

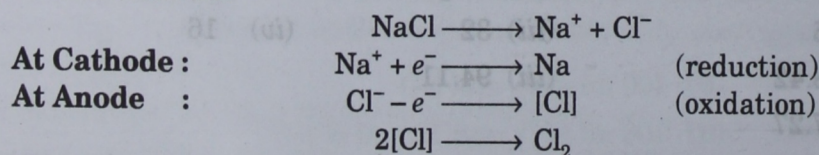
Electrolysis

IMPORTANT POINTS TO REMEMBER

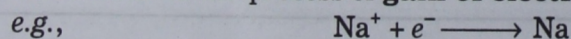
- The **conductors** allow the **passage of electric current** through them in the **solid state**.
- The **insulators do not** allow the **passage of electric current** through them.
- In **conductors**, the current passes by the **flow of electrons**.
- The **electrolytes** allow the **passage of electric current** through them in **molten, fused or aqueous solution**.
- In **electrolytes**, the **current passes** by the **flow of ions**.
- The **non-electrolytes do not** allow the **passage of electric current** through them.
- When **current** is **passed** through **electrolyte**, it undergoes **chemical decomposition**, whereas in **conductor** when the **current** is **passed** it gets only **heated up** and **no new product** is formed, *i.e.*, a **physical change** takes place.

<i>Conductors</i>	<i>Electrolytes</i>
(i) They are metals.	(i) They are ionic compounds.
(ii) They are solids.	(ii) They exist in fused or molten state and in its aqueous solution.
(iii) The passage of electric current is by the flow of electrons.	(iii) The passage of electric current is by the flow of ions.
(iv) The passage of electric current through a conductor is a physical change <i>i.e.</i> , the conductor gets only heated up, no new product is formed.	(iv) The passage of electric current through an electrolyte is a chemical change.

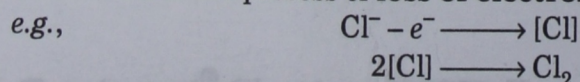
- The two terminals of the cell are called as **cathode** and **anode**.
- Cathode** is the **negative** terminal of the cell. **Cations** migrate towards **cathode**. The current **leaves** the electrolyte through the **cathode**.
- Anode** is the **positive** terminal of the cell. **Anions** migrate towards **anode**. The current **enters** the electrolyte through the **anode**.
- Electrolysis** is a **redox reaction**. **Reduction** takes place at **cathode** and **oxidation** at **anode**. The process of **reduction** and **oxidation** take place **simultaneously**. Therefore electrolysis is referred to as redox reaction.



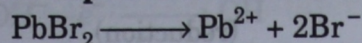
- Reduction** is the process of **gain of electrons** and it takes place at **cathode**.



- Oxidation** is the process of **loss of electrons** and it takes place at **anode**.

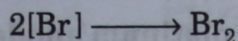


14. Molten Lead bromide is electrolysed by using inert electrodes. At cathode, lead metal is obtained whereas at anode Bromine vapours are obtained.



At Cathode : $\text{Pb}^{2+} + 2e^- \longrightarrow \text{Pb}$ (reduction)

At Anode : $2\text{Br}^- - 2e^- \longrightarrow 2[\text{Br}]$ (oxidation)



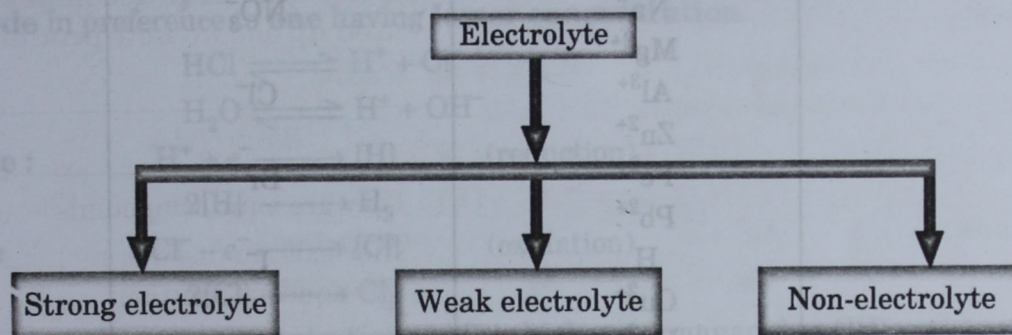
15. The ionic compounds which in their fused, molten state or in aqueous solution allow the passage of electric current are called as electrolytes.

16. There are eighteen vertical columns in the periodic table. The order for the arrangement of the group is (from left to right) I A, II A, III B, IV B, V B, VI B, VII B, VIII (undivided), I B, II B, III A, IV A, V A, VI A, VII A and zero. But according to the latest recommendations of IUPAC the groups are numbered from 1 to 18.

17. The elements of group 1, 2, 13, 14, 15, 16 and 17 are called as normal elements or representative elements. The elements of these groups are called as normal elements or representative elements. These elements have incomplete outer most shell.

18. The elements of group 3, 4, 5, 6, 7, 8, 9, 11 and 12 are known as transition elements.

19. The elements of group 18 or zero group are called as inert gases or noble gases or rare gases as they have stable configuration following the octet rule.



20. Strong electrolyte : The electrolytes which almost completely dissociate in their aqueous solutions or molten states. The solution mainly consists of ions.

