CHEMISTRY NOTES

FORM 2

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**INTRODUCTION TO ELECTROLYSIS (ELECTROLYTIC CELL)**

**1**.Electrolysis is defined simply as the **decomposition** of a **compound** by an electric current/**electricity**.

A compound that is decomposed by an electric current is called an electrolyte. Some electrolytes are **weak** while others are **strong**.

**2**.Strong electrolytes are those that are fully ionized/dissociated into (many) ions. Common strong electrolytes include:

(i)all **mineral** acids

(ii)all strong **alkalis**/sodium hydroxide/potassium hydroxide.

(iii)all soluble **salts**

**3**.Weak electrolytes are those that are partially/partly ionized/dissociated into (few) ions.

Common weak electrolytes include:

(i)all **organic** acids

(ii)all **bases** except sodium hydroxide/potassium hydroxide.

(iii)**Water**

**4**. A compound that is **not** decomposed by an electric current is called non-electrolyte.

Non-electrolytes are those compounds /substances that exist as molecules and thus cannot ionize/dissociate into(any) ions .

Common non-electrolytes include:

(i) most organic solvents (e.g. petrol/paraffin/benzene/methylbenzene/ethanol)

(ii)all hydrocarbons(alkanes /alkenes/alkynes)

(iii)Chemicals of life(e.g. proteins, carbohydrates, lipids, starch, sugar)

**5**. An electrolytes in **solid** state have **fused** /joined ions and therefore do **not** conduct electricity but the **ions** (cations and anions) are **free** and **mobile** in **molten** and **aqueous** (solution, dissolved in water) state.

**6**.During electrolysis, the free ions are attracted to the **electrodes**.

An electrode is a rod through which current enter and leave the electrolyte during electrolysis.

An electrode that does not influence/alter the products of electrolysis is called an **inert electrode.**

Common inert electrodes include:

(i)**Platinum**

(ii)**Carbon graphite**

Platinum is not usually used in a school laboratory because it is very **expensive**. Carbon graphite is **easily**/readily and **cheaply** available (from used dry cells).

**7**.The **positive** electrode is called **Anode**.The anode is the electrode through which **current enter** the electrolyte/**electrons leave** the electrolyte

**8**.The **negative** electrode is called **Cathode**. The cathode is the electrode through which **current leave** the electrolyte / **electrons enter** the electrolyte

**9**. During the electrolysis, free **anions** are attracted to the **anode** where they **lose** /**donate** electrons to form **neutral** atoms/molecules. i.e.

M(l) -> M+(l) + e (for cations from molten electrolytes)

M(s) -> M+(aq) + e (for cations from electrolytes in aqueous state / solution / dissolved in water)

The neutral atoms /molecules form the **products** of electrolysis at the anode. This is called **discharge** at anode

**10.** During electrolysis, free **cations** are attracted to the **cathode** where they **gain** /**accept/acquire** electrons to form **neutral** atoms/molecules.

X+ (aq) + 2e -> X(s) (for cations from electrolytes in aqueous state / solution / dissolved in water)

2X+ (l) + 2e -> X (l) (for cations from molten electrolytes)

The neutral atoms /molecules form the **products** of electrolysis at the cathode. This is called **discharge** at cathode.

**11.** The below set up shows an electrolytic cell.



**12.** For a compound /salt containing only two ion/binary salt the products of electrolysis in an electrolytic cell can be determined as in the below examples:

**a)To determine the products of electrolysis of molten Lead(II)chloride**

(i)Decomposition of electrolyte into free ions;

PbCl2 (l) -> Pb 2+(l) + 2Cl-(l)

(Compound decomposed into free cation and anion in **liquid** state)

(ii)At the cathode/negative electrode(-);

Pb 2+(l) + 2e -> Pb (l)

(Cation / Pb 2+ gains / accepts / acquires electrons to form free **atom)**

(iii)At the anode/positive electrode(+);

2Cl-(l) -> Cl2 (g) + 2e

(Anion / Cl- donate/lose electrons to form free **atom** then agas **molecule)**

(iv)Products of electrolysis therefore are;

I.At the cathode grey beads /solid lead metal.

II.At the anode pale green chlorine gas.

