

ELECTROLYSIS

SOLVED EXAMPLE

1. Classify following substances under three headings:

Strong electrolytes, Weak electrolytes, Non-electrolytes.

Acetic acid, ammonium chloride, ammonium hydroxide, carbon tetrachloride, dilute hydrochloric acid, sodium acetate, dilute sulphuric acid, urea, glucose.

Ans. Strong electrolytes - Ammonium chloride, dilute hydrochloric acid, dilute sulphuric acid.

Weak electrolytes - Ammonium hydroxide, acetic acid, sodium acetates.

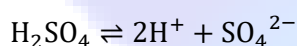
Non-electrolyte - Carbon tetra chloride, urea, glucose.

2. (i) Write equations to show the electrolytic dissociation of:

(a) Two acids (b) Two bases.

(ii) When fused sodium chloride is electrolyzed, explain exactly what happens at the electrodes and explain how the electricity is conducted?

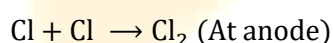
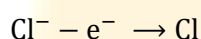
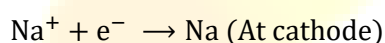
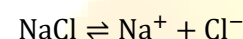
Ans. (i) (a) Acids:



(b) Bases:



(ii) When electricity is passed through fused sodium chloride, the electrolysis starts as follows:



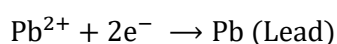
Sodium metal is deposited at cathode, while chlorine gas is liberated at anode. Electricity is conducted with the help of free sodium and chloride ions, which are present in fused sodium chloride.

3. A certain metal, say M, does not liberate hydrogen from dilute sulphuric acid, but displaces copper from aqueous copper (II) sulphate. State the most likely place for the metal in electrochemical series.

Ans. The activity series is obtained, when we examine replacement of one metal ion from its solution by another metal. The metal (M) which displaces copper from aqueous copper (II) sulphate is placed at higher position as compared to copper in activity series.

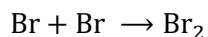
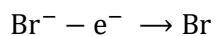
4. How will you electrolyze the molten solution of lead bromide?

Ans. Molten lead bromide (PbBr_2) forms Br^- ions and positive lead ions (Pb^{2+}) move to the cathode, and gain two electrons and change into lead atom.



Lead is deposited at the cathode.

The negative bromide ion migrates to the anode. It loses an electron and becomes a bromine atom. The two bromine atoms join bromine molecule. It is liberated as bromine gas (which is brown gas).



5. (i) What are the particles present in a non-electrolyte?
 (ii) What is conductivity of metals due to?
 (iii) What should be the physical state of lead bromide, if it is to conduct electricity?
 (iv) What particles are present in pure lead bromide?

- Ans. (i) Molecules are present in a non-electrolyte.
 (ii) The conductivity of metals is due to movement of electrons.
 (iii) Lead bromide should be in molten state, if it is to conduct electricity.
 (iv) Lead ions and bromide ions are present in pure lead bromide in molten state.

6. During the electrolysis of aqueous copper sulphate, between copper electrodes, the sulphate and hydroxyl ions remain as spectator ions.

Ans. During electrolysis of aqueous copper sulphate using copper electrodes, the two anions OH^- and SO_4^{2-} migrate to the anode, but none of them get discharged because the copper of the anode dissolves in the solution producing copper ions and electrons. Hence, OH^- and SO_4^{2-} ions remain as spectator ions.

7. Mention the type of ions present, the products obtained and the electrode reactions that occur, when the following are electrolyzed :

- (i) Molten lead bromide between steel cathode and graphite anode.
 (ii) Water acidified with sulphuric acid between platinum electrodes.
 (iii) Aqueous copper sulphate between copper electrodes.
 (iv) Aqueous copper sulphate between copper cathode and platinum anode.

Ans.

	Cathode	Anode
(i) Electrode used Ions present Products Reaction	Steel Pb^{2+} Lead $\text{Pb}^{2+} + 2e^- \rightarrow \text{Pb}$	Graphite Br^- Bromine $2 \text{Br}^- - 2e^- \rightarrow \text{Br}_2$
(ii) Electrode used Ions present Products Reaction	Platinum H^+ Hydrogen $4\text{H}^+ + 4e^- \rightarrow 2\text{H}_2$	Platinum OH^- and SO_4^{2-} Oxygen $4\text{OH}^- - 4e^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
(iii) Electrode used Ions present Products Reaction	Copper Cu^{2+} and H^+ Copper atom $\text{Cu}^{2+} (\text{aq}) + 2e^- \rightarrow \text{Cu} (\text{s})$	Copper OH^- and SO_4^{2-} Copper ions $\text{Cu} (\text{s}) - 2e^- \rightarrow \text{Cu}^{2+} (\text{aq})$
(iv) Electrode used Ions present Products Reaction	Copper Cu^{2+} and H^+ Copper atom $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu} (\text{s})$	Platinum OH^- and SO_4^{2-} Oxygen $4\text{OH}^- - 4e^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2$

