

Question Bank

Electrolysis

1. (a) What do you understand by the terms
(i) electrolytes (ii) non-electrolytes?
(b) Arrange electrolytes and non-electrolytes from the following substances (i) sugar solution (ii) dil. sulphuric acid (iii) fused lead bromide (iv) solution of sulphur in carbon disulphide (v) aqueous sodium chloride solution (vi) solid potassium nitrate crystals (vii) ethyl alcohol (viii) acidulated water (ix) caustic soda solution (x) petrol.

Ans. (a) (i) Electrolyte : A chemical compound in fused state or aqueous state which conducts direct electric current and at the same time decomposes to form neutral atoms at the electrodes is called an electrolyte.

(ii) Non-electrolyte : A chemical compound in liquid state, which does not conduct electricity is called a non-electrolyte.

(b) Electrolytes are (i) dilute sulphuric acid
(ii) fused lead bromide (iii) aqueous sodium chloride solution
(iv) acidulated water and (v) caustic soda solution.

Non-electrolytes are (i) sugar solution (ii) solution of sulphur in carbon disulphide (iii) solid potassium nitrate crystals (iv) ethyl alcohol and (v) petrol.

2. Define the following terms :

- (a) Electrolysis (b) Electrode
(c) Cathode (d) Anode
(e) Anion (f) Cation
(g) Voltmeter.

[7]

Ans. (a) Electrolysis : The process due to which a chemical compound in the fused state or in aqueous state conducts direct electric current, resulting in the discharge of ions of an electrolyte into neutral atoms at the electrodes is called electrolysis.

- (b) **Electrodes** : The metal rods or plates through which the current enters or leaves an electrolyte are called electrodes.
- (c) **Cathode** : The electrode connected to the negative terminal of battery is called cathode.
- (d) **Anode** : The electrode connected to the positive terminal of battery is called anode.
- (e) **Anions** : The negatively charged ions which discharge at anode are called anions.
- (f) **Cations** : The positively charged ions which discharge at cathode are called cations.
- (g) **Voltmeter** : A glass vessel in which electrolysis is carried out is called voltmeter.

3. Pick out the cations and anions from the list given below :

- (i) SO_4^{2-} (ii) NH_4^{1+} (iii) OH^{1-} (iv) Pb^{2+} (v) NO_3^{1-}
 (vi) Ag^{1+} (vii) Cu^{2+} (viii) H^{1+} (ix) CN^{1-} (x) Cl^{1-} .

Ans. Cations are : NH_4^{1+} ; Pb^{2+} ; Ag^{1+} ; Cu^{2+} ; H^{1+} .

Anions are : SO_4^{2-} ; OH^{1-} ; NO_3^{1-} ; CN^{1-} ; Cl^{1-} .

4. Fill in the blank spaces of the following sentences :

- (i) The metal plate through which electric current enters in an electrolyte is called _____. It has _____ of electrons.
- (ii) The metal plate through which _____ leaves from an electrolyte is called _____. It has _____ electrons.
- (iii) The ions which discharge on negative electrode during electrolysis _____ electrons. Thus, the ion is said to be _____.
- (iv) The ions which discharge on positive electrode during electrolysis _____ electrons. Thus, the ion is said to be _____.
- (v) Hydrogen and metallic ions are _____ because they _____ electrons.
- (vi) Non-metallic ions are _____, because they _____ electrons.

[6]

- Ans. (i)** (a) anode; (b) deficiency
(ii) (a) current; (b) cathode; (c) excess
(iii) (a) gain; (b) cation
(iv) (a) lose; (b) anion
(v) (a) cations; (b) gain
(vi) (a) anions; (b) lose
- 5. (a)** What do you understand by the term electrolytic dissociation? [1]
(b) The ionisation of sodium chloride in water is 99%. What do you mean by the statement? [1]

Ans. (a) Electrolytic dissociation : The process in which separation of ions of an ionic compound takes place on heating or in an aqueous solution is called electrolytic dissociation.
(b) It means that at any time 99 molecules of sodium chloride are in an ionised state, out of 100 molecules of sodium chloride.