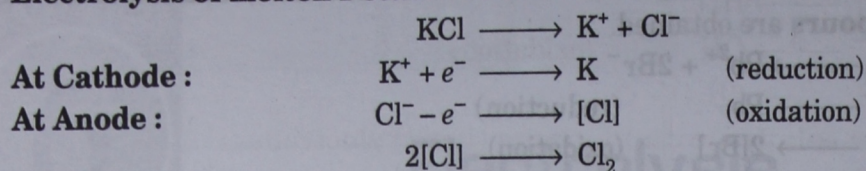
21. Weak electrolyte : The electrolytes which partially or incompletely dissociate in their aqueous solutions. The solution contains both ions and molecules.

22. Non-electrolyte : The solutions which do not ionise are called as non-electrolytes.

Examples of Strong, Weak and Non-electrolytes :

Strong electrolytes	Weak electrolytes	Non-electrolytes
(i) Strong acids : HCl, H ₂ SO ₄ , HNO ₃ .	(i) Weak acids : CH ₃ COOH, HF, H ₂ SO ₃ , H ₃ PO ₃ , H ₂ CO ₃ .	(i) Petrol
(ii) Strong bases : NaOH, KOH	(ii) Weak bases : H ₃ PO ₄ , NH ₄ OH	(ii) Sugar solution
(iii) All salts are strong electrolytes.		(iii) Liquid ammonia (iv) Carbon tetrachloride (v) Non-polar covalent compounds.

23. Electrolysis : The chemical process in which the ionic compounds in their fused, molten or aqueous solutions allow the passage of electric current, undergo simultaneous chemical decomposition leading to the discharge of ions at electrodes is called as electrolysis.

24. Electrolysis of molten Potassium chloride with inert electrodes :

Whenever **molten metallic chloride** is electrolysed, **platinum anodes** are not used.

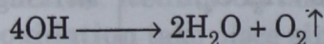
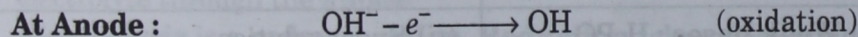
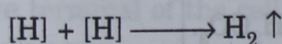
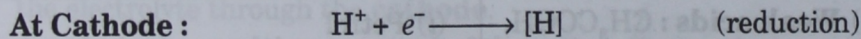
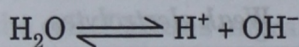
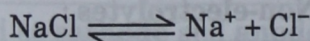
25. If the **solution** contains **more than two cations** and **anions** then the **preferential discharge of ions** depends upon the following factors :

- Relative position of ions in the electrochemical series.**
- The concentration of ions in the electrolyte.**
- The nature of electrodes.**

26. The series in which the **cations** and **anions** are arranged in the **decreasing order of their reactivity** is called as **electrochemical series**. The **ions lying below** in the **electrochemical series** are discharged in **preference** to first to the ions lying **above** in the **electrochemical series**.

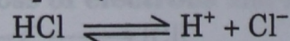
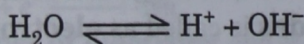
Cations	Anions
K^+	SO_4^{2-}
Ca^{2+}	
Na^+	NO_3^-
Mg^{2+}	
Al^{3+}	Cl^-
Zn^{2+}	
Fe^{2+}	Br^-
Pb^{2+}	
H	I^-
Cu^{2+}	
Hg^{2+}	OH^-
Ag^+	

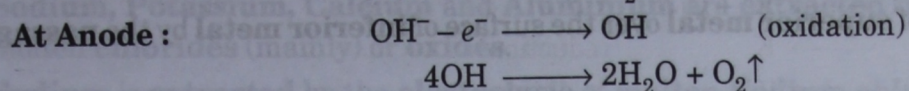
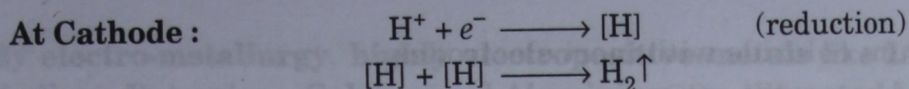
27. For example, during the **electrolysis** of **aqueous solution** of **Sodium chloride**, **Hydrogen ions** are discharged **at cathode** in preference to **Sodium ions** whereas **Hydroxyl ions** are discharged **at anode** in preference to **Chloride ions** as **Hydrogen ion** is lying **below Sodium ion** and **Hydroxyl ion** is lying **below Chloride ion** in the **electrochemical series**.



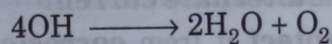
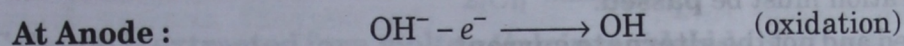
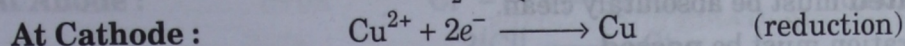
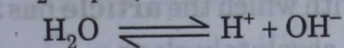
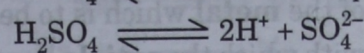
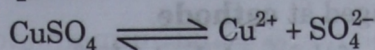
Products at Cathode - Hydrogen, **Products at Anode** - Oxygen

28. **Electrolysis of acidulated water** is considered as an example of **catalysis**. As **catalysts** only **alter** the **rate of reaction** without taking part in the reaction, so water is **feebly ionized** and on adding the drop of **acid** its ionization **increases**. When acidulated water or dilute hydrochloric acid is electrolysed with inert electrodes, then **hydrogen** is obtained at **cathode** and **oxygen** is obtained at **anode** in the ratio of **2 : 1** by volume respectively.





29. Electrolysis of Copper sulphate solution with Platinum (inert) electrodes :

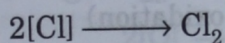
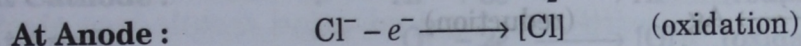
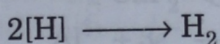
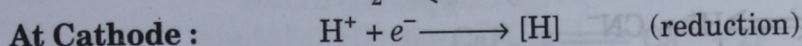
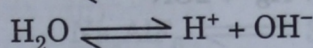
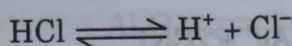


Observations :

(a) Size of cathode increases.

