CLASS 10TH CHEMISTRY WORKSHEET CHAPTER - METAGULLARY

Exercise 7A

Question 1

(a) Name the three classes in which elements are classified. Which was the first metal used by man?

(b) Name the metal and non-metal present in abundance in the earth crust.

Answer

(a) The three classes in which elements are classified are –

1. metals,
2. non-metals and
3. metalloids.

Copper was the first metal used by man for making utensils, weapons and for other purposes.

(b) The most abundant metal present in the earth's crust is **Aluminum** and the most abundant non-metal present in the earth's crust is **Oxygen**.

Question 2

Name the metal which is a constituent of:

(a) blood pigment

(b) plant pigment

Answer

(a) **Iron** is a component of blood pigment (haemoglobin).

(b) **Magnesium** is present in plant pigment (chlorophyll).

Question 3

Give the importance of the following in living beings:

(a) Nitrogen

(b) Hydrogen

(c) Carbon

Answer

(a) Nitrogen — It is the most abundant element present in the atmosphere. It's presence in air reduces the rate of combustion. Due to it's inertness, it is used to preserve food.

(b) Hydrogen — It is the lightest element known and is used in the hydrogenation of vegetable oils to make ghee. As a fuel and in the manufacture of compounds. It is also the essential part of organic compounds.

(c) Carbon — Proteins, fats, carbohydrates, enzymes, vitamins, etc. are all compounds of carbon and are essential for the growth and development of living organisms.

Question 4

State the position of the following in the periodic table:

(a) Alkali metals

(b) Alkaline earth metals

(c) Halogens

(d) Aluminum

Answer

(a) Alkali metals — Group I (IA), the first column on the left of the periodic table.

(b) Alkaline earth metals — Group 2 (IIA), the second column on the left of the periodic table

(c) Halogens — Group 17 (VII A)

(d) Aluminium — Group 13 (III A), present on the right of periodic table.

Question 5

Name:

(a) a liquid non-metal

(b) two metalloids

(c) a metals which do not corrode easily
(d) two metals which react with cold water
(e) a non-metal which can form a positive ion.
(f) a non-metal which shows reducing property.

Answer

(a) a liquid non-metal — **bromine**
(b) two metalloids — **boron and silicon**
(c) metals which do not corrode easily — **aluminium**
(d) two metals which react with cold water — **potassium and sodium**
(e) a non-metal which can form a positive ion — **hydrogen**
(f) a non-metal which shows reducing property — **carbon**

Question 6

From the list of characteristics given below, select the five which are relevant to non-metals and their compounds:
A. Ductile
B. Conduct electricity
C. Brittle
D. Acidic oxides
E. Basic oxides
F. Discharged at anode
G. Discharged at cathode
H. Ionic chlorides
I. Covalent chlorides
J. Reaction with dilute sulphuric acid yields hydrogen
K. 1, 2 or 3 valence electrons
L. 5, 6, 7 valence electrons
(Write the five letters corresponding to the correct characteristics)

Answer

D. Acidic oxides
C. Brittle
F. Discharged at anode
I. Covalent chlorides
L. 5,6,7 valence electrons

Question 7a

Why are alkali metals kept in kerosene oil?

Answer

Alkali metals are very reactive, they react with atmospheric reagents like oxygen, carbon dioxide and water vapour and form compounds, so they are kept in inert solvent.

Question 7b

Why is hydrogen kept in the metal activity series?

Answer

Hydrogen, though a non-metal is kept in the metal activity series because it can form a positive ion H^+ similar to metals.

Question 7c

Why do gold ornaments look new even after several years of use?

Answer

As gold is less reactive, and do not react under normal conditions with oxygen, water, carbon dioxide and other reagents. Hence, it looks new and does not lose it's glitter and shine even after years.

Question 8

From the metals : copper, iron, magnesium, sodium and zinc, select a different metal in each case which :
(a) does not react with dilute hydrochloric acid,
(b) can form 2+ and 3+ ions,
(c) arrange the above metals in the decreasing order of reactivity.

Answer

(a) does not react with dilute hydrochloric acid — **Copper**
(b) can form 2+ and 3+ ions — **Iron**
(c) arrange the above metals in the decreasing order of reactivity — **Na > Mg > Zn > Fe > Cu**

Question 9

Which metal occurs as :
(a) a sulphide,
(b) a halide,
(c) a carbonate,
(d) an oxide.
Also give the names of their respective ores.

Answer

(a) a sulphide — Zn; Ore — Zinc Blende [ZnS]
(b) a halide — Sodium; Ore — Rock salt [NaCl]
(c) a carbonate — Calcium; Ore — Limestone [$CaCO_3$]
(d) an oxide — Aluminium; Ore — Bauxite [$Al_2O_3.2H_2O$]

Question 10a

Distinguish between a mineral and an ore.

Answer

Mineral	**Ore**
The compounds of various metals found in nature associated with their earthly impurities are called minerals.	The naturally occurring minerals from which metals can be extracted profitably and conveniently are called ores.
All minerals are not ores.	All ores are minerals.

Question 10b

Distinguish between an ore and a metallic compound.

Answer

Ore	**Metallic compound**
The naturally occurring minerals from which metals can be extracted profitably and conveniently are called ores.	Metallic compound is a compound that contains one or more metals.
Ores are naturally occurring substances.	Metallic compounds can be naturally occurring or synthesized.
Ores are extracted for the purpose of obtaining metal.	Metallic compounds can serve various purposes such as being used in industry as raw materials, in medicine, as catalysts, as jewellery and so on.

Question 11

Which metal can be extracted from each one of the following ores:
(a) bauxite

(b) calamine
(c) haematite

Answer

(a) Bauxite - Aluminum [Al]
(b) Calamine - Zinc [Zn]
(c) Haematite - Iron [Fe]

Question 12

Explain the following terms:
(a) ore
(b) gangue

Answer

(a) Ores are those minerals from which metals are extracted commercially at a comparatively lower cost with minimum efforts.
(b) The earthly impurities like soil, mud, sand, silica (SiO_2), limestone, rocks, etc. that are mixed with valuable minerals in an ore deposit are called gangue or matrix.

Exercise 7B

Question 1

Give the principles of:
(a) Hydrolytic method
(b) Froth floatation process
(c) Electromagnetic separation

Answer

(a) **Hydrolytic method** — The difference in the densities of the ore and the gangue is the main criterion.
(b) **Froth floatation process** — The process depends on the preferential wettability of the ore with oil (pine oil) and the gangue particles by water .
(c) **Electromagnetic separation** — Magnetic properties of the ores.

Question 2

(a) Name the methods by which concentrated ore is converted to metallic oxide
(b) State three objectives achieved during the roasting of ores.

