ELECTROLYSIS #5

Practice Problems -

1. Electrolysis Of Sodium Chloride solution :

→ $NaCl\ (aq)$

IONS PRESENT	Na^+, Cl^-, H^+, OH^-
CATIONS	Na^+, H^+
ANIONS	Cl^-, OH^-
EQUATION AT CATHODE	$2H^+ + 2e^- \longrightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- - 4e^- \longrightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$
IONS **LEFT** IN THE ELECTROLYTE	Na^+, Cl^-

2. Electrolysis Of Potassium Iodide solution -

→ $KI\ (aq)$

IONS PRESENT	K^+, I^-, H^+, OH^-
CATIONS	K^+, H^+
ANIONS	I^-, OH^-
EQUATION AT CATHODE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \rightarrow 2H_2O + O_2 +$
IONS **LEFT** IN THE ELECTROLYTE	K^+, I^-

3. Electrolysis Of Calcium Bromide solution - $CaBr_2$ (aq)

IONS PRESENT	Ca^{2+}, Br^-, H^+, OH^-
CATIONS	Ca^{2+}, H^+
ANIONS	Br^-, OH^-
EQUATION AT CATHODE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
IONS **LEFT** IN THE ELECTROLYTE	Ca^{2+}, Br^-

4. Electrolysis Of Sodium Hydroxide solution - $NaOH$ (aq)

IONS PRESENT	Na^+, OH^-, H^+, OH^-
CATIONS	Na^+, H^+
ANIONS	OH^-
EQUATION AT CATHODE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
IONS **LEFT** IN THE ELECTROLYTE	Na^+

5. Electrolysis Of Copper (II) Sulfate solution - $CuSO_4$ (aq)

IONS PRESENT	Cu^{2+}, SO_4^{2-}, H^+, OH^-
CATIONS	Cu^{2+}, H^+
ANIONS	SO_4^{2-}, OH^-
EQUATION AT CATHODE	$Cu^{2+} + 2e^- \rightarrow Cu$ (REDUCTION)
EQUATION AT ANODE	$4OH^- - 4e^- \rightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \rightarrow 2H_2O + O_2 + 4e^-$
IONS **LEFT** IN THE ELECTROLYTE	H^+, SO_4^{2-}

6. Electrolysis Of Magnesium Nitrate solution - $MgNO_3$ (aq)

IONS PRESENT	Mg^{2+}, NO_3^-, H^+, OH^-
CATIONS	Mg^{2+}, H^+
ANIONS	
EQUATION AT CATHODE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ (OXIDATION)
IONS **LEFT** IN THE ELECTROLYTE	Mg^{2+}, NO_3^-

7. Electrolysis Of Hydrochloric acid -
   - HCl (aq)

IONS PRESENT	H^+, Cl^-, H^+, OH^-
CATIONS	H^+
ANIONS	Cl^-, OH^-
EQUATION AT CATHODE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ (OXIDATION)
IONS **LEFT** IN THE ELECTROLYTE	Cl^-

SUMMARY:

	SOLUTION ELECTROLYZED	CATHODE	ANODE	PRODUCT AT CATHODE	PRODUCT AT ANODE:
1.	Hydrochloric acid (concentrated)	Carbon / Platinum	Carbon	Hydrogen	CHLORINE
2.	Sulfuric acid (dilute)	Platinum	Platinum	Hydrogen	OXYGEN
3.	Sodium Hydroxide	Platinum	Platinum	Hydrogen	OXYGEN
4.	Sodium Chloride (concentrated)	Platinum	Platinum	Hydrogen	CHLORINE
5.	Sodium Chloride (dilute)	Carbon	Carbon	Hydrogen	OXYGEN
6.	Sodium Chloride (molten)	Carbon	Carbon	Sodium	CHLORINE
7.	Lead (II) Bromide (molten)	Carbon	Carbon	Lead	BROMINE
8.	Copper (II) Sulfate	Carbon	Carbon	Copper	OXYGEN
9.	Copper (II) Sulfate	Copper	Copper	Copper (deposited)	COPPER(DISSOLVED)

Effect Of Concentration Of The Selective Discharge Of Anions -

An anion in higher concentration is **more easily** discharged at the Anode.

For example, in the electrolysis of **concentrated** Sodium Chloride solution, two different ions are present in the electrolyte : Cl- and OH- ions.

According to the selective discharge of anion, OH- should be discharged at the anode preferentially. However, in the concentrated Sodium Chloride solution, Cl- ions are **far more numerous** than OH- ions. So, Cl- ions are discharged at the anode in preference to OH- ions.

Electrolysis Of **Concentrated Sodium Chloride :**

↳ conc. NaCl (aq)

IONS PRESENT	Na^+, Cl^-, H^+, OH^-
CATIONS	Na^+, H^+
ANIONS	Cl^-, OH^-
EQUATION AT CATHDOE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$2Cl^- - 2e^- \rightarrow Cl_2$ (OXIDATION) $\Rightarrow 2Cl^- \rightarrow Cl_2 + 2e^-$

Electrolysis Of **concentrated Calcium Bromide** solution - → conc. $CaBr_2$ (aq)

IONS PRESENT	Ca^{2+}, Br^-, H^+, OH^-
CATIONS	Ca^{2+}, H^+
ANIONS	Br^-, OH^-
EQUATION AT CATHDOE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	$2Br^- - 2e^- \rightarrow Br_2$ (OXIDATION) $\Rightarrow 2Br^- \rightarrow Br_2 + 2e^-$

Electrolysis Of Water -

Pure, **distilled water** is a covalent compound which has simple molecular structure. So, it does not conduct electricity.

If a **small amount of ionic compounds**, such as Sodium Chloride or any **dilute acid** like Hydrochloric acid or Sulfuric acid is added to the pure, distilled water, then the water becomes a **good conductor of electricity** as the water gets ionized.

When electrolysis of (impure) water is carried out, two products are formed, **Hydrogen** and **Oxygen**.

IONS PRESENT	H^+, OH^-
CATIONS	H^+
ANIONS	OH^-
EQUATION AT CATHDOE	$2H^+ + 2e^- \rightarrow H_2$ (REDUCTION)
EQUATION AT ANODE	

EQUATION AT ANODE	$4OH^- - 4e^- \longrightarrow 2H_2O + O_2$ (OXIDATION) $\Rightarrow 4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$

$2H^+ + 2e^- \longrightarrow H_2$ $\times 2$

$4OH^- - 4e^- \longrightarrow 2H_2O + O_2$ $\times 1$

$4H^+ + 4e^- \longrightarrow 2H_2$

(+) $4OH^- - 4e^- \longrightarrow 2H_2O + O_2$

$4H^+ + 4OH^- \longrightarrow 2H_2 + 2H_2O + O_2$

The products of electrolysis of water are **two volume of Hydrogen at the Cathode** and **one volume of Oxygen at the Anode**.

NOTE:
For all the electrolysis of molten / aqueous electrolytes, all were done using **inert / unreactive electrodes** such as Platinum or Graphite.