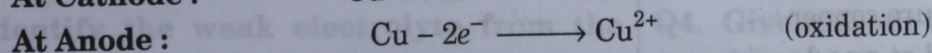
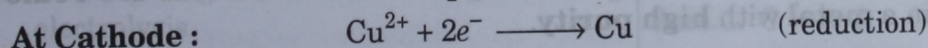
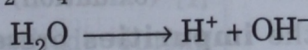
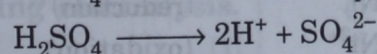
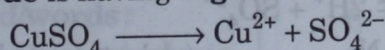
(b) Colour of the electrolyte slowly fades away *i.e.*, it changes from blue to colourless.

- 30. During the electrolysis of concentrated hydrochloric acid**, instead of hydroxyl ions, **chloride ions** are discharged at **anode** because the **concentration of chloride ions** is greater than that of **hydroxyl ions**. So, **greater the concentration of ion, greater is the probability of the ion being discharged at the electrode** in preference to **one having lower concentration**.



Cl^- will discharge because concentration of Cl^- is higher as compared to OH^- .

- 31. During the electrolysis of acidified Copper sulphate solution with Copper electrodes**, the **Copper electrodes** are **attackable**, *i.e.*, the **Copper anode** takes part in the **chemical reaction**, as the electrode has the lower electrode potential (*i.e.*, easily loses electron) as compared to the ions present in the electrolyte. But during the **electrolysis of Copper sulphate solution with platinum electrodes**, the **electrodes** are **non-attackable**, *i.e.*, they do not enter the chemical reaction with the electrolyte. This is because the **electrode** is having **higher reduction potential** than the **ions** present.



Neither Sulphate nor Hydroxyl ions are discharged but instead of that Copper anode loses electrons.

During the electrolysis of acidified Copper sulphate solution with Copper electrodes, the following changes take place :

(a) Size of cathode increases.

(b) Size of anode decreases.

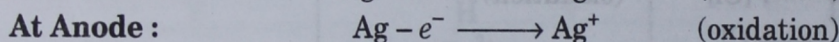
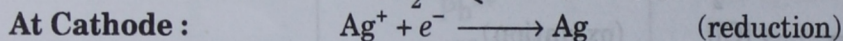
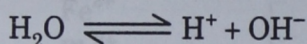
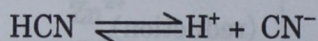
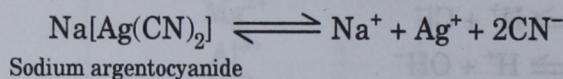
(c) The colour of electrolyte does not fade, *i.e.*, it remains blue.

- 32. Electrolysis finds wider application** in various fields, *e.g.*,

(a) Electroplating.

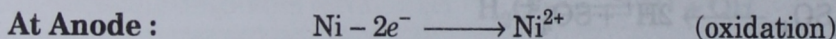
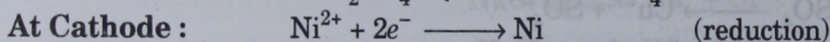
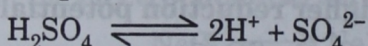
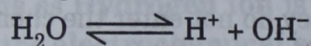
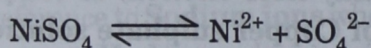
- (b) Electro-refining
(c) Electro-metallurgy.

33. **Electroplating** is the **coating** of **superior metal** over the surface of **inferior metal** by the **passage** of **electric current**.
34. The conditions for electroplating are
- The **article** to be **electroplated** is hanged at **cathode**.
 - The **electrolyte** must contain the **ions** of the **metal** which is to be **electroplated**.
 - The **anode** must be made of **pure metal** with which the **article** has to be **electroplated**.
 - The **article** to be **electroplated** must be absolutaly clean.
 - A low **current** for longer duration must be **passed**.
 - Direct current** should be used and not the **alternate current**.
35. An **article** is **electroplated** in order to **protect** it from **corrosion** and to **increase** the **physical appearance** of the article.
36. To **electroplate** a **copper bell** with **silver** :
- Copper bell** is hanged at **cathode**.
 - Anode** is made of **pure silver**.
 - The **electrolyte** must contain **silver ions**. Sodium argentocyanide is used as an **electrolyte**. Silver nitrate cannot be used as an **electrolyte** because it **decomposes very rapidly** and leads to the formation of uneven layer.



37. **Electroplating with Nickel :**

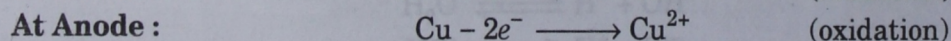
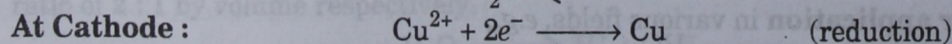
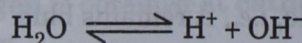
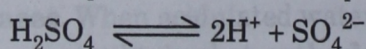
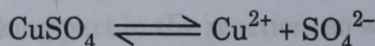
- Electrolyte** used is acidified **Nickel sulphate** solution.
- Article** to be **electroplated** is hanged at **cathode**.
- Block of **pure nickel metal** is made as anode.



38. **Electro-refining** is a process in which the **impurities** present in the **metal** are **removed electrolytically** so as to obtain a **metal** with **high purity**.