Answer

(a) Roasting and Calcination are the methods of converting concentrated ore to metallic oxide.
(b) During roasting:

1. Moisture is removed
2. Organic matter is oxidised and removed.
3. It makes the ore porous and so ore gets heated uniformly.

Question 3

Name:
(a) the processes involved in (i) dressing of the ores (ii) refining of the ores.
(b) two metallic oxides which cannot be reduced by carbon, carbon monoxide or hydrogen.

Answer

(a) The processes involved in:
(i) Dressing of ores are:

1. Gravity separation /Hydraulic washing
2. Froth floatation
3. Magnetic separation
4. Chemical method/Leaching

(ii) Refining of ores are:

1. Distillation

2. Liquation
3. Electro refining

(b) sodium oxide and potassium oxide

Question 4

Why does iron or zinc not occur free in nature?

Answer

Iron and zinc are moderately reactive metals. They tend to react with other elements, such as oxygen and sulphur forming iron oxides and zinc sulphides. These compounds are more stable and are found as minerals in nature.

Question 5

What do you observe when hydrogen is passed over heated copper oxide?

Answer

When hydrogen is passed over heated copper oxide (CuO), the black CuO changes to pink/brown Cu and H_2O is released.

$$\mathrm{CuOblack} + \mathrm{H_2} \xrightarrow{\Delta} \mathrm{Cupink/brown} + \mathrm{H_2O}$$

Question 6

Compare roasting and calcination.

Answer

Roasting	**Calcination**
The ore is heated in the excess air.	The ore is heated in the absence of air
Generally sulphide ores are roasted and hence sulphur dioxide is given out.	Generally carbonate and hydrated ores are calcinated and hence carbon dioxide and water vapour is given off.
$2ZnS + 3O_2 \overset{800-900^{\circ}C}{\rightarrow} 2ZnO + 2SO_2[g]$	$ZnCO_3 \rightarrow ZnO + CO_2[g]$
Volatile impurities are removed as oxides (SO_2, P_2O_5, As_2O_3) and the ore becomes porous and more reactive.	Moisture and organic impurities are removed and the ore becomes porous and more reactive.

Question 7

(a) Name an ore of zinc

(b) Which process is applied to concentrate it?

(c) How is concentrated ore changed to oxide?

Answer

(a) **Zinc blende**, chemical name is **Zinc sulphide** and formula is **ZnS**.

(b) **Froth floatation process** is applied to concentrate ZnS.

(c) The concentrated ore is changed to oxide by heating Zinc blende (ZnS) in excess of air. The reaction is as follows:

$$2ZnS + 3O < em > 2 \overset{800^{\circ}C}{\rightarrow} 2ZnO + 2SO < /em > 2$$

Question 8

(a) Some metallic oxides can be reduced by hydrogen, carbon, carbon monoxide and some cannot. Explain.

(b) Write balanced equation for the reduction of copper (II) oxide by hydrogen.

Answer

(a) The metals in the middle of the activity series such as iron, lead, copper, etc., are moderately reactive and are found as sulphides or carbonates in nature. They are obtained by the reduction of their oxides with carbon, carbon monoxide and hydrogen.

While, oxides of highly active metals like sodium and potassium have great affinity for oxygen and so cannot be reduced by common reducing agents like carbon, carbon monoxide or hydrogen.

(b) $\mathrm{CuOblack + H < em > 2 \xrightarrow{\Delta} Cupink/brown + H 2O}$

Question 9

How are the following metallic oxides reduced. Write equations :

(a) Iron (II) oxide

(b) Zinc oxide

Answer

(a) Iron (II) oxide is reduced by CO:

$$\mathrm{FeO + CO \xrightarrow{\Delta} Fe + CO_2[g]}$$

(b) Zinc oxide is reduced by coke :

$$\mathrm{ZnO + C \xrightarrow{1400°C} Zn + CO[g]}$$

Question 10

State why aluminium is extracted from it's oxide by electrolysis while copper, lead, iron by reducing agents and mercury and silver by thermal decomposition.

Answer

Oxides of highly active metals like potassium, sodium, calcium, magnesium and aluminium have great affinity towards oxygen and so cannot be reduced by common reducing agents like carbon, carbon monoxide or hydrogen. They are obtained by electrolytic reduction of fused metallic salts (halides and oxides) using inert electrodes.

The metals in the middle of the activity series such as iron, lead, copper, etc., are moderately reactive and are found as sulphides or carbonates in nature. They are obtained by the reduction of their oxides with carbon, carbon monoxide and hydrogen.

Mercury and silver are very less reactive, placed in the end of the reactivity series. The oxides of these metals are reduced to metals by heating alone.

Question 11

An ore on being heated in air forms sulphurous anhydride. Write the process used for the concentration of this ore.

Answer

Froth floatation process can be used for the concentration of this ore as formation of sulphurous anhydride suggests that it is a sulphide ore. Sulphide ores are lighter than the impurities present hence froth floatation process is used for the concentration of this ore.

Question 12

(a) Define roasting. Name an ore on which roasting is done. Give balanced equation.

(b) Define calcination. Give an example and equation for calcination.

Answer

(a) Roasting — It is the process of heating the concentrated ore to a high temperature in the presence of excess air.

Example — Zinc blende (ZnS) is roasted to yield it's oxide, zinc oxide

$$\mathrm{2ZnS + 3O < em > 2 \xrightarrow{800°C} 2ZnO + 2SO 2}$$

(b) Calcination — If an ore is carbonate or a hydrated oxide, it is heated in the absence of air to a temperature that is high but insufficient to melt the ore. The process is known as Calcination.

Example — carbonate and hydrated ores are calcinated like $ZnCO_3$

$$\mathrm{ZnCO < em > 3 \rightarrow ZnO + CO 2[g]}$$

Question 13

How are the metals like sodium, potassium and calcium obtained. Give equations.

Answer

Oxides of highly active metals like sodium, potassium and calcium are obtained by electrolytic reduction of fused metallic salts (halides and oxides) using inert electrodes.

