iv) B – Al D – Fe
(c) Amphoteric oxides are:
(i) Metal oxides which do not react with acids but reacts with bases.
(ii) Metal oxides which reacts with both acids as well as bases.
(iii) Metal oxides which reacts with acids but do not react with bases.
(iv) Metal oxides which shows no reaction with either acids or bases.
(d) Which of the following is amphoteric in nature:
(i) Both aluminium oxide and zinc oxide
(ii) Only zinc oxide
(iii) Only aluminium oxide
(iv) Neither of them.
(e) The reaction in which heat is generated is called as:
(i) Exothermic reaction
(ii) Endothermic reaction
(iii) Decomposition reaction
(iv) Precipitation reaction

Ans. (a) (i) A - Al and C - Fe
(b) (i) B = oxide of iron D – oxide of Al
(c) (ii) Metal oxides which reacts with both acids as well as bases.
(d) (i) Both aluminium oxide and zinc oxide
(e) (i) Exothermic reaction 1+1+1+1

Q. 3. Read the following passage and answer any four questions from (a) to (e).
Sohan went door to door posing as a goldsmith. He promised to bring back the glitter of old and dull gold ornaments. An unsuspecting lady gave a set of gold bangles to him which he dipped in a particular solution. The bangles sparkled like new but their weight was reduced drastically. The lady was sad but after a futile argument, the man beat a hasty retreat.
(a) Which of the following is used for dissolution of gold?
(i) Hydrochloric acid
(ii) Sulphuric acid
(iii) Nitric acid
(iv) Aqua regia
(b) The composition of aqua-regia is
(i) Dil. HCl: Conc. HNO_3 3: 1
(ii) Conc. HCl: Dil. HNO_3 3: 1
(iii) Conc. HCl: Conc. HNO_3 3: 1
(iv) Dil. HCl: Dil. HNO_3 3: 1
(c) Which of the following is incorrect?
(i) Aqua regia is a strong oxidising agent.
(ii) Aqua regia is a strong reducing agent.
(iii) Aqua regia dissolves gold in it.
(iv) Aqua regia is a mixture of hydrochloric acid and nitric acid.
(d) Aqua regia dissolves:
(i) Gold and platinum
(ii) Gold and silver
(iii) Platinum and silver
(iv) Only gold
(e) Examples of Noble metals are:
(i) Gold (ii) Silver
(iii) Platinum (iv) All of the above

Ans. (a) Correct option: (d)
Explanation: Aqua Regia is a mixture of concentrated HNO_3 and concentrated HCl. It is used for dissolution of gold.
(b) Correct option: (c)
Explanation: Aqua regia is a mixture of nitric acid and hydrochloric acid, that is 3 part conc. HCl and one part conc. HNO_3 (3: 1).
(c) (ii) Aqua regia is a strong reducing agent.
(d) (i) gold and platinum
(e) (iv) all of the above 1+1+1+1

Q. 4. Read the passage and answer any four questions from (a) to (e).
During extraction of metals, electrolytic refining is used to obtain pure metals. During the process, the impure metal is made the anode and a thin strip of pure metal is made the cathode. The solution of the metal salt is used as an electrolyte. On passing the current through the electrolyte, the pure metal from the anode dissolves from the electrolyte. An equivalent of pure metal from the electrolyte is deposited on the cathode.
(a) The process of purification of the metal obtained after reduction, is called:
(i) Extraction (ii) Refining
(iii) Froth floatation (iv) Electrolysis
(b) Which of the metals are refined by electrolytic refining?
I. Au II. Cu
III. Na IV. K
(i) I and II (ii) I and III
(iii) II and III (iv) II and IV
(c) During electrolytic refining of zinc, it gets
(i) deposited on cathode.
(ii) deposited on anode.
(iii) deposited on cathode as well as anode.
(iv) remains in the solution.
(d) In electrolytic refining of copper, impure copper act as _____ and pure copper as _____:
(i) cathode , anode
(ii)) cathode, electrolyte
(iii)) anode , cathode
(iv) electrolyte, cathode
(e) Anode is _____ electrode while cathode is --------electrode:
(i) negative, positive
(ii) reducing, oxidising
(iii) both a and b
(iv) neither a nor b

Ans. (a) (ii) Refining

(b) **Correct option:** (a)

Explanation: Metals like Cu, Zn, Ag and Au are refined by electrolytic refining.