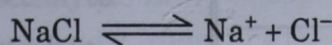
39. During electro-refining of impure copper :

- Impure copper** is hanged at **anode**.
- Pure strip of copper** is made as **cathode**.
- The **electrolyte** is **acidified copper sulphate solution**.



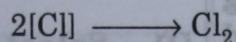
10. By electro-metallurgy, highly electropositive metals like **Lithium, Beryllium, Magnesium, Sodium, Potassium, Calcium and Aluminium** are extracted by the **electrolysis** of their fused or molten **chlorides** (mainly) or **oxides**.

11. **Sodium** is extracted by the **electrolysis** of **molten Sodium chloride**. **Cathode** used is of **iron** and **anode** used is of **graphite**.

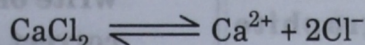


At Cathode : $\text{Na}^+ + e^- \longrightarrow \text{Na}$ (reduction)

At Anode : $\text{Cl}^- - e^- \longrightarrow [\text{Cl}]$ (oxidation)

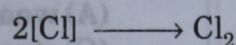


12. **Calcium** is extracted from **molten Calcium chloride**. **Cathode** used is of **iron** and **anode** used is of **graphite**.

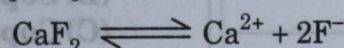
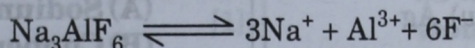
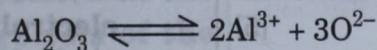


At Cathode : $\text{Ca}^{2+} + 2e^- \longrightarrow \text{Ca}$ (reduction)

At Anode : $2\text{Cl}^- - 2e^- \longrightarrow 2[\text{Cl}]$ (oxidation)

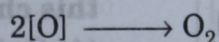


13. **Aluminium** is extracted from **molten Alumina** dissolved in **molten cryolite** and **fluorspar**. **Anode** is of **Carbon blocks** (graphite rods) and cathode is the lining of gas carbon.



At Cathode : $\text{Al}^{3+} + 3e^- \longrightarrow \text{Al}$ (reduction)

At Anode : $\text{O}^{2-} - 2e^- \longrightarrow [\text{O}]$ (oxidation)



PREVIOUS YEARS' QUESTIONS

2012

Q1. Some word/words are missing in the following statement. You are required to rewrite the statement in the correct form using the appropriate word/words :

(i) Cations migrate during electrolysis.

[1]

Ans. (i) Cations migrate to the cathode during electrolysis.

Q2. Identify the weak electrolyte from the following :

(A) Sodium Chloride solution

(B) Dilute Hydrochloric acid

(C) Dilute Sulphuric acid

(D) Aqueous acetic acid.

[1]

Ans. D

Q3. Match the following :

Column A

1. Acid salt

2. Double salt

[5]

3. Ammonium hydroxide solution

4. Dilute hydrochloric acid

5. Carbon tetrachloride

Column B

A. Ferrous ammonium

B. Contains only ions sulphate

C. Sodium hydrogen sulphate

D. Contains only molecules

E. Contains ions and molecules

Ans. 1. C 2. A 3. E 4. B 5. D

Q4. Give reasons for the following :

An aqueous solution of sodium chloride conducts electricity.

Ans. Sodium chloride is an ionic compound which dissociates completely in its aqueous solution into its free ions.

Q5. Select the correct answer from the list given in brackets :

(i) An aqueous electrolyte consists of the ions mentioned in the list, the ion

which could be discharged most readily during electrolysis.

[Fe²⁺, Cu²⁺, Pb²⁺, H⁺].

(ii) The metallic electrode which does not take part in an electrolytic reaction.

[Cu, Ag, Pt, Ni].

(iii) The ion which is discharged at the anode during the electrolysis of copper sulphate solutions using copper electrodes as anode and cathode. [Cu²⁺, OH⁻, SO₄²⁻, H⁺].

(iv) When dilute sodium chloride is electrolysed using graphite electrodes, the cation is discharged at the cathode most readily.

[Na⁺, OH⁻, H⁺, Cl⁻],

(v) During silver plating of an article using potassium argentocyanide as an electrolyte, the anode material should be [Cu, Ag, Pt, Fe]. [5]

Ans. (i) Cu²⁺ (ii) Pt (iii) Cu (iv) H⁺ (v) Ag

2011

Q1. Why the electrolysis of acidulated water is considered to be an example of catalysis? [1]

Ans. On adding acid to water, it speeds up the reaction without taking part in the reaction.

Q2. Differentiate between electrical conductivity of copper sulphate solution and copper metal. [3]

Copper sulphate solution	Copper metal
(i) Flow of electricity is due to movement of ions.	(i) Flow of electricity is due to movement of electrons.
(ii) Chemical change takes place.	(ii) Physical change takes place.

Q.3 During the electrolysis of copper (II) sulphate solution using platinum as cathode and carbon as anode:

(i) What do you observe at the cathode and at the anode? [1]

(ii) What change is noticed in the electrolyte? [1]

(iii) Write the reactions at the cathode and at the anode. [2]

Ans. (i) Cathode – size increases and Anode – size decreases

(ii) The blue solution slowly fades away.

(iii) Cathode : Cu²⁺ + 2e⁻ → Cu

Anode : 4OH⁻ - 4e⁻ → 4OH

4OH → 2H₂O + O₂

C + O₂ → CO₂

2010

Q1. Select the correct answer from the choices A, B, C and D which are given.

Write only the letter corresponding to the correct answer.