- 6.** Solid sodium chloride is a non-conductor of electricity. However, in fused state, it conducts electric current. Explain. [3]

Ans. In solid state, the sodium and chloride ions are held firmly in the crystalline structure by the electrostatic forces. Thus, as the ions are not free to migrate to cathode or anode, therefore, solid sodium chloride does not conduct electric current.

However, in fused state, the electrostatic forces between the sodium and chloride ions are weakened, such that ions can migrate towards oppositely charged electrodes, and therefore, fused sodium chloride conducts electric current.

- 7.** By giving four examples in each case, define or explain the terms (a) strong electrolyte (b) weak electrolyte. [4]

Ans. (a) The electrolytes which are very good conductor of electricity and consist of mostly ions in the fused state or in aqueous state are called strong electrolytes.

Examples : (i) fused lead bromide

(ii) dilute sulphuric acid

(iii) aqueous sodium hydroxide

(iv) fused alumina in cryolite.

(b) The electrolytes which are poor conductor of electricity and consist of ions as well as molecules are called weak electrolytes.

Examples : (i) Tap water

(ii) Aqueous acetic acid solution

(iii) Carbonic acid

(iv) Ammonium hydroxide solution.

8. Pick out strong and weak electrolytes from the following list :

(i) Copper sulphate solution

(ii) Carbonic acid

(iii) Limewater

(iv) Sodium hydroxide solution

(v) Sodium carbonate solution

(vi) Nitric acid

(vii) Zinc sulphate solution

(viii) Lead nitrate solution.

[4]

Ans. Strong electrolytes : Copper sulphate solution, sodium hydroxide solution, nitric acid, zinc sulphate solution, lead nitrate solution.

Weak electrolytes : Carbonic acid, limewater, sodium carbonate solution.

9. Write all the ions present in the aqueous solutions of the following :

(i) Caustic potash

(ii) Acetic acid

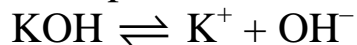
(iii) Magnesium sulphate

(iv) Formic acid

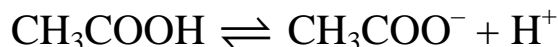
(v) Phosphoric acid

(vi) Ammonium chloride solution.

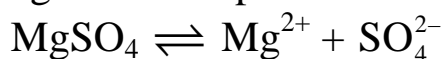
Ans. (i) From caustic potash solution :



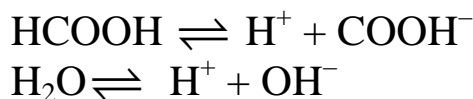
(ii) From acetic acid solution :



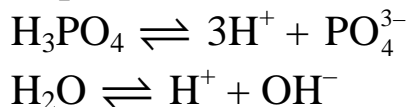
(iii) From magnesium sulphate solution :



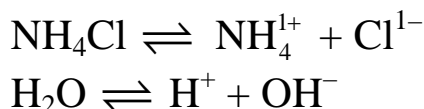
(iv) From formic acid solution :



(v) From phosphoric acid solution :



(vi) From ammonium chloride solution :



10. (a) Al^{3+} ; Cu^{2+} ; Na^{1+} ; Zn^{2+} ions are present in an aqueous solution such that the concentration of ions is the same. Write the order of discharge of ions during electrolysis. [2]
- (b) Amongst OH^{1-} , Br^{1-} and Cl^{1-} , which ion is likely to discharge first and why? [1]

Ans. (a) (1) Cu^{2+} (2) Zn^{2+} (3) Al^{3+} (4) Na^{1+} .

(b) (1) OH^- will discharge first as its position is lowest in the electronegativity series.