Sodium

Electrolyte : Fused sodium chloride

Reaction : $NaCl \rightleftharpoons Na^+ + Cl^-$

Reaction at cathode : $Na^+ + e^- \longrightarrow Na$
Reaction at anode : $Cl^- - e^- \longrightarrow Cl$
$Cl + Cl \longrightarrow Cl_2$
Potassium
Electrolyte : Fused potassium bromide
Reaction : $KBr \rightleftharpoons K^+ + Br^-$
Reaction at cathode : $K^+ + e^- \longrightarrow K$
Reaction at anode : $Br^- - e^- \longrightarrow Br$
$Br + Br \longrightarrow Br_2$
Calcium
Electrolyte : Fused calcium chloride
Reaction : $CaCl_2 \rightleftharpoons Ca^{2+} + 2Cl^-$
Reaction at cathode : $Ca^{2+} + 2e^- \longrightarrow Ca$
Reaction at anode : $Cl^- - e^- \longrightarrow Cl$
$Cl + Cl \longrightarrow Cl_2$

Question 14
Give equations for the reduction of :
(a) Iron (II) oxide
(b) Iron (III) oxide
(c) Lead (II) oxide
(d) Zinc oxide

Answer
(a) Reduction of Iron (II) oxide

$$FeO + C \xrightarrow{\Delta} Fe + CO$$
$$FeO + CO \xrightarrow{\Delta} Fe + CO_2$$
$$FeO + H < em > 2 \xrightarrow{\Delta} Fe + H 2O$$

(b) Reduction of Iron (III) oxide

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3 + heat$$

(c) Reduction of Lead (II) oxide

$$PbO + C \xrightarrow{\Delta} Pb + CO$$
$$PbO + CO \xrightarrow{\Delta} Pb + CO_2$$
$$PbOyellow + H < em > 2 \xrightarrow{\Delta} Pbgreenish\ white + H 2O$$

(d) Reduction of Zinc oxide

$$ZnO + C \xrightarrow{1400°C} Zn + CO$$

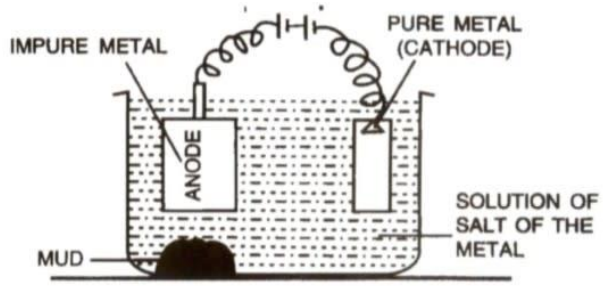
Question 15
(a) On which factors does purification of metals depend?
(b) Name the methods used for purification.
(c) With a labelled diagram explain electro-refining of a particular metal.

Answer
(a) Purification of metal depends on:
1. nature of metal
2. nature of impurities present in the metal and
3. purpose for which the metal is to be used.

(b) Methods used for purification are :
1. Distillation

2. Liquation
3. Electro refining

(c) The below labelled diagram shows the electro-refining of a particular metal:



An electrolytic cell is used in electro-refining to refine impure metal using electrical energy to drive a chemical reaction. The cell consists of an electrolyte, two conducting electrodes (cathode and anode) in a non-conducting vessel. The impure metal is made the anode, and a thin sheet of pure metal is the cathode. The electrolyte is a salt solution of the metal to be refined, with a small amount of sulphuric acid added to increase conductivity. On passing electric current, metal ions are reduced to metal at the cathode. Equivalent mass of anode dissolves from the anode and goes into the solution as metal ions.

At anode: $M - ne^- \longrightarrow M^{n+}$

At cathode: $M^{n+} + ne^- \longrightarrow M$ [M is a metal]

Pure metal deposits at cathode while impurities settle down and form anode mud.

Question 16

Choose the correct option:

(a) The metal other than aluminum, which has a strong affinity for oxygen is:

(A) Copper

(B) Magnesium

(C) Silver

(D) Gold

(b) A metallic oxide which cannot be reduced by normal reducing agents:

(A) Zinc oxide

(B) Magnesium oxide

(C) Copper (II) oxide

(D) Iron (III) oxide

Answer

(a) Magnesium

Reason — Oxides of highly active metals like potassium, sodium, calcium, magnesium and aluminium have great affinity for oxygen

(b) Magnesium oxide

Reason — Oxides of highly active metals like potassium, sodium, calcium, magnesium and aluminium have great affinity for oxygen and so cannot be reduced by common reducing agents like carbon, carbon monoxide or hydrogen. They are obtained by electrolytic reduction of fused metallic salts (halides and oxides) using inert electrodes.

Question 17

Fill in the blanks:

(a) Usually ..... (sulphide/carbonate) ores are subjected to ..... (calcination/roasting) which is done in the absence of air

(b) Zinc blende is converted to oxide by ..... (roasting/calcination) process.

(c) Froth floatation process is generally used to concentrate ..... ores (sulphides/carbonate)

Answer

(a) Usually ***carbonate*** ores are subjected to ***calcination*** which is done in the absence of air

(b) Zinc blende is converted to oxide by ***roasting*** process.
(c) Froth floatation process is generally used to concentrate ***sulphides*** ores.

Exercise 7C

Question 1

State the position of aluminium in the periodic table.

Answer

Aluminum — Period 3, Group 13 (III A).

Question 2

(a) Give the chemical names and formulae of the main ores of
(i) aluminium,
(ii) iron and
(iii) zinc.
(b) Which impurities are present in bauxite?
(c) What is red mud, how is it removed?

Answer

(i) Ores of aluminium :

Name	Chemical name	Formula
Bauxite	Hydrated aluminium oxide	$Al_2O_3.2H_2O$
Cryolite	Sodium aluminium flouride	Na_3AlF_6

(ii) Ores of iron:

Name	Chemical name	Formula
Red haematite	Anhydrous ferric oxide	Fe_2O_3
Brown haematite	Hydrated ferric oxide	$2Fe_2O_3.3H_2O$

(iii) zinc

Name	Chemical name	Formula
Zinc Blende	Zinc sulphide	ZnS
Calamine	Zinc Carbonate	$ZnCO_3$

(b) Bauxite contains 60% aluminium oxide, the rest being sand, ferric oxide and titanium oxide.
(c) Finely grinded Bauxite is heated under pressure with caustic soda. Bauxite dissolves and forms sodium meta aluminate, leaving behind insoluble impurities called red mud. It consists of ferric oxide, sand etc. which are removed by filtration.

Question 3

In order to obtain 1 tonne of aluminium, the following inputs are required: 4 tonnes of bauxite, 150 kg of sodium hydroxide and 600 kg of graphite. The aluminium compound in bauxite is aluminium oxide and the main impurity is iron (III) oxide. Aluminium is obtained by the electrolysis of aluminium oxide dissolved in cryolite.
(a) When bauxite is treated with sodium hydroxide solution, what happens to
(i) the aluminium oxide
(ii) the iron (III) oxide
(b) (i) Name the process used for the purification of bauxite.
(ii) Write the equation for the action of heat on aluminium hydroxide.
(c) (i) Write the formula of cryolite.

(ii) Write down the word which correctly completes the following sentence:
By dissolving aluminium oxide in cryolite a ..... (conducting/non-conducting) solution is produced.
(iii) Why is so much graphite required for the electrolytic process?
(iv) Write the equation for the reaction which takes place at the cathode
(v) What is the cathode made up of?