(i) A particular solution contains molecules and ions of the solute so it is a:

(A) weak acid (B) strong acid

(C) strong base (D) salt solution

(ii) A compound which liberates reddish brown gas around the anode during electrolysis in its molten state is :

(A) Sodium chloride

(B) Copper(II) oxide

(C) Copper(II) sulphate

(D) Lead(II) bromide

(iii) During ionization metals lose electrons, this change can be called:

(A) Oxidation (B) Reduction

(C) Redox (D) Displacement [3]

Ans. (i) D (ii) D (iii) A

Q2. Mr. Ramu wants to electroplate his key chain with nickel to prevent rusting. For this electroplating :

(i) Name the electrolyte.

(ii) Name the cathode.

(iii) Name the anode.

(iv) Give the reaction at the cathode.

(v) Give the reaction at the anode. [5]

Ans. (i) Acidified nickel sulphate solution

(ii) Key chain

(iii) Pure nickel

(iv) Ni²⁺ + 2e⁻ → Ni

(v) Ni - 2e⁻ → Ni²⁺

Q3. Three different electrolytic cells A, B and C are connected in separate circuits. Electrolytic cell A contains sodium chloride solution. When the circuit is completed, a bulb in the circuit glows brightly. Electrolytic cell B contains acetic

acid solution and in this case the bulb in the circuit glows dimly. The electrolytic cell C contains sugar solution and the bulb does not glow. Give a reason for each of these observations. [3]

Ans. Electrolytic cell A is a strong electrolyte.

Electrolytic cell B is a weak electrolyte.

Electrolytic cell C is a non-electrolyte.

2009

Q1. Match substance A to E listed below with appropriate description in parts :

- (A) Sulphur
- (B) Silver chloride
- (C) Hydrogen chloride
- (D) Copper (II) sulphate
- (E) Graphite

A pink metal which is deposited at the cathode during the electrolysis of the solution of this salt. [1]

Ans. (D)

Q2. A metal article is to be electroplated with silver. The electrolyte selected is sodium argentocyanide.

- (i) What kind of salt is sodium argentocyanide?
- (ii) Why is it preferred to silver nitrate as an electrolyte?
- (iii) State one condition to ensure that the deposit is smooth, firm and long lasting.
- (iv) Write the reaction taking place at the cathode.
- (v) Write the reaction taking place at the anode. [5]

Ans. (i) Complex salt

(ii) Silver nitrate decomposes rapidly and the coating is not even.

(iii) The article to be plated must be absolutely clean, the current should be passed for longer duration.

(iv) $\text{Ag}^+ + e^- \longrightarrow \text{Ag}$

(v) $\text{Ag} - e^- \longrightarrow \text{Ag}^+$

Q3. Aqueous solution of Nickel sulphate contains Ni^{2+} and SO_4^{2-} ions.

(i) Which ion moves towards the cathode?

(ii) What is the product at the anode? [2]

Ans. (i) Nickel ions

(ii) Oxygen

2008

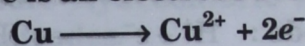
Q1. Select the correct answer from the choices A, B, C, D which are given.

During the electrolysis of molten lead bromide, which of the following takes place? [1]

- A. Bromine is released at the cathode
- B. Lead is deposited at the anode
- C. Bromine ions gain electrons
- D. Lead is deposited at the cathode.

Ans. D

Q2. (a) Here is an electrode reaction



At which electrode (anode or cathode) would such a reaction take place? Is this an example of oxidation or reduction?

(b) A solution contains magnesium ions (Mg^{2+}), Iron (II) ions (Fe^{2+}) and copper ions (Cu^{2+}). On passing an electric current through this solution which ions will be first to be discharged at the cathode? Write the equation for the cathode reaction.

(c) Why is carbon tetrachloride, which is a liquid, a non-electrolyte? [5]

Ans. (a) Anode. It is an example of oxidation.

(b) Cu^{2+} ions, $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu}$.

(c) Carbon tetrachloride is a non-electrolyte because it is a non-polar covalent compound thus, it contains only molecules and ions are absent.

2007

Q1. Choose A, B, C or D to match the descriptions (i) to (v) below. Some alphabets may be repeated.

- A. non-electrolyte
- B. strong electrolyte
- C. weak electrolyte
- D. metallic conductor

- (i) Molten ionic compound
- (ii) Carbon tetrachloride
- (iii) An aluminium wire
- (iv) A solution containing solvent molecules, solute molecules and ions formed by the dissociation of solute molecules.
- (v) A sugar solution with sugar molecules and water molecules. [5]

- Ans.** (i) B or strong electrolyte
(ii) A or non-electrolyte
(iii) D or metallic conductor
(iv) C or weak electrolyte
(v) A or non-electrolyte

2006

Q1. Write the equations for the reactions which take place at cathode and at anode when acidified water is electrolysed. [2]

- Ans.** At Cathode : $H^+ + e^- \longrightarrow [H]$ (reduction)
 $2[H] \longrightarrow H_2$
At Anode : $OH^- - e^- \longrightarrow OH$ (oxidation)
 $4[OH] \longrightarrow 2H_2O + O_2$

Q2. Name the following :

- (i) A solution of this compound is used as the electrolyte when copper is purified.
- (ii) When this compound is electrolysed in molten state, lead is obtained at the cathode. [2]

- Ans.** (i) Acidified copper sulphate solution.
(ii) Lead bromide.

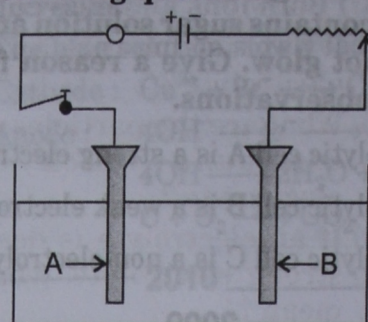
Q3. State what is observed when copper sulphate solution is electrolysed by using a platinum anode. [1]

- Ans.** When copper sulphate solution is electrolysed by using platinum anode, the blue colour of electrolyte slowly fades away.