11. Give two differences between a metal and an electrolyte, with respect to their electrical properties.

or

Compare flow of electricity through copper metal and copper sulphate solution. [2]

1. A metal conducts electric current but does not undergo any chemical reaction, whereas an electrolyte conducts electric current and at the same time undergoes a chemical reaction.
2. A metal conducts electric current due to the migration of electrons, whereas an electrolyte conducts electric current due to the migration and discharge of cations and anions.

12. Give two differences between an atom and an ion. [2]

Ans. 1. An atom is electrically neutral whereas an ion is electrically charged.

2. An atom does not undergo any chemical change on the passage of electric current, whereas an ion undergoes a chemical change on the passage of electric current.

13. State the reactions occurring at the anode during the electrolysis of :

(i) Copper sulphate solution, using copper electrodes.

(ii) Copper sulphate solution, using platinum electrodes.

(iii) Aluminium oxide, dissolved in cryolite using carbon electrodes. [3]

Ans. (i) $\text{Cu} - 2e^- \longrightarrow \text{Cu}^{2+}$.

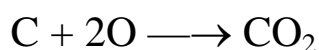
The copper atoms at anode ionise to form Cu^{2+} ions and enter in the copper sulphate solution.

(ii) $4\text{OH}^- - 4e^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$

Hydroxyl ions discharge in preference to sulphate ions.

(iii) $\text{O}^{2-} - 2e^- \longrightarrow \text{O}$

The oxide ions discharge to form oxygen atoms which react with the carbon anode to form carbon dioxide.



14. Explain, why a solution of ionic compound is an electrolyte while that of covalent compound is non-electrolyte. [2]

Ans. The solution of ionic compound has free ions which can migrate to cathode and anode and discharge. Thus, a solution of ionic compound is a good conductor of electricity, and hence is an electrolyte.

However, a solution of covalent compound, consists of only molecules and does not have any free ions, which could migrate to cathode or anode. Hence, it is a non-electrolyte.

15. Explain the following :

(i) A solution of sugarcane does not conduct electricity, but a solution of sodium chloride is a good conductor. [2]

(ii) Copper is a good conductor of electricity, but is a non-electrolyte. [2]

Ans. (i) The sugarcane solution consists of only molecules and does not have any free ions which can migrate to cathode or anode. Hence, sugar solution is a bad conductor of electricity.

The sodium chloride solution mainly consists of free sodium and chloride ions which can migrate to oppositely charged electrodes. Hence, a solution of sodium chloride is a good conductor of electricity.

(ii) In case of an electrolyte, (1) the ions must migrate to oppositely charged electrodes (2) a chemical reaction must take place.

As copper does not satisfy any of the above conditions, therefore, it is good conductor of electricity, but is a non-electrolyte.

16. Complete the following paragraph by inserting one of the following words in each blank space: [4]

heated, lead, electrolysis, lattice, melts, electrodes, bromine, ions.

Solid lead (II) bromide will not conduct electric current. The _____ are held in a rigid crystal _____ and are not free to move to _____. When solid is _____, it _____ and allows the passage of electric current. _____ is liberated at cathode and _____ at anode. The decomposition of an electrolyte by an electric current is called _____.

Ans. Solid lead (II) bromide will not conduct electric current. The ions are held in a rigid crystal lattice and are not free to move to electrodes. When solid is heated, it melts and allows the passage of electric current. Lead is liberated at the cathode and bromine at the anode. The decomposition of an electrolyte by an electric current is called electrolysis.

17. Complete the table given below :

<i>Electrolyte</i>	<i>Cathode</i>	<i>Anode</i>	<i>Product at cathode</i>	<i>Product at anode</i>
<i>Dil. sulphuric acid</i>	<i>Platinum</i>	<i>Platinum</i>		
<i>Cu (II) SO₄ solution</i>	<i>Copper</i>	<i>Copper</i>		
<i>Cu (II) SO₄ solution</i>	<i>Platinum</i>	<i>Platinum</i>		

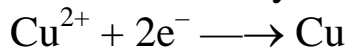
Ans.