Answer

(a) Aluminium oxide dissolves and forms sodium meta aluminate. Iron (III) oxide is left behind as red mud and is removed by filtration.

$Al_2O_3.2H_2O + 2NaOH \longrightarrow 2NaAlO_2 + 3H_2O$

(b) (i) Bayer's process

(ii) The equation for the action of heat on aluminium hydroxide is:

$$2Al(OH)_3 \overset{1000°C}{\rightarrow} Al_2O_3 + 3H_2O$$

(c) (i) Na_3AlF_6

(ii) By dissolving aluminium oxide in cryolite, a ***conducting*** solution is produced.

(iii) Thick Graphite rods attached to copper clamps dipping into fused electrolyte are used as anode. The graphite (anode) is oxidized by oxygen to CO and further forms CO_2, so it is consumed and has to be replaced from time to time. Hence, large amount of graphite is required.

Equation:

$2C + O_2 \longrightarrow 2CO$

$2CO + O_2 \longrightarrow 2CO_2$

(iv) Reaction at the cathode:

$4Al^{3+} + 12e^- \longrightarrow 4Al$

(v) Inner carbon lining of the electrolytic cell

Question 4

Aluminium is extracted from it's chief ore, bauxite. The ore is first purified and then the metal is extracted from it by electrolytic reduction.

(a) Write three balanced equations for the purification of bauxite.

(b) Name a chemical used for dissolving aluminium oxide. In which state is the chemical used?

(c) Write an equation for the reaction which takes place at the anode during the extraction of aluminium by the electrolytic process.

Answer

(a) The three balanced equations for the purification of bauxite are:

$Al_2O_3.2H_2O + 2NaOH \longrightarrow 2NaAlO_2 + 3H_2O$

$NaAlO_2 + 2H_2O \longrightarrow NaOH + Al(OH)_3\downarrow$

$$2Al(OH)_3 \overset{heat}{\underset{1000°C}{\rightarrow}} Al_2O_3 + 3H_2O$$

(b) The chemical used for dissolving aluminium oxide is **cryolite**. It is used in **molten state.**

(c) At anode:

$6O^{2-} - 12e^- \longrightarrow 6[O]$

$3[O] + 3[O] \longrightarrow 3O_2$

Anode is oxidised to carbon monoxide which further forms carbon dioxide

$2C + O_2 \longrightarrow 2CO$

$2CO + O_2 \longrightarrow 2CO_2$

Question 5

(a) A to F below relate to the source and extraction of either zinc or aluminium:

A. Bauxite

B. Coke

C. Cryolite

D. Froth floatation
E. Sodium hydroxide solution
F. Zinc blende
(i) Write down the three letters each from the above list which are relevant to
1. Zinc
2. Aluminium

(ii) Fill in the blanks using the most appropriate words from A to F.
1. The ore from which aluminium is extracted must first be treated with ..... so that pure aluminium oxide can be obtained.
2. Pure aluminium oxide is dissolved in ..... to make a conducting solution.

(iii) Write the formula of cryolite.

Answer
1. F → Zinc blende, D → Froth flotation, B → Coke
2. C → Cryolite, A → Bauxite, E → Sodium hydroxide solution

(ii) Fill in the blanks using the most appropriate words from A to F.
1. The ore from which aluminium is extracted must first be treated with ***sodium hydroxide*** so that pure aluminium oxide can be obtained.
2. Pure aluminium oxide is dissolved in ***cryolite*** to make a conducting solution.

(iii) Cryolite [Sodium aluminium flouride] — $\mathbf{Na_3AlF_6}$

Question 6a

Explain with reasons:
In the electrolytic reduction of alumina, the graphite anode is gradually consumed.
or
Why the anode has to be replaced from time to time in this process?

Answer

In the electrolytic reduction of alumina, the graphite (anode) is oxidized by oxygen to CO and further forms CO_2, so it is consumed and has to be replaced from time to time.
Equation:
$2C + O_2 \longrightarrow 2CO$
$2CO + O_2 \longrightarrow 2CO_2$

Question 6b

Explain with reasons:
Roasting is carried out on sulphide ores and not on carbonates ores.

Answer

Roasting is done in presence of air and provides oxygen to metal sulphides, which is required to convert them to metallic oxide and SO_2. Whereas, carbonate is changed to oxide by loss of CO_2, which occurs in the absence of air and when heated to a high temperature. Hence, roasting is not done on carbonates.

Question 6c

Explain with reasons:
Carbon can reduce lead oxide but not aluminium oxide.

Answer

Oxides of highly active metals like sodium, potassium, aluminium have great affinity for oxygen and so cannot be reduced by common reducing agents like carbon, carbon monoxide or hydrogen whereas lead is in the middle of activity series and is moderately active. So carbon can reduce lead oxide easily.

Question 6d

Explain with reasons:
Electrolytic reduction is done to obtain aluminium.

Answer

Oxides of highly active metals like potassium, sodium, calcium, magnesium and aluminium have great affinity for oxygen and so cannot be reduced by common reducing agents like carbon, carbon monoxide or hydrogen.
They are obtained by electrolytic reduction of fused metallic salts (halides and oxides) using inert electrodes.

Question 6e

Explain with reasons:
Why 'the food containing iron salts' should not be cooked in aluminium utensils?

Answer

As aluminium is above iron in the metal reactivity series hence, it can displace iron from iron salts. Therefore, food containing iron salts should not be cooked in aluminium utensils.

Question 6f

Explain with reasons:
A neutral gas other than oxygen is formed at the anode during electrolysis of fused alumina.

Answer

The oxygen gas produced at anode reacts with carbon electrode, which further produces carbon monoxide, a neutral gas.

$2C + O_2 \longrightarrow 2CO$

Question 6g

Explain with reasons:
Why is powdered coke sprinkled on top of the electrolyte?

Answer

The layer of powdered coke is sprinkled on top of the electrolyte as :

1. it prevents the burning of anode.
2. it reduces heat loss by radiation.

Question 7

For each substance listed below, explain it's significance in the extraction of aluminium:
(a) Bauxite
(b) Sodium hydroxide
(c) Cryolite
(d) Graphite

Answer

(a) **Bauxite** — Main ore from which aluminium is extracted. It contains 60% Al_2O_3
(b) **Sodium hydroxide** — Sodium hydroxide is used in the purification of bauxite ore by converting it into alumina. It acts as an effective solvent for the aluminum oxide in bauxite and helps to remove impurities like ferric oxide, sand, etc. which are collectively called as red mud.
(c) **Cryolite** — Lowers the fusion temperature from 2050°C to 950°C. and enhances conductivity.
(d) **Graphite** — Thick Graphite rods attached to copper clamps dipping into fused electrolyte are used as anode.

