# KCSE ONLINE REVISION

# ELECTROLYSIS

# 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.

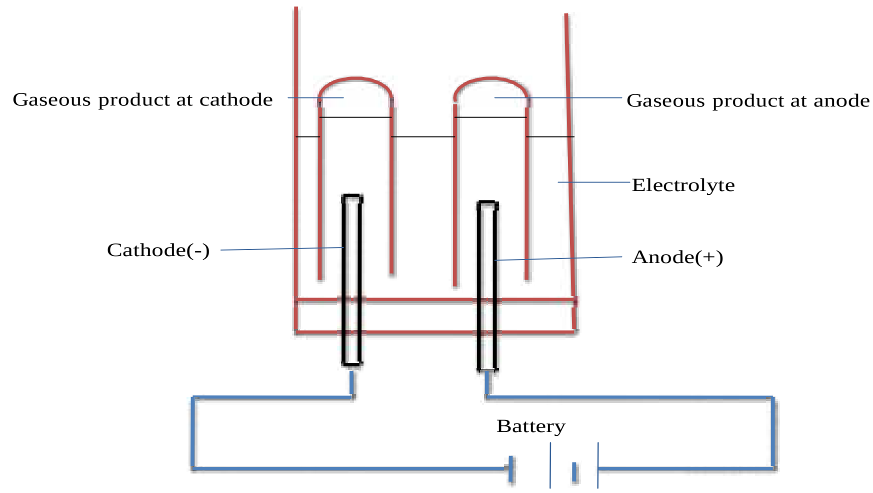
$X^{+}(aq)$ + 2e -> $X(s)$ (for cations from electrolytes in aqueous state / solution / dissolved in water)

$2X^{+}(l)$ + 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.

## Simple set up of 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)<u>To determine the products of electrolysis of molten Lead(II)chloride</u>**

(i)Decomposition of electrolyte into free ions;

$PbCl_2$ (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) -> $Cl_2$ (g) + 2e

(Anion / $Cl^-$ donate/lose electrons to form free **atom** then a gas **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)<u>To determine the products of electrolysis of molten Zinc bromide</u>**

(i)Decomposition of electrolyte into free ions;

$ZnBr_2$ (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 / $Zn^{2+}$ gains / accepts / acquires electrons to form free **atom)**

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

$2Br^-$(l) -> $Br_2$ (g) + 2e

(Anion / $Br^-$ donate/lose electrons to form free **atom** then a liquid **molecule** which change 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)<u>To determine the products of electrolysis of molten sodium chloride</u>**

(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) -> $Cl_2$ (g) + 2e

(Anion / $Cl^-$ donate/lose electrons to form free **atom** then a gas **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)<u>To determine the products of electrolysis of molten Aluminium (III)oxide</u>**

(i)Decomposition of electrolyte into free ions;

$Al_2O_3$ (l) -> $2Al^{3+}$(l) + $3O^{2-}$(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(+);
$6O^{2-}$(l) -> $3O_2$ (g) + 12e
(Anion /$6O^{2-}$ donate/lose 12 electrons to form free **atom** then three gas **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.

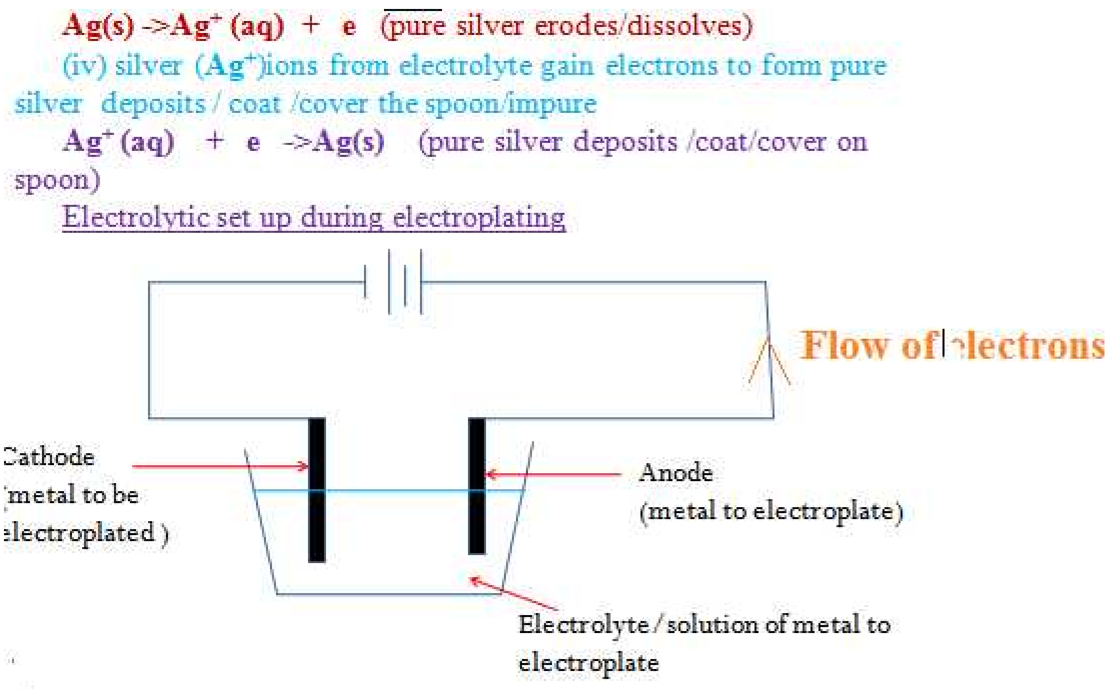
**13.**In industries electrolysis has the following uses/applications:

**(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; **$Cu^{2+}$ (aq) + 2e -> Cu(s)** (Pure copper deposits on the strip
(ii)At the anode; **Cu(s) ->$Cu^{2+}$ (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)

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