<i>Electrolyte</i>	<i>Cathode</i>	<i>Anode</i>	<i>Product at cathode</i>	<i>Product at anode</i>
<i>Dil. sulphuric acid</i>	<i>Platinum</i>	<i>Platinum</i>	<i>Hydrogen gas</i>	<i>Oxygen gas</i>
<i>Cu (II) SO₄ solution</i>	<i>Copper</i>	<i>Copper</i>	<i>Copper deposits</i>	<i>Copper dissolves</i>
<i>Cu (II) SO₄ solution</i>	<i>Platinum</i>	<i>Platinum</i>	<i>Copper deposits</i>	<i>Oxygen gas</i>

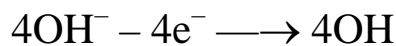
18. (a) Describe what would you see at the anode and the cathode during electrolysis of copper (II) chloride, using platinum as cathode and carbon as anode. Write ionic equations for the reactions at anode and cathode. [2]

(b) Give two uses of electrolysis. [2]

Ans. (a) On platinum cathode, a reddish layer of copper is deposited.



On carbon anode, carbon dioxide gas is formed, due to the discharge of OH⁻ ions.



(b) (i) Electrolysis is used for electroplating.

(ii) Electrolysis is used for electro-refining of metals.

19. (a) Why does molten sodium chloride decompose on the passage of electric current? [2]
- (b) (i) Name two metals normally manufactured by the electrolysis of fused compounds. [1]
- (ii) Name two compounds used in (b) (i) above. [1]
- (iii) For one of the above metals, explain the reaction taking place at the cathode. [1]
- (c) State the reactions occurring at anode during the electrolysis of : [3]
- (i) copper sulphate solution using copper anode.
- (ii) copper sulphate solution using platinum anode.
- (iii) dilute sulphuric acid using platinum anode.

Ans. (a) On the passage of electric current through molten sodium chloride, sodium ions migrate to the cathode and chloride ions migrate to the anode.

At the cathode, sodium ions gain electrons and at the anode, chloride ions lose electrons to form sodium and chlorine atoms.



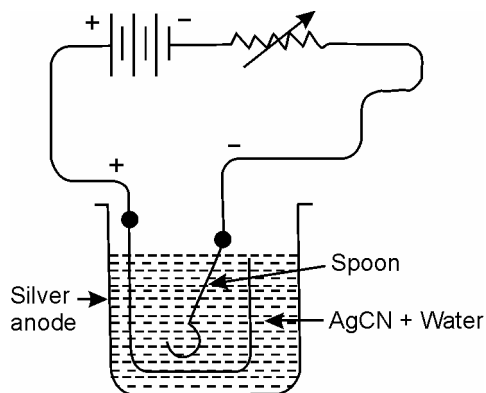
- (b) (i) Aluminium and sodium.
- (ii) Alumina (Al_2O_3) for the manufacture of aluminium.
Sodium chloride (NaCl) for the manufacture of sodium.
- (iii) $\text{Al}^{3+} + 3\text{e}^- \longrightarrow \text{Al}$ (At cathode)
 $\text{Na}^{1+} + 1\text{e}^- \longrightarrow \text{Na}$ (At cathode)
- (c) (i) $\text{Cu} - 2\text{e}^- \longrightarrow \text{Cu}^{2+}$. Copper atoms ionise to form Cu^{2+} ion. OH^- or SO_4^{2-} do not discharge.
- (ii) $4\text{OH}^- - 4\text{e}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$. OH^- ions discharge in preference to SO_4^{2-} to liberate oxygen gas.
- (iii) $4\text{OH}^- - 4\text{e}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$. OH^- ions discharge in preference to SO_4^{2-} to liberate oxygen gas.