(c) **Correct option:** (a)

Explanation: Ions of zinc are positively charged, thus while electrolytic refining of zinc, zinc is deposited at cathode (negatively charged pole).

(d) (iii) anode, cathode

(e) (iii) both a and b 1+1+1+1

Q. 5. Read the given passage and answer any four questions from (a) to (e).

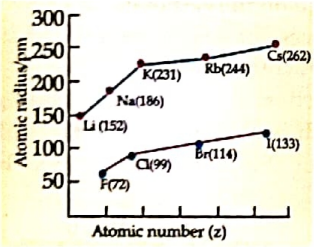
Metallic Character:

The ability of an atom to donate electrons and form positive ion (cation) is known as electro-positivity or metallic character. Down the group, metallic character increases due to increase in atomic size and across the period, from left to right electro-positivity decreases due to decrease in atomic size.

Non-Metallic Character:

The ability of an atom to accept electrons to form a negative ion (anion) is called non-metallic character or electronegativity. The elements having high electro-negativity have a higher tendency to gain electrons and form anion.

Down the group, electronegativity decreases due to increase in atomic size and across the period, from left to right electro -negativity increases due to decrease in atomic size.



(a) Which of the following correctly represents the decreasing order of metallic character of Alkali metals plotted in the graph? U

(i) Cs>Rb>Li>Na>K (ii) K>Rb>Li>Na>Cs

(iii) Cs>Rb>K>Na>Li (iv) Cs>K>Rb>Na>Li

(b) Hydrogen is placed along with Alkali metals in the modern periodic table though it shows non-metallic character: U

(i) as Hydrogen has one electron & readily loses electron to form negative ion.

(ii) as Hydrogen can easily lose one electron like alkali metals to form positive ion.

(iii) as Hydrogen can gain one electron easily like Halogens to form negative ion.

(iv) as Hydrogen shows the properties of non-metals.

(c) Which of the following has highest electronegativity? C

(i) F (ii) Cl

(iii) Br (iv) I

(d) Identify the reason for the gradual change in electronegativity in halogens down the group. C

(i) Electronegativity increases down the group due to decrease in atomic size.

(ii) Electronegativity decreases down the group due to decrease in tendency to lose electrons.

(iii) Electronegativity decreases down the group due to increase in atomic radius/ tendency to gain electron decreases.

(iv) Electronegativity increases down the group due to increase in forces of attractions between nucleus & valence electrons.

(e) Which of the following reason correctly justifies that "Fluorine (72pm) has smaller atomic radius than Lithium (152pm)"? R

(i) F and Li are in the same group. Atomic size increases down the group

(ii) F and Li are in the same period. Atomic size increases across the period due to increase in number of shells

(iii) F and Li are in the same group. Atomic size decreases down the group

(iv) F and Li are in the same period and across the period atomic size/radius decreases from left to right.

Ans. (a) (iii) Cs > Rb > K > Na > Li

(b) (ii) as Hydrogen can easily lose one electron like alkali metals to form positive ion

(c) (i) F

(d) (iii) Electronegativity decreases down the group due to increase in atomic radius/ tendency to gain electron decreases.

(e) (iv) F and Li are in the same period and across the period atomic size/radius decreases from left to right. 1+1+1+1

Q. 6. In a thermite reaction, a compound of iron reacts with a metal.

(a) The metal used is: R

(i) Zinc (ii) Aluminium

(iii) Magnesium (iv) None of these.

(b) After completion of this reaction, a metal is obtained in the molten state. Identify the metal: C

(i) Zinc (ii) Aluminium

(iii) Iron (iv) Magnesium

(c) The correct equation to justify thermite reaction is: R

(i) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ – Heat.