Question 8

Distinguish between electrolytic methods of reduction and refining.

Answer

Electrolytic reduction	**Electrolytic refining**
Metals higher in the activity series like potassium and sodium cannot be reduced by common reducing agents like CO or C, hence, these metals are obtained by electrolytic reduction of fused metallic salts.	It is the method by which crude metal is purified.
Cathode is usually made of iron and anode of graphite.	Impure metal is made the anode while pure metal is the cathode.

Electrolytic reduction	Electrolytic refining
It precedes electrolytic refining.	It is done after electrolytic reduction.

Question 9

Give three ways in which the metal zinc differs from the non-metal carbon. At least one of the differences must be a chemical difference.

Answer

Zinc	Carbon
Zinc is a metal.	Carbon is a non-metal.
Zinc forms electrovalent bonds.	Carbon forms covalent bonds.
Zinc has a relatively low melting point of 419.5°C.	Carbon has a high melting point of 3500°C.

Question 10

(a) Aluminium is a more active metal than iron but suffers less corrosion. Why?

(b) Explain and give reasons why aluminium vessels should not be cleaned with powders containing alkalis.

Answer

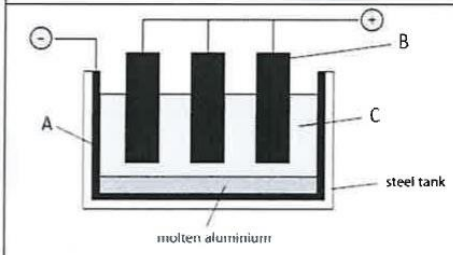
(a) Aluminum forms a thin, protective layer of aluminium oxide (Al_2O_3) on its surface that prevents further oxidation and corrosion. The oxide layer acts as a barrier that protects the metal underneath from being exposed to the elements, thus minimizing corrosion.

(b) Aluminium vessels should not be cleaned with powders containing alkalis because alkalis are water soluble and aluminum metal will react with alkalis to form sodium meta aluminate that can be toxic to our health.

$2Al + 2NaOH + 2H_2O \longrightarrow 2NaAlO_2 + 3H_2$

Question 11

Given below in column A is a schematic diagram of the electrolytic reduction of alumina. Identify the parts labelled as A, B and C with the correct options from the column B.

Column A		Column B
	1.	Platinum
	2.	Anode
	3.	Cathode
	4.	Electrolyte mixture
	5.	Bauxite

Answer

From the above table:

A ⟶ 3. Cathode

B ⟶ 2. Anode

C ⟶ 4. Electrolytic mixture

Question 12

Fill in the blanks :

(a) During the concentration of bauxite ore, aluminium goes in ..... (soluble/insoluble) part because of its ..... (acidic/basic/amphoteric) nature.

(b) In Hoope's process, pure aluminium is collected at the ..... (top/bottom) of the electrolytic cell.

Answer

(a) During the concentration of bauxite ore, aluminium goes in ***soluble*** part because of it's ***amphoteric*** nature.

(b) In Hoope's process, pure aluminium is collected at the ***top*** of the electrolytic cell.

Exercise 7D

Question 1

Explain the following:

(a) Zinc is used to cover iron so as to prevent rusting of iron. Why?

(b) In construction work, why is the alloy of aluminium–duralumin used rather than pure aluminium?

Answer

(a) As zinc is more reactive than iron, hence it forms a dense and impermeable layer of zinc oxide over iron which protects the iron beneath from rusting.

(b) As duralumin has strength up to six times greater than pure aluminium hence, alloy of aluminium–duralumin is used rather than pure aluminium in construction work.

Question 2

What is an alloy? How do the properties of an alloy differ from it's constituents?

Answer

An alloy is a homogeneous mixture of two or more metals or of one or more metals with certain non-metallic elements.

The properties of alloys are often greatly different from those of the components.

1. Gold is too soft to be used without a small percentage of copper.
2. The corrosion and oxidation resistance of steel is markedly increased by adding 15 to 18% of chromium and often a few percent of nickle (stainless steel).
3. The presence of carbon up to 1.5% greatly affects the properties of steel.
4. A low percentage of molybdenum improves the toughness and wear resistance of steel.

Alloys are made to change the property of their major constituent to achieve a specific objective.

Question 3

Both Brass and bronze contain copper as major constituents. Name other elements in these alloys.

Answer

1. The other element in Brass is **Zinc**
2. The other elements in Bronze are **Tin and Zinc**.

Question 4

Name an alloy of:

(a) Aluminium used in aircraft construction.

(b) Lead used in electrical wiring or electrical work in joining metals.

(c) Copper in electrical appliances or household vessels.

(d) Zinc used in naval ships.

Answer

(a) Aircraft construction — Duralumin

(b) Electrical wiring or electrical work in joining metals — Solder or fuse metal

(c) Electrical appliances — Brass

Household vessels — Bronze

(d) Naval ships — Brass

Question 5

What is an amalgam? State it's use with an example.

Answer

Amalgam is a mixture or an alloy of mercury with a number of metals or alloys such as sodium, zinc, gold, and silver, as well as some non-metals.

For example, Dental amalgam is a mixture of mercury and a silver-tin alloy. It is often used in dentistry as a filling material for cavities in teeth. The mercury acts as a binding agent that holds the other metals together to form a solid, durable material.

Question 6

(a) State two properties of brass that render it more useful for some purposes than it's components.

(b) Name a metal which forms a liquid alloy at ordinary temperature.

Answer

(a) Two properties of brass are:

1. Hardness and tensile strength — Brass is stronger than its components, Copper and Zinc.
2. Corrosion resistance — Brass has good corrosion resistance due to the presence of zinc in its composition.

(b) Sodium.

Question 7

Name the constituents of:

(a) Duralumin

(b) Solder

(c) Bronze

(d) Brass

Answer

(a) Aluminium (95%), copper (4%), magnesium (0.5%) and manganese (0.5%).

(b) Lead (50%) and tin (50%).

(c) Copper (80%), tin (18%) and zinc (2%).

(d) Copper (60-70%) and zinc (40-30%)

Question 8

Name the following:

(a) A metal which is liquid at room temperature.

(b) A metal which is always present in the amalgam.

(c) The process of heating an ore to a high temperature in the presence of air.

(d) The compound formed by the reaction between calcium oxide and silica.

(e) A compound which is added to lower the fusion temperature of the electrolytic bath in the extraction of aluminium

(f) Name an allotrope of a non-metal that allows electricity to pass through it.

Answer

(a) Mercury

(b) Mercury

(c) Roasting

(d) Slag i.e., Calcium silicate

$CaO + SiO_2 \longrightarrow CaSiO_3$ [Calcium silicate]

(e) Cryolite

(f) Graphite

Question 9

Name the alloy used for the following purposes.