20. (a) Give the name of a metal which is extracted by electrolysis.
 (b) At which electrode metal ions are discharged during electrolysis?
 (c) Give one important application of electrolysis (Not extraction of metals or electroplating). [3]

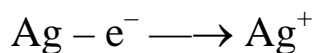
Ans. (a) Aluminium.
 (b) Cathode.
 (c) Electro-refining of impure metals.

21. (a) Why is electrolysis of acidulated water considered an example of catalysis? [2]
 (b) If molten magnesium chloride is electrolysed, suggest a suitable anode. [2]
 (c) (i) Draw a labelled diagram for the apparatus used to electroplate a spoon with silver. [2]
 (ii) What are the ionic reactions that take place :
 (1) at the anode (2) at the cathode? [2]

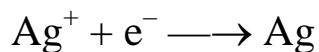
Ans. (a) It is because, the amount of sulphuric acid does not change when water is electrolysed. The sulphuric acid just helps in increasing the conductivity of water.
 (b) Graphite anode. It is because graphite does not react with nascent chlorine.
 (c) (i) Diagram is given below :



(ii) Reaction of the anode :



Reaction of the cathode :



22. What products are formed when the following chemicals are electrolysed?

<i>Chemical</i>	<i>Product at cathode</i>	<i>Product at anode</i>
<i>Dilute sulphuric acid</i>		
<i>Molten lead bromide</i>		
<i>Aqueous CuSO₄ sol. with copper electrodes</i>		

Ans.

[4]

<i>Chemical</i>	<i>Product at cathode</i>	<i>Product at anode</i>
<i>Dilute sulphuric acid</i>	<i>Hydrogen gas</i>	<i>Oxygen gas</i>
<i>Molten lead bromide</i>	<i>Lead metal</i>	<i>Bromine</i>
<i>Aqueous CuSO₄ sol. with copper electrodes</i>	<i>Copper deposits</i>	<i>Copper dissolves</i>

23. (a) Complete the table giving (i) ions present (ii) products at electrodes during electrolysis.

<i>Substance</i>	<i>Ions present</i>	<i>Product at</i>	
		<i>Cathode</i>	<i>Anode</i>
<i>Molten lead bromide</i>			
<i>Copper sulphate solution using copper electrodes</i>			

[3]

- (b) Name a substance which when dissolved in water contains (i) only ions (ii) ions and molecules.

[2]

- (c) Electrolysis is used in the purification of metals. Name (i) anode (ii) cathode (iii) electrolyte you would use to get pure copper from a piece of impure copper. [3]

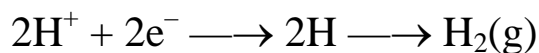
Ans. (a)

<i>Substance</i>	<i>Ions present</i>	<i>Product at</i>	
		<i>Cathode</i>	<i>Anode</i>
<i>Molten lead bromide</i>	<i>Pb²⁺ and Br⁻ ions</i>	<i>Lead</i>	<i>Bromine</i>
<i>Copper sulphate solution using copper electrodes</i>	<i>Cu²⁺, H⁺, OH⁻, SO₄²⁻</i>	<i>Copper deposits</i>	<i>Copper dissolves</i>

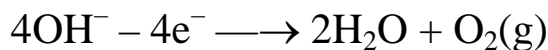
- (b) (i) Sodium chloride.
(ii) Acetic acid.
- (c) (i) The anode is made from impure copper.
(ii) The cathode is made from pure copper.
(iii) Electrolyte is saturated copper sulphate solution, acidified with dil. H₂SO₄.
24. (a) When copper sulphate solution is electrolysed with copper electrodes, the blue copper ions are discharged at cathode and get deposited at it, yet the blue colour of copper sulphate does not fade. Explain. [2]
- (b) Write the equations of reactions which take place at the cathode and the anode when dilute sulphuric acid is electrolysed with platinum electrodes. [2]

Ans. (a) It is because the number of copper ions discharged at the cathode are equal to the number of copper atoms which ionise to form copper ions at the anode.
As the concentration of copper ions does not change in electrolyte, therefore, blue colour of copper sulphate solution does not fade.