IMPORTANT QUESTIONS

- Q1. (a)** What should be the physical state of Lead bromide if it is electrolysed?
(b) What particles are present in pure Lead bromide?
(c) Write the equations for the reactions which take place at the electrodes during the electrolysis of Lead bromide.

Q4. Study the diagram given below and answer the following questions:



- (i) Give the names of the electrodes A and B.
- (ii) Which electrode is the oxidizing electrode? [2]

- Ans.** (i) A : Anode
B : Cathode
(ii) A or Anode

2005

- Q1. (i)** Explain why copper, though a good conductor of electricity is a non-electrolyte.
(ii) Name the gas released at the cathode when acidulated water is electrolysed.
(iii) Explain why solid Sodium chloride does not allow electricity to pass through. [3]

- Ans.** (i) Copper though a good conductor of electricity is a non-electrolyte because on passing electric current it does not decompose and does not undergo any chemical change. Copper in molten state does not contain free ions also.
(ii) The gas released at cathode when acidulated water is electrolysed is hydrogen.
(iii) Solid sodium chloride does not allow the electric current to pass through it as the ions are held strongly and are not free to move.

- Ans. (a)** Molten or fused.
(b) Lead ions and Bromide ions.
(c) At Cathode : $Pb^{2+} + 2e^- \longrightarrow Pb$
At Anode : $2Br^- - 2e^- \longrightarrow 2[Br]$
 $2[Br] \longrightarrow Br_2 \uparrow$

Q2. (a) Give one example in each case of a substance which contains

- (i) Ions only (ii) Molecules only
 (iii) Both ions and molecules
- (b) (i) What is meant by the term electrolyte?
 (ii) What are the particles present in a compound which is a non-electrolyte?
 (iii) If an electrolyte is described as a strong electrolyte, what does this mean?

(c) The following questions refer to the electrolysis of Copper sulphate solution with Copper electrode :

- (i) Compare the change in mass of the cathode with the change in mass of the anode.
 (ii) What is seen to happen to the colour of the Copper sulphate solution if Platinum electrodes are used? Explain this observation.
 (iii) What is the practical application of the electrolysis of Copper sulphate solution? Briefly describe one such application.

Ans. (a) (i) Sodium chloride solution

(ii) Carbon tetrachloride

(iii) Acetic acid

(b) (i) Electrolyte is an ionic compound which, in fused, molten or aqueous solution, allows the passage of electric current through it.

(ii) Molecules

(iii) The electrolyte almost completely ionizes in its aqueous solution and the solution contains mainly ions.

(c) (i) Size of cathode increases.
 Size of anode decreases.

(ii) The colour of the solution fades.

(iii) Electro-refining of impure Copper.

Q3. Define electrolysis.

Ans. The chemical process in which the ionic compounds in fused, molten or aqueous solution allow the passage of electric current and undergo simultaneous chemical decomposition leading to the discharge of ions at electrodes is called as electrolysis.

Q4. The following questions related to the electroplating of an article with silver :

- (a) Name the electrode formed by the article to be plated.
 (b) What ions must be present in the electrolyte?

- (c) What should be the nature of anode?
 (d) How is the passage of electricity through electrolyte is different from the passage of electricity through a Copper wire?

Ans. (a) Cathode (b) Silver ions (c) Attackable
 (d) The passage of current through electrolyte is by the ions whereas the passage through conductor is by the electrons.

Q5. Name the product at cathode and anode during the electrolysis of :

- (a) Molten Lead bromide with inert electrodes.
 (b) Molten Sodium chloride with inert electrodes.
 (c) Acidified Copper sulphate solution with inert electrodes.
 (d) Acidulated water with inert electrodes.
 (e) Dilute Hydrochloric acid with inert electrodes.
 (f) Concentrated Hydrochloric acid with inert electrodes.

Ans.

Cathode	Anode
(a) Lead metal	Bromine vapours
(b) Sodium metal	Chlorine gas
(c) Copper	Oxygen
(d) Hydrogen	Oxygen
(e) Hydrogen	Oxygen
(f) Hydrogen	Chlorine

Q6. What will you observe (a) at cathode (b) at anode (c) in electrolyte during the electrolysis of Copper sulphate solution with Copper electrodes?

Ans. (a) At cathode — Size of cathode increases
 (b) At anode — Size of anode decreases
 (c) Electrolyte — The colour of electrolyte remains same, i.e., blue.

Q7. What is the material for cathode and anode during the electro-refining of impure Copper?

Ans. Cathode — Pure copper
 Anode — Impure copper

Q8. (a) Name the metals extracted by electrolysis.

- (b) Name the compounds from which these metals are extracted.
 (c) What is the state of the compounds from which these metals are extracted?

Ans. (a) Sodium, Potassium, Calcium, Magnesium, etc.

(b) These metals are extracted from their chlorides, *i.e.*,

Sodium — Sodium chloride

Potassium — Potassium chloride

Calcium — Calcium chloride

Magnesium — Magnesium chloride

(c) They are extracted in their fused or molten state.

Q9. Name all the particles present in

(a) Sodium chloride solution

(b) Molten Sodium chloride

(c) Sulphurous acid

(d) Carbon tetrachloride

Ans. (a) Sodium ions Chloride ions

Hydrogen ions Hydroxyl ions

Water molecules.

(b) Sodium ions and Chloride ions

(c) Hydrogen ions Sulphite ions

Hydroxyl ions

Sulphurous acid molecule

Water molecule

(d) Molecules of Carbon tetrachloride

Q10. Write equations for the reactions taking place at cathode and at anode during the electrolysis of :

(a) Acidified Nickel sulphate solution with Nickel electrode.