(a) Making electric circuits

(b) Making medals

(c) Making parts of watches

(d) Surgical instruments

(e) Aircraft

Answer

(a) Making electric circuits — Brass

(b) Making medals — Bronze

(c) Making parts of watches — Brass
(d) Surgical instruments — Stainless steel
(e) Aircraft — Duralumin

Question 10

Using the information in the table below, complete the following :
(a) ..... is the metallic element.
(b) Metal atoms tend to have a maximum of ..... electrons in the outermost energy level.
(c) Non-metallic elements tend to form ..... oxides while metals tend to form ..... oxides.
(d) Non-metallic elements tend to be ..... conductors of heat and electricity.
(e) Metals tend to ..... electrons and act as ..... agents in their reactions with elements and compounds.

	X	**Y**
Normal electronic configuration	2, 8, 7	2, 8, 2
Nature of oxide	Dissolves in water and turns blue litmus red	Very low solubility in water. Dissolves in hydrochloric acid
Tendency for oxidizing and reducing reactions	Tends to oxidise elements and compounds	Tends to act as a reducing agent
Electrical and thermal conductivity	Very poor electrical conductor and poor thermal conductivity	Good electrical conductor and good thermal conductor
Tendency to form alloys and amalgams	No tendency to form alloys	Forms alloys

Answer

(a) ***Y*** is the metallic element.
(b) Metal atoms tend to have a maximum of ***three*** electrons in the outermost energy level.
(c) Non-metallic elements tend to form ***acidic*** oxides while metals tend to form ***basic*** oxides.
(d) Non-metallic elements tend to be ***poor*** conductors of heat and electricity.
(e) Metals tend to ***lose*** electrons and act as ***reducing*** agents in their reactions with elements and compounds.

Miscellaneous Exercises — Multiple Choice Type

Question 1

The main ore used for the extraction of iron is:

1. Haematite
2. Calamine
3. Bauxite
4. Cryolite

Answer

Haematite

Reason — Iron is mainly extracted from its chief ore haematite (Fe_2O_3)

Question 2

Heating an ore in a limited supply of air or in the absence of air at a temperature just below it's melting point is known as :

1. Smelting
2. Ore dressing
3. Calcination

4. Bessemerisation

Answer

Calcination

Reason — When an ore is a carbonate or a hydrated oxide, it is heated in the absence of air (or air might be supplied in a limited quantity) to a temperature that is high but insufficient to melt the ore. The process is known as Calcination.

Question 3

The compound that is not an ore of aluminium is:

1. Cryolite
2. Corundum
3. Fluorspar
4. Bauxite

Answer

Fluorspar

Reason — Fluorspar, also known as fluorite, is a mineral form of calcium fluoride which acts as a solvent along with cryolite, for the electrolytic mixture. Whereas, Bauxite, Corundum and cryolite are the ores of aluminium.

Question 4

Fused alumina is reduced to aluminium by electrolytic reduction, since:

1. alumina is highly stable.
2. alumina is least stable.
3. alumina is not reduced by drying agents.
4. alumina is not reduced by reducing agents.

Answer

alumina is not reduced by reducing agents.

Reason — Electrolytic reduction is chosen as the method for reducing alumina. Since, aluminium oxide due to its great affinity for oxygen is a very stable compound. It is not reduced easily by common reducing agents like carbon, carbon monoxide or hydrogen.

Question 5

The chemical name of the principal ore of aluminium is:

1. sodium aluminium fluoride
2. aluminium oxide
3. hydrated aluminium fluoride
4. hydrated aluminium oxide

Answer

hydrated aluminium oxide

Reason — Main ore of aluminium is bauxite ($Al_2O_3.2H_2O$) and its chemical name is **hydrated aluminium oxide**

Question 6

Brass is an alloy of

1. Copper and tin
2. Copper and zinc
3. Zinc and lead
4. Lead and tin

Answer

Copper and zinc

Reason — Brass is an alloy of Copper and zinc. Brass is stronger than its components.

Question 7

Steel is an alloy of iron and:

1. Nickel
2. Zinc
3. Carbon
4. Aluminium

Answer

Nickel

Reason — Steel is an alloy of iron, chromium, nickle and carbon. it is made to increase the strength of iron.

Question 8

The reason for using aluminium in the alloy duralumin is

1. Aluminium is brittle.
2. Aluminium gives strength.
3. Aluminium brings lightness.
4. Aluminium lowers melting point.

Answer

Aluminium brings lightness.

Reason — Aluminium is used in duralumin along with copper because it imparts lightness.

Question 9

Duralumin is an alloy with composition:

P — Al and Mg

Q — Al, Cu and Mg

R — Al and Mn

1. Only P
2. Only Q
3. Both P and R
4. Only R

Answer

Only Q

Reason — Duralumin ia an alloy with composition of **Aluminium (95%), Copper (4%) and Magnesium (0.5%)**.

Question 10

Assertion (A): Hydrogen is a non-metal and can even form positive ions.

Reason (R): Metals are defined as the elements which form positive ions by the loss of electrons.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true but R is not the correct explanation of A.

Explanation — Hydrogen is a non-metal which also forms positive ions by losing its electron like metals. Hence, assertion (A) is true.

Metals are defined as the elements which form positive ions by the loss of electrons. Hence, reason (R) is true. However, reason (R) does not explain how hydrogen form positive ion. Hence, reason (R) is not correct explanation of assertion (A).

Question 11

Assertion (A): Sodium and potassium are reactive elements.

Reason (R): Sodium and potassium occur in free states

1. Both A and R are true and R is the correct explanation of A.

2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

A is true but R is false.

Explanation — Sodium and potassium are highly reactive in nature. Hence, assertion (A) is true. Sodium and potassium are so reactive. So, they do not occur in free states. They quickly combine with other elements. Hence reason (R) is false.

Question 12

Assertion (A): Minerals are the substances from which metals can be extracted profitably.

Reason (R): Ores are those minerals from which metals are extracted commercially and profitably.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

A is false but R is true.

Explanation — Minerals are the naturally occurring compounds of metals. But not every mineral can be used to extract metals profitably. Hence assertion (A) is false.

Ores are those minerals from which metals are extracted commercially at a comparatively lower cost and with minimum effort. Hence reason (R) is true.

Question 13

Assertion (A): Aluminium is extracted from its ore bauxite.

Reason (R): Bauxite is the only ore of aluminium.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

A is true but R is false.

Explanation — Main ore of aluminium is bauxite ($Al_2O_3.2H_2O$). Hence, assertion (A) is true.

Bauxite is **not** the only ore of aluminium. Aluminium can be extracted from other ores like cryolite and corundum. Hence reason (R) is false.