8. With reference to electroplating answer the following :

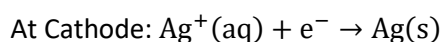
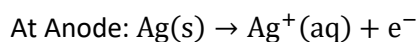
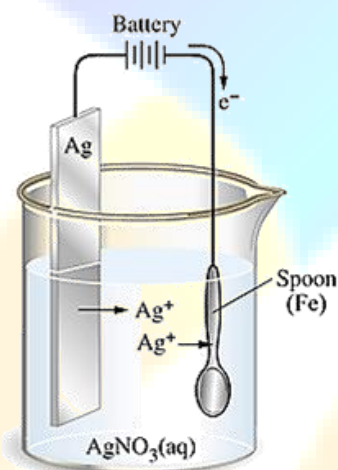
- (i) Why are articles electroplated?
- (ii) Why a small current passed for a longer period is preferred over high current for a shorter period?
- (iii) Why the article to be electroplated is made a cathode?
- (iv) Why a direct current is used?

Ans. (i) Articles are electroplated for the following reasons:

- (a) To prevent it from corrosion.
 - (b) To improve the appearance of the metal articles.
- (ii) To get a uniform and smooth coating of superior metal, a small current should be used -for a longer time.
- (iii) The article to be electroplated is always placed at cathode because the metal is always deposited at cathode.
- (iv) Direct current is used to get smooth coating and the phase of the current is same at all instance of time.

9. How a spoon is electroplated with silver?

Ans.



Silver nitrate solution is taken in a beaker. Silver wire and a spoon, which is to be plated with silver, are dipped in the solution. Silver wire is connected with the positive terminal of the battery which acts as anode and spoon is connected with the negative terminal of the battery which acts as cathode.

When electric current is passed through silver nitrate solution, electrolysis takes place and silver is deposited as a fine thin film at the surface of spoon. The spoon is coated with silver and looks as a silver spoon.

10. 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.

Ans. In Cell A: Sodium chloride being strong electrolyte dissociates completely and therefore current flows better.

- In Cell B: Acetic acid being weak electrolyte ionizes only partially and therefore, only a weak current flow.

- In Cell C: Sugar being a covalent compound does not ionise at all and therefore, no current flows.

11. Why are acids, bases and salts classified as electrolytes?

Ans. Acids, bases and salts are classified as electrolytes because these compounds dissociate into ions, conduct electricity and undergo chemical decomposition at the same time.

12. Metals like potassium, calcium, sodium, etc., can be extracted only by electrolysis.

Ans. Metals like K, Ca, Na, etc., can be extracted only by electrolysis because conventional reducing agents such as coke, carbon monoxide, hydrogen do not supply sufficient energy to break ionic bonds between the active metals and their chlorides or oxides.

13. Copper is a good conductor of electricity, but it is a non-electrolyte. Why?

Ans. During metallic conduction, the chemical properties of copper are intact as it does not undergo chemical decomposition. Since, the flow of electricity only produces heat and energy and no new products are formed copper metal is thus a good conductor of electricity but is a non-electrolyte.

14. A solution of ionic compound is an electrolyte, while that of covalent compound is non-electrolyte?

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

15. Does wax conduct electricity? Give reason to justify your answer.

Ans. No, wax does not conduct electricity because wax, being a covalent compound, does not have positively or negatively charged ions which could not be weakened by heating or in aqueous solution. Therefore due to absence of free ions, wax does not conduct electricity.

16. Mercury is a liquid and allows the flow of electricity, though it is not an electrolyte.

Ans. An electrolyte is a substance which on dissolving in water breaks up into positively and negatively charged ions. But mercury is a metal, so on dissolving in water, it can't break up into cations and anions, when electric current passes through mercury it doesn't undergo any decomposition and no new substance is formed. Electric current passes through mercury due to the presence of free electrons in its penultimate shell and not due to the formation of ions.

Hence, mercury is a metallic conductor and not an electrolyte.

17. A solution of cane sugar does not conduct electricity, but a solution of sodium chloride is a good conductor

Ans. The sugar cane solution is a covalent compound. When it is dissolved in water, does not dissociate to give free ions which could migrate to cathode or anode. Hence, sugar solution is bad conductor of electricity. The sodium chloride solution mainly consists of free sodium and chloride ions which

could migrate to positively charged electrodes. Hence, solution of sodium chloride is good conductor of electricity.

18. During electrolysis high voltage is not favoured. Why?

Ans. During electrolysis high voltage is not favoured because the electrolytic conduction increases with rise in temperature, i.e., decrease in resistance. Increase in resistance can only be obtained by applying low voltage during electrolysis.

Thus, only electricity is suitable as reducing agent which provides unlimited amount of energy to break ionic bonds easily.

19. While electrolyzing concentrated sulphuric acid, the bulb glows very dimly but when diluted, the bulb glows brightly. Why?

Ans. Concentrated (99%) sulphuric acid behaves like a weak electrolyte as it has very little hydronium ions in it. But when added to water, it becomes diluted and produces a large, number of hydronium ions. Now, it behaves like a stronger electrolyte and hence the bulb glows brightly.

20. Why electrolysis of acidulated water is considered example of electrolysis?

Ans. It is because the amount of sulphuric acid does not change when water is electrolyzed. The sulphuric acid just helps in increasing the conductivity of water.