(b) Acidified Copper sulphate solution with Copper electrode.

(c) Acidified Copper sulphate solution with Platinum electrode.

(d) Acidulated water with inert electrodes.

(e) Molten Lead bromide with inert electrodes.

Ans. (a) Cathode $\text{Ni}^{2+} + 2e^- \longrightarrow \text{Ni}$

Anode $\text{Ni} - 2e^- \longrightarrow \text{Ni}^{2+}$

(b) Cathode $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu}$

Anode $\text{Cu} - 2e^- \longrightarrow \text{Cu}^{2+}$

(c) Cathode $\text{Cu}^{2+} + 2e^- \longrightarrow \text{Cu}$

Anode $\text{OH}^- - e^- \longrightarrow \text{OH}$

$4\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$

(d) Cathode $\text{H}^+ + e^- \longrightarrow [\text{H}]$

$2[\text{H}] \longrightarrow \text{H}_2$

Anode $\text{OH}^- - e^- \longrightarrow \text{OH}$

$4\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$

(e) Cathode $\text{Pb}^{2+} + 2e^- \longrightarrow \text{Pb}$

Anode $2\text{Br}^- - 2e^- \longrightarrow 2[\text{Br}]$

$2[\text{Br}] \longrightarrow \text{Br}_2$

Q11. Classify the following as strong electrolyte, weak electrolyte and non-electrolyte.

Carbonic acid, Magnesium hydroxide, dilute Nitric acid, Sodium hydroxide, Petrol, Sugar solution.

Ans.

Strong electrolyte	Weak electrolyte	Non-electrolyte
Dilute Nitric acid, Sodium hydroxide	Carbonic acid, Magnesium hydroxide	Sugar solution, Petrol

Q12. What change will you observe in the electrolyte during the electrolysis of Copper sulphate solution with inert electrodes ?

Ans. The colour of the Electrolyte fades, *i.e.*, from blue it changes to colourless.

Q13. Name the solution which contain :

(a) Only ions or mostly ions

(b) Only molecules

(c) Ions as well as molecules

Ans. (a) Any strong electrolyte

(b) Any non-electrolyte

(c) Any weak electrolyte

Q14. An aqueous solution containing OH^- , NO_3^- , SO_4^{2-} ions. Name

(i) the ion which will migrate towards anode.

(ii) the product obtained at anode.

Ans. (i) OH^- (ii) Oxygen

Q15. What should be the physical state of the following compounds if it is to conduct electricity ?

(i) Lead bromide (ii) Sodium chloride

Ans. (i) Molten or fused

(ii) Molten or fused and in its aqueous solution.

Q16. Acidulated water is electrolysed in Hofmann's voltameter to liberate two gases. In this context answer the following questions.

(i) Name the gases evolved at each electrode.

(ii) What is the material used for electrodes ?

(iii) What is the ratio of gases evolved by volume ?

Ans. (i) Cathode-Hydrogen

Anode - Oxygen

(ii) Platinum (iii) $\text{H}_2 : \text{O}_2 \equiv 2 : 1$

Let's Recall

Fill Your Answer in the Space Given for Each Question.

Q1. Match the following :

A.

Column-I	Column-II
(i) Ammonium hydroxide	(a) Positive terminal of battery.
(ii) Hydrochloric acid	(b) Negative terminal of battery
(iii) Carbon tetrachloride	(c) Conductor
(iv) Copper	(d) Non-electrolyte
(v) Cathode	(e) Strong electrolyte
(vi) Anode	(f) Weak electrolyte

Ans. (i) (ii) (iii) (iv) (v) (vi)

B.

Column-I	Column-II
(i) Cation	(a) Negatively charged ion
(ii) Anion	(b) Loss of electrons
(iii) Oxidation	(c) Gain of electrons
(iv) Reduction	(d) Positively charged ion

Ans. (i) (ii) (iii) (iv) (v) (vi)

Q2. Fill in the blanks.

- (i) Electrolysis is a _____ process.
- (ii) Copper is a good _____ but is a _____.
- (iii) _____ sodium chloride does not conduct electricity.
- (iv) During the electrolysis of molten ionic chloride, _____ is obtained at cathode and _____ is obtained at anode.
- (v) When molten ionic chloride is electrolysed anode is not made of _____.
- (vi) All salts are _____ electrolytes.
- (vii) The solution of strong electrolyte contains only _____.
- (viii) Weak electrolytes have _____ and _____ in their solutions.
- (ix) _____ takes place at cathode.
- (x) _____ takes place at anode.

Q3. State whether the following statements are True or False.

- (i) During the electrolysis of aqueous solution of sodium chloride, sodium ions are discharged at cathode.
- (ii) Electrolysis is an example of redox reaction.
- (iii) The solution of sulphur dioxide in water contains only ions.
- (iv) During electro-refining of impure copper, pure copper is made cathode.
- (v) Electroplating is done to protect the metal from corrosion.
- (vi) Out of OH^- ions and Cl^- , OH^- ions will discharge first at electrode.

- (vii) A greasy article will lead to the formation of smooth layer.
- (viii) During the electrolysis of acidified copper sulphate solution with copper anode, oxygen is liberated at anode.
- (ix) Anion migrate towards cathode.
- (x) Cations migrate towards cathode.

Q4. Each question has four options out of which only one option is correct. Dark the bubble for correct answer.

- (i) During the electrolysis of acidified copper sulphate solution with platinum electrodes the colour of the electrolyte ?
- (a) remains blue
 - (b) becomes darker
 - (c) fades away
 - (d) first becomes dark and then fades away.