**b)To determine the products of electrolysis of molten Zinc bromide**

(i)Decomposition of electrolyte into free ions;

ZnBr2 (l) -> Zn 2+(l) + 2Br-(l)

(Compound decomposed into free cation and anion in **liquid** state)

(ii)At the cathode/negative electrode(-);

Zn 2+(l) + 2e -> Zn(l)

(Cation / Zn2+ gains / accepts / acquires electrons to form free **atom)**

(iii)At the anode/positive electrode(+);

2Br-(l) -> Br2 (g) + 2e

(Anion / Br- donate/lose electrons to form free **atom** then aliquid **molecule** whichchange to **gas** on heating)

(iv)Products of electrolysis therefore are;

I.At the cathode grey beads /solid Zinc metal.

II.At the anode **red** bromine **liquid** / **red/brown** bromine **gas.**

**c)To determine the products of electrolysis of molten sodium chloride**

(i)Decomposition of electrolyte into free ions;

NaCl (l) -> Na +(l) + Cl-(l)

(Compound decomposed into free cation and anion in **liquid** state)

(ii)At the cathode/negative electrode(-);

2Na+(l) + 2e -> Na (l)

(Cation / Na+ gains / accepts / acquires electrons to form free **atom)**

(iii)At the anode/positive electrode(+);

2Cl-(l) -> Cl2 (g) + 2e

(Anion / Cl- donate/lose electrons to form free **atom** then agas **molecule)**

(iv)Products of electrolysis therefore are;

I.At the cathode grey beads /solid sodium metal.

II.At the anode pale green chlorine gas.

**d)To determine the products of electrolysis of molten Aluminium (III)oxide**

(i)Decomposition of electrolyte into free ions;

Al2O3 (l) -> 2Al 3+(l) + 3O2-(l)

(Compound decomposed into free cation and anion in **liquid** state)

(ii)At the cathode/negative electrode(-);

4Al 3+ (l) + 12e -> 4Al (l)

(Cation / Al 3+ gains / accepts / acquires electrons to form free **atom)**

(iii)At the anode/positive electrode(+);

6O2-(l) -> 3O2 (g) + 12e

(Anion /6O2- donate/lose 12 electrons to form free **atom** then threegas **molecule)**

(iv)Products of electrolysis therefore are;

I.At the cathode grey beads /solid aluminium metal.

II.At the anode colourless gas that relights/rekindles glowing splint.

**13.**In industries electrolysis has the following uses/applications:

**(a)Extraction of reactive metals from their ores.**

Potassium, sodium ,magnesium, and aluminium are extracted from their ores using electrolytic methods.

**(b)Purifying copper after exraction from copper pyrites ores.**

Copper obtained from copper pyrites ores is not pure. After extraction, the copper is refined by electrolysing copper(II)sulphate(VI) solution using the **impure** copper as **anode** and a thin strip of **pure** copper as **cathode**. Electrode ionization take place there:

(i)At the cathode; **Cu2+ (aq) + 2e -> Cu(s)** (Pure copper deposits on the strip

(ii)At the anode; **Cu(s) ->Cu2+ (aq) + 2e** (impure copper erodes/dissolves)

**(c)Electroplating**

The label EPNS(**E**lectro **P**lated **N**ickel **S**ilver) on some steel/metallic utensils mean they are plated/coated with silver and/or Nickel to **improve** their **appearance**(**add** their **aesthetic** value)and **prevent**/slow **corrosion**(**rusting** of iron). Electroplating is the process of coating a metal with another metal using an electric current. During electroplating, the **cathode** is made of the metal to be **coated**/impure.

**Example:**

During the electroplating of a spoon with silver

(i)the spoon/impure is placed as the cathode(negative terminal of battery)

(ii)the pure silver is placed as the anode(positive terminal of battery)

(iii)the pure silver erodes/ionizes/dissociates to release electrons:

**Ag(s) ->Ag+ (aq) + e** (impure silver erodes/dissolves)

(iv) silver (**Ag+**)ions from electrolyte gain electrons to form pure silver deposits / coat /cover the spoon/impure

**Ag+ (aq) + e ->Ag(s)**  (pure silver deposits /coat/cover on spoon)