Question 14

Assertion (A): Metallurgy deals with the production and purification of metals.

Reason (R): Reduction is one of the methods of extraction of metals.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true but R is not the correct explanation of A.

Explanation — Metallurgy deals with the production and purification of metals and manufacture of alloys. Hence, assertion (A) is true.

They are many different methods of concentration or purification of an ore and reduction is one of the methods of extraction of metals. Hence, reason (R) is true.

But reason (R) doesn't explain why it is important to purify and produce the pure metal from the process of metallurgy. Hence, reason (R) is not correct explanation of assertion (A).

Question 15

Assertion (A): The concentration of aluminium is not done by leaching process.

Reason (R): In leaching process, the ore is dissolved in an acid or alkali

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

A is false but R is true.

Explanation — The leaching method is used for the concentration of metals like aluminium, silver and gold. Hence, assertion (A) is false.

The ore is treated with a suitable reagent like acid, base or some other reagent, such that the ore is soluble in it but the impurities are not. The impurities are removed by filtration. Hence, reason (R) is true.

Question 16

Assertion (A): Bayer's process is used in the extraction of aluminium from its main ore.

Reason (R): Bayer's process is done for the refinement of aluminium,

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

A is true but R is false.

Explanation — Bayer's process is used for the purification of bauxite ore. Where, bauxite is converted into alumina. Which is reduced to aluminium using electrolytic reduction. Hence, assertion (A) is true.

Refining of aluminium is done by hoope's electrolytic process **not** bayer's process. Hence, reason (R) is false.

Question 17

Assertion (A): Reactive metals like calcium, magnesium cannot be obtained by reduction.

Reason (R): Reactive metals have a great affinity towards oxygen

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true and R is the correct explanation of A.

Explanation — Highly reactive metals like calcium, magnesium have great affinity towards oxygen and so cannot be reduced by common reducing agents like coke (carbon), carbon monoxide or hydrogen. Such metals are obtained by electrolytic reduction. Hence, both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

Question 18

Assertion (A): Aluminium is obtained from its oxide by electrolysis.

Reason (R): Aluminium has a great affinity towards oxygen so common reducing agents are not able to reduce it.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true and R is the correct explanation of A.
Explanation — Aluminium oxide (Al_2O_3) is obtained from its ore bauxite through bayer's process. Since aluminium oxide is highly reactive and has greater affinity towards oxygen so it cannot be reduced by common reducing agent. Thus, it is reduced to aluminium using electrolysis. Hence, both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

Question 19

Assertion (A): For electrical heating devices like electric iron and heater, alloys are used.
Reason (R): Alloys have a greater resistance and low melting point.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true but R is not the correct explanation of A.
Explanation — Alloys are used for heating devices like electric iron and heater because of its high resistance to electricity. Hence, assertion (A) is true. Generally alloys have great resistance to electricity. Thus, they can produce more heat and alloys also have lower melting point than its individual component. Hence, reason (R) is true. However, in case of electrical iron and heater, alloys have high melting point to withstand the heat, Hence, reason (R) is not correct explanation of assertion (A).

Question 20

Assertion (A): Bronze is used in making medals, statues, etc.
Reason (R): Bronze is hard and easily cast.

1. Both A and R are true and R is the correct explanation of A.
2. Both A and R are true but R is not the correct explanation of A.
3. A is true but R is false.
4. A is false but R is true.

Answer

Both A and R are true and R is the correct explanation of A.
Explanation — Bronze is composed of copper (80%), tin (18%) and zinc (2%). It is used in making medals, statues, utensils, etc. Hence, assertion (A) is true.
Bronze is used in making of medals, statues, utensils, bearing and coins because of its hardness and it can be casted easily. Hence, reason (R) is true and it is the correct explanation of assertion (A).

Miscellaneous Exercises — Very Short Answer Type

Question 1

Name the following:
(a) A metal which is found abundantly in the Earth's crust.
(b) The process used for the enrichment of sulphide ore.
(c) A metal present in cryolite other than sodium.
(d) A metal which is unaffected by dilute or concentrated acids.
(e) A metal present in period 3, group 1 of the periodic table.
(f) The property possessed by metals by which they can be beaten into sheets.
(g) A compound added to lower the fusion temperature of electrolytic bath in the extraction of aluminium.
(h) The ore of zinc containing its sulphide.
(i) The *solution* used to react with *Bauxite* as a first step in obtaining pure aluminium oxide, in the Baeyer's process.
(j) The *compound* added to pure alumina to lower the fusion temperature during the electrolytic reduction of alumina.

Answer

(a) Aluminium

(b) Froth floatation process
(c) Aluminium
(d) Gold
(e) Sodium
(f) Malleability
(g) Cryolite (Na_3AlF_6)
(h) Zinc Blende (ZnS).
(i) Sodium hydroxide
(j) Cryolite (Na_3AlF_6)

Question 2

Choose the most appropriate answer from the following list of oxides which fit the description. Each answer may be used only once:
[SO_2, SiO_2, Al_2O_3, MgO, CO, Na_2O]
(a) A basic oxide
(b) An oxide which dissolves in water forming an acid
(c) An amphoteric oxide.
(d) A covalent oxide of a metalloid

Answer

(a) Na_2O
(b) SO_2
(c) Al_2O_3
(d) SiO_2

Miscellaneous Exercises — Short Answer Type

Question 1

State the main components of the following alloys :
(a) Brass
(b) Duralumin
(c) Bronze.

Answer

(a) Brass — Cu [60-80%], Zn [40-20%]
(b) Duralumin — Al [95%], Mg [0.5%], Mn [0.5%], Cu [4%]
(c) Bronze — Cu [80%], Zn [1%], Sn [19%]

Question 2

For each of the substances listed below, describe the role played in the extraction of aluminium
(a) Cryolite
(b) Sodium hydroxide
(c) Graphite

Answer

(a) Addition of Cryolite :

1. Lowers the fusion point of the mixture i.e., mixture fuses around 950°C instead of 2050°C.
2. Enhances the mobility of the fused mixture by acting as a solvent for the electrolytic mixture.
3. Enhances the conductivity of the mixture since, pure alumina is almost a non-conductor of electricity.

(b) Sodium hydroxide is added to bauxite ore during purification of bauxite. Bauxite is reacted with a conc. solution of NaOH under pressure for 2 hrs as a first step in obtaining Al_2O_3. The impurities present in bauxite mainly Fe_2O_3 and SiO_2 remain unaffected with conc. NaOH as impurities are not amphoteric. Bauxite, being amphoteric reacts with the base forming sodium salt [sodium aluminate] and water. Hence, impurities are separated out.
(c) Thick Graphite rods attached to copper clamps dipping into fused electrolyte are used as anode.