(ii) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al2O_3$ + Heat.

(iii) $Al_2O_3 + 2Fe \rightarrow 2Al + Fe_2O_3$ + Heat.

(iv) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$.

(d) The correct name for Fe_2O_3 is: C

(i) Ferrous oxide (ii) Ferric oxide

(iii) Ferrous hydroxide (iv) Ferric hydroxide

Ans. (ii) Aluminium

(b) (iii) Iron

(c) (ii) $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$+ Heat.

(d) (ii) Ferric oxide 1+1+1+1

Know the Terms

- **Malleability:** The ability of a metal due to which it can be beaten into large thin sheets is called **malleability.**
- **Ductility:** It is the ability of metal due to which it can be drawn into thin and long wires. Copper, aluminium and iron can be drawn into wires. Silver, gold and platinum are highly ductile metals.
- **Electrical conductance:** It is the property due to which electric current can pass through the metal. It is due to presence of free electrons or mobile electrons. Copper, silver, gold and aluminium are good conductors of electricity.
- **Thermal conductivity:** It is the property due to which metals can conduct heat. *e.g.*, Copper, silver, aluminium, gold and iron are good conductors of heat.
- **Metallic lustre:** Metals in their pure state have bright shining surfaces. This property is called **metallic lustre.**
- **Sonorous:** When metals are struck with a hard substance, they produce sound. This property is called **sonority** and the metals are said to be **sonorous.**
- **Neutral oxides:** The oxides which are neither acidic nor basic in nature, are known as **Neutral oxides.** They neither react with acids nor with bases. Some non-metals form neutral oxides. Example CO, NO, N_2O etc.
- **Metallurgy:** All the processes involved in the extraction of metals from their ores and refining them for use, is called metallurgy.
- **Ore-dressing:** It is a process of removing unwanted substances from the ore. This is also known as concentration of the ore or enrichment of ore. It is usually done by hydraulic washing, magnetic separation or froth floatation process.
- **Froth floatation process:** It is the process based on the principle that the mineral particles are more wetted by the oil, whereas the gangue particles are wetted by water. Compressed air is bubbled through the mixture. As a result of agitation, oil froth is formed which contains minerals which float on the top of water and can be separated easily.
- **Gangue:** The unwanted material present in the ores mined from earth is called **Gangue.** It needs to be removed prior to the extraction process.
- **Leaching:** It makes use of difference in the chemical properties of minerals and gangue. The ore is treated with suitable reagent which reacts with the ore, but not with the gangue. The purified ore is regenerated by sequence of reactions. An example of leaching is Bayer's method of obtaining pure aluminium oxide from Bauxite.
- **Roasting:** It is the process in which ore is heated in the presence of air so as to obtain metal oxides, which can be reduced easily to get free metal. Sulphide ores are converted into oxides by roasting.

$$2ZnS(s) + 3O_2(g) \xrightarrow{\text{Heat}} 2ZnO(s) + 2SO_2(g)$$

- **Calcination:** It is the process of heating ore in absence of air so as to remove moisture, volatile impurities and to convert carbonate ores into oxides.

$$ZnCO_3(s) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$$

- **Thermite process:** It is a process in which molten metal oxides are treated with aluminium powder. It is highly exothermic reaction. The molten metal obtained is used for welding of railway tracks or cracked machine parts.

$2Al$	+	Fe_2O_3	$\longrightarrow$	$2Fe$	+	Al_2O_3	+	Heat
Aluminium		Haematite		Molten iron		Aluminium oxide		

- **Refining:** It is a process of converting impure metal into pure metal by different processes depending on the nature of metals. It is a process of purification of metal.
- **Flux:** The substance which reacts with gangue to form a fusible mass which can easily be removed is known as flux. *e.g.*, CaO (Calcium oxide) is used as flux so as to remove SiO_2 (Silica) as gangue.
- **Slag:** The fusible mass formed by the reaction of flux and gangue is known as **slag.** Slag is lighter than molten metal, hence floats over molten metal and can be easily removed. It prevents metal from oxidation.