(b) Reaction at the cathode :



Reaction at the anode :



25. Name the product formed at (i) cathode (ii) anode, when molten lead bromide is electrolysed. [2]

Ans. (i) At cathode, lead metal is formed.

(ii) At anode, bromine is liberated.

26. Following questions are related to electroplating of an article with silver :

(i) Name the electrode formed by the article to be electroplated.

(ii) What ions must be present in the electrolyte?

(iii) What should be nature of anode? [3]

Ans. (i) Article to be electroplated forms cathode.

(ii) Silver ions must be present in the electrolyte.

(iii) The anode should be of the same metal which is to be electroplated.

27. (a) Answer the following questions about electroplating a copper wire with silver.

(i) What ions must be present in the electrolyte?

(ii) Of what substance must the anode be made?

(iii) What should be made cathode?

(iv) What is the equation of reaction which takes place at the cathode? [2]

(b) Why is it necessary to add acid to water before proceeding with the electrolysis of water? [2]

Ans. (a) (i) Silver ions must be present in electrolyte.

(ii) The anode should be made from silver.

(iii) The article to be electroplated should be made the cathode.

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

(b) Water is a bad conductor of electricity and is feebly ionised. The addition of an acid makes it a good conductor as acid molecules ionise.

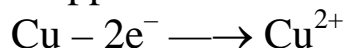
28. With reference to nature of electrodes - name three active and three inert electrodes. [2]

Ans. **Active electrodes** are those which take part in an electrolytic reaction. Copper, nickel and silver are active electrodes.

Inert electrodes are those which do not take part in an electrolytic reaction. Graphite, platinum and iron are inert electrodes.

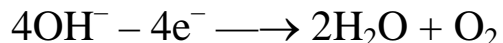
29. State with reason for the difference in product formed at anode during electrolysis of copper sulphate using copper and platinum as anode. [2]

Ans. When copper is used as anode, it being an active anode ionises to form copper ions which enter the solution.



Thus, its mass continuously decreases.

When platinum is used as anode, it being inert anode does not ionise. Instead amongst the SO_4^{2-} and OH^- ions, the later discharge at anode to liberate oxygen gas.



30. Give a reason why metals such as copper, silver and lead are electro-refined, but not sodium, potassium and calcium. [2]

Ans. The metals sodium, potassium and calcium can be prepared by the electrolysis of their fused salts. As the process of electrolysis is followed during their extraction, therefore, they are not electro-refined.

However, copper, silver and lead are extracted by reducing their ores with carbon. Thus, they contain large number of impurities, which can be removed by electro-refining.

31. Explain the term electro-metallurgy. At which electrode the extracted metal always deposits.

Ans. The process of extraction of metals from their purified ores (in the form of chlorides or oxide) in fused state is called electro-metallurgy. The extracted metal always deposits at cathode.

32. Select the correct answers from A, B, C and D from the following list.
- (i) The ion/ions which is/are discharged during electrolysis of aqueous CuSO_4 , using copper electrodes.
(a) Cu^{2+} (b) SO_4^{2-} (c) H^{1+} (d) OH^{1-}
- (ii) The metallic electrode which does not take part in an electrolytic reaction
(a) Ni (b) Fe (c) Ag (d) Cu
- (iii) A covalent compound which conducts electricity in aqueous state
(a) C_2H_4 (b) NH_3 (c) CS_2 (d) CCl_4
- (iv) The cation which readily discharges at cathode
(a) Cu^{2+} (b) Pb^{2+} (c) Fe^{2+} (d) H^{1+}
- (v) The anion which discharges at anode with great difficulty.
(a) OH^{1-} (b) SO_4^{2-} (c) Br^{1-} (d) NO_3^{1-}

Ans. (i) Cu^{2+} (ii) Fe (iii) NH_3 (iv) Cu^{2+} (v) SO_4^{2-}