Ans. a b c d

- (ii) During the electrolysis of acidified copper sulphate solution with copper anode, the colour of electrolyte
- (a) remains blue
 - (b) becomes darker
 - (c) fades away
 - (d) first becomes dark and then fades away.

Ans. a b c d

- (iii) Passing of electric current through a conductor results in
- (a) physical change
 - (b) chemical change
 - (c) both physical and chemical change
 - (d) None of these

Ans. a b c d

- (iv) Which of the following pairs of metals are extracted only by electrolysis ?
- (a) Na, Pb
 - (b) Ca, Cu
 - (c) Na, Ca
 - (d) Ag, K.

Ans. a b c d

- (v) During the electrolysis of concentrated hydrochloric acid, the product obtained at anode is
- (a) oxygen
 - (b) hydrogen
 - (c) chlorine
 - (d) None of these.

Ans. a b c d

- (vi) Passing of an electric current through electrolytes results in
- (a) Physical change
 - (b) Chemical change
 - (c) Both (a) and (b)
 - (d) None of these.

Ans. a b c d

Q5. Choose from the following strong, weak and non-electrolyte.

Ammonium hydroxide, Hydroiodic acid, Phosphoric acid, Phosphorous acid, Sugar solution, Sodium chloride, Petrol, Carbon tetrachloride.

Strong electrolyte

Weak electrolyte

Non-electrolyte

ANSWERS

1. **A.** (i) f (ii) e (iii) d (iv) c (v) b (vi) a
B. (i) d (ii) a (iii) b (iv) c
2. (i) redox (ii) conductor, non-electrolyte (iii) solid (iv) metal, chlorine
(v) platinum (vi) strong (vii) ions (viii) ions, molecules
(ix) reduction (x) oxidation
3. (i) False (ii) True (iii) False (iv) True (v) True
(vi) True (vii) False (viii) False (ix) False (x) True
4. (i) c (ii) a (iii) a (iv) c (v) c (vi) b

5. Strong electrolyte	Weak electrolyte	Non-electrolyte
Hydroiodic acid	Ammonium hydroxide	Sugar solution
Sodium chloride	Phosphorous acid	Petrol
	Phosphoric acid	Carbon tetrachloride

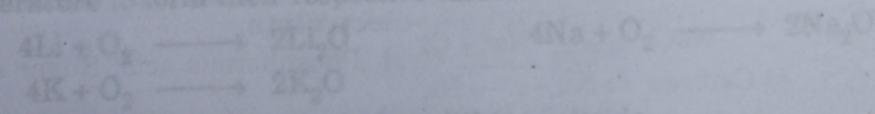
Material for anode	Material for cathode	Electrolyte used	Application of electrolysis
Copper	Pure copper	Copper sulphate solution	Electroplating of copper
Silver	Pure silver	Silver nitrate solution	Spoon with silver
Impure copper	Pure copper	Copper sulphate solution	Electro-refining of impure copper

(b) (i) For the electroplating of copper spoon with silver, give equations for the reactions taking place at cathode and anode.

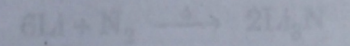
(ii) For the electro-refining of impure copper, give equations for the reactions taking place at cathode and at anode. Also mention the material for cathode and anode.

5. Elements of group IA are called alkali metals. The members of this group are Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Caesium (Cs) and Francium (Fr).

(i) Reaction of alkali metals with air: Lithium, sodium and potassium react with oxygen at normal temperature to form their respective oxides.



Lithium reacts with nitrogen to form lithium nitride.



(ii) Reaction of alkali metals with water: These metals on reaction with cold water form soluble bases called as alkali.

Self Evaluation Test

Time : 30 minutes

Marks : 25

Q1. The following questions are related with the electrolysis of copper sulphate solution with copper anode.

- (i) What changes are observed at cathode and at anode
- (ii) What happens to the colour of electrolyte.
- (iii) Give equations for the reactions at cathode and at anode.

Q2. Differentiate between

- (i) weak electrolyte and strong electrolyte
- (ii) electrolyte and conductor.

Q3. Give reasons why

- (i) Acidified copper sulphate solution is a good electrolyte but is non-conductor.
- (ii) For lead bromide to conduct electricity it should always be in molten or fused state but not in its aqueous solution.
- (iii) Solid ionic compounds do not conduct electricity.
- (iv) Electrolysis of acidulated water is considered as an example of catalysis.
- (v) Silver nitrate solution is not used as an electrolyte for electroplating of copper article with silver.

Q4. Name the product obtained at anode and write the equations for the reactions taking place at anode when the following are electrolysed with inert electrodes.

- (i) Dil.HCl
- (ii) Molten alumina
- (iii) Fused lead bromide

Q5. (a) Copy and complete the table given below :

Application of electrolysis	Electrolyte used	Material for cathode	Material for anode
(i) Electroplating of copper spoon with silver.	_____	_____	_____
(ii) Electro-refining of impure copper.	_____	_____	_____

(b) (i) For the electroplating of copper spoon with silver, give equations for the reactions taking place at cathode and at anode.

(ii) What is anode mud ?

(iii) For the electro-refining of impure copper, give equations for the reactions taking place at cathode and at anode. Also, mention the material for cathode and anode.

Q5. Choose from the following strong, weak and non-electrolyte.

Ammonium hydroxide, Hydroiodic acid, Phosphoric acid, Phosphorous acid, Sugar solution, Sodium chloride, Petrol, Carbon tetrachloride.

Strong electrolyte

Weak electrolyte

Non-electrolyte