Question 3

Write the chemical formula of one main ore of iron and aluminium.

Answer

Chemical formulae of main ores of iron and aluminium are:

	Name	Chemical name	Formula
Ore of iron	Haematite	Ferric oxide	Fe_2O_3
Ore of aluminium	Bauxite	Hydrated aluminium oxide	$Al_2O_3.2H_2O$

Question 4

State the property of the metal being utilised in the following:

Use of metal	Property
Zinc in galvanisation	
Aluminium in thermite welding	

Answer

Use of metal	Property
Zinc in galvanisation	It oxidises more readily than iron, thus preventing the rusting of iron
Aluminium in thermite welding	It is a good reducing agent.

Question 5

The following questions are relevant to the extraction of Aluminium :

(a) State the reason for addition of caustic alkali to bauxite ore during purification of bauxite.

(b) Give a balanced chemical equation for the above reaction.

(c) Along with cryolite and alumina, another substance is added to the electrolyte mixture. Name the substance and give one reason for the addition.

Answer

(a) Bauxite is reacted with a conc. solution of NaOH (caustic alkali) under pressure for 2 hrs as a first step in obtaining Al_2O_3.

The impurities present in bauxite mainly Fe_2O_3 and SiO_2 remain unaffected with conc. NaOH as impurities are not amphoteric.

Bauxite, being amphoteric reacts with the base forming salt [sodium aluminate] and water. Hence, impurities are separated out. Therefore, caustic alkali is added to bauxite ore during purification of bauxite.

(b) Balanced chemical equation for the conversion of impure bauxite to sodium aluminate is given below:

$$\underset{\text{Amphoteric oxide}}{Al2O3.2H2O\ [\text{Impure bauxite}]} + \underset{\text{Base}}{2NaOH\ [\text{conc. soln}]} \xrightarrow{150-200^{\circ}C} \underset{\text{Salt}}{2NaAlO2[\text{sodium aluminate}]} + \underset{\text{Water}}{3H2O}$$

(c) Fluorspar is added to the electrolyte mixture as it lowers the fusion point of the mixture i.e., the mixture fuses around 950°C instead of 2050°C.

Question 6

Write the constituents of the electrolyte for the extraction of aluminium.

Answer

It is a mixture of molten **alumina (Al_2O_3) 20%, cryolite (Na_3AlF_6) 60% and fluorspar (CaF_2) 20%**.

Question 7

Write the *equation* for the reaction where the aluminium oxide for the electrolytic extraction of aluminium is obtained by heating aluminium hydroxide.

Answer

Conversion of $Al(OH)_3$ - to pure alumina - heat on $Al(OH)_3$

$$2Al(OH)3[\text{aluminium hydroxide}] \overset{1100°C}{\rightarrow} Al2O3[\text{pure alumina}] + 3H_2O$$

Question 8

Write the *equation* for the reaction that occurs at the cathode during the extraction of aluminium by electrolysis.

Answer

$2Al^{3+} + 6e^- \longrightarrow 2Al$

Question 9

Explain why it is preferable to use a number of graphite electrodes as anode instead of a single electrode, during the above electrolysis.

Answer

The oxygen evolved at the anode escapes as a gas or reacts with the carbon anode. The carbon anode is thus oxidized to carbon monoxide which either burns giving carbon dioxide or escapes out through an outlet. [$2C + O_2 \longrightarrow 2CO$; $2CO + O_2 \longrightarrow 2CO_2$] The carbon anode is hence consumed and renewed periodically after a certain period of usage. It is therefore preferable to use a number of graphite electrodes as anode instead of a single electrode.

Miscellaneous Exercises — Long Answer Type

Question 1

The following is an extract from 'Metals in the Service of man, Alexander and street/Pelican 1976'.
'Alumina (aluminium oxide) has a very high melting point of over 2000°C so that it cannot readily be liquefied. However, conversion of alumina to aluminium and oxygen, by electrolysis, can occur when it is dissolved in some other substance'.

(a) Which solution is used to react with bauxite as a first step in obtaining pure aluminium oxide?

(b) The aluminium oxide for the electrolytic extraction of aluminium is obtained by heating aluminium hydroxide. Write the equation for this reaction.

(c) Name the element which serves both as the anode and the cathode in the extraction of aluminium.

(c) Write the equation for the reaction that occurs at the cathode during the extraction of aluminium by electrolysis.

(d) Give the equation for the reaction which occurs at the anode when aluminium is purified by electrolysis.

(e) Give the equation for the reaction which occurs at the anode when aluminium is purified by electrolysis.

Answer

(a) Sodium hydroxide

(b) The equation for the action of heat on aluminium hydroxide is:

$$2Al(OH)_3 \overset{1000°C}{\rightarrow} Al_2O_3 + 3H_2O$$

(c) The element is **Carbon**. As carbon lining acts as cathode and graphite acts as anode, hence, we can say that element that acts both as cathode and anode is Carbon.

(d) Reaction at the cathode:

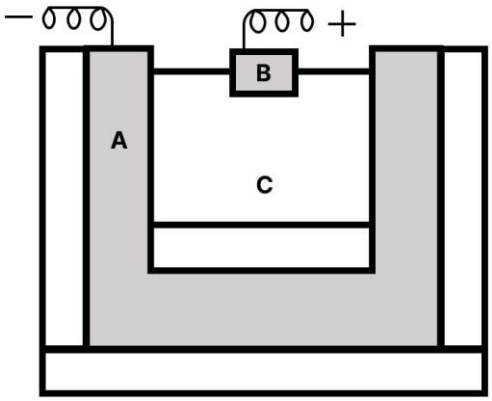
$Al^{3+} + 3e^- \longrightarrow Al$

(e) Reaction at the anode:

$Al - 3e^- \longrightarrow Al^{3+}$

Question 2

The following is a sketch of an electrolytic cell used in the extraction of aluminium:



(i) What is the substance of which the electrodes A and B are made?

(ii) At which electrode (A or B) is the aluminium formed?

(iii) What are the two aluminium compounds in the electrolyte C?

(iv) Why is it necessary for electrode B to be continuously replaced?

Answer

(i) A (cathode) is made of **carbon** and B (anode) is made of **graphite.**

(ii) Aluminium is formed at **cathode i.e., electrode A.**

(iii) Two aluminium compounds in the electrolyte C are **alumina [Al_2O_3]** and **Cryolite [Na_3AlF_6]**

(iv) In the electrolytic reduction of alumina, the graphite (anode) is oxidised by oxygen to CO and further forms CO_2, so it is consumed and has to be replaced from time to time.

Equation:

$2C + O_2 \longrightarrow 2CO$

$2CO + O_2 \longrightarrow 2CO_2$