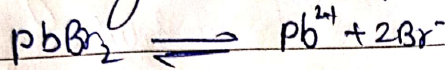


## 6. ELECTROLYSIS

- ① Give reasons for the following
- ② Electrolysis of molten lead bromide is considered to be a reaction in which oxidation and reduction go side by side i.e. a redox reaction
- ③ The blue colour of aqueous copper sulphate fades when it is electrolysed using platinum electrodes
- ④ Lead bromide undergoes electrolytic decomposition in the molten state but is a non electrolyte in solid state
- ⑤ Aluminium is extracted from its oxide by electrolytic reduction and not by conventional reducing agents
- ⑥ The ratio of hydrogen and oxygen formed at the cathode and anode is 2:1 by volume
- ⑦ In the electrolysis of acidified water, dilute sulphuric acid is preferred to dilute nitric acid for acidification
- ⑧ Ammonia is un-ionised in the gaseous state but in the aqueous solution, it is a weak electrolyte
- ⑨ A graphite anode is preferred to other inert electrodes during electrolysis of fused lead bromide
- ⑩ For electroplating with silver, silver nitrate is not used as electrolyte

- ② Carbon tetrachloride is a liquid but does not conduct electricity.
- ③ Potassium is not extracted by electrolysis of its aqueous salt solution.

④ During this reaction loss of electron at anode and gain of electrons at cathode. Thus oxidation and reduction goes side by side. Therefore, it is redox reaction.

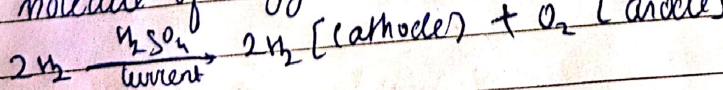


⑤ Due to decrease in  $Cu^{2+}$  ions the blue colour fades and the solution becomes colourless.

⑥ The ions are free to move when lead bromide is in molten state, but in solid state the ions are tightly packed due to electrostatic force of attraction. Therefore lead bromide undergoes electrolytic dissociation in molten state and is non-electrolyte in solid state.

⑦ Aluminium is not reduced by reducing agent as it has great affinity towards oxygen. Therefore it is extracted from its oxide by electrolytic reduction.

⑧ As,  $4H^+$  are needed at cathode and  $4OH^-$  at anode to form two molecules of water. Hence for every two molecules of hydrogen and one molecule of oxygen are liberated at cathode and anode.



⑨ Because  $HNO_3$  is volatile.

⑩

(h) Graphite is not affected by bromine vapours.

(i) Deposition of silver nitrate is very fast and hence not smooth and uniform

(j) Carbon tetrachloride is a covalent compound, there are no free ions in it

(k) Because it reacts with water, hence is not extracted from aqueous solution

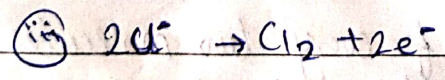
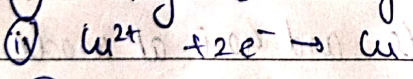
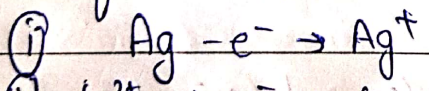
Q2. Copy and complete the following table which refers to two practical applications of electrolysis

(i) Silver plating of a spoon	Anode	Electrolyte Solution of potassium argentocyanide	Cathode Article to be electroplated
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(ii) Purification of copper	Impure copper	Soln of copper sulphate and dilute sulphuric acid	This strip of pure copper
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(iii) Extraction of sodium	Nickel	fused anhydrous NaOH	iron
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(b) Write equations of reactions taking place at anode for Q2.(a)

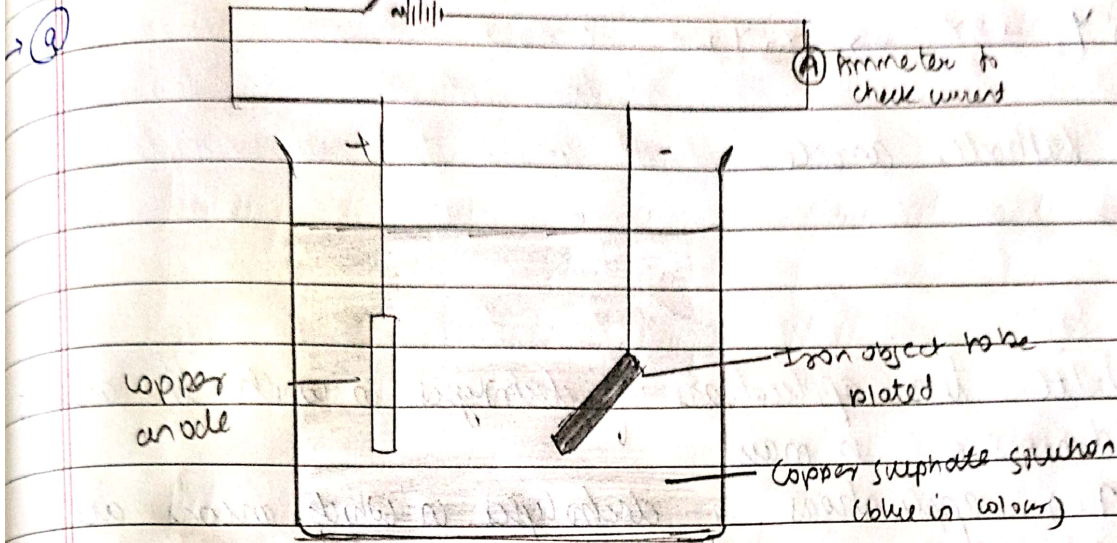


(3) (a) Draw a labelled diagram to show how iron is electroplated with copper.

(b) Which solution is preferred as electrolyte for Fe or FeSO<sub>4</sub>.

⑨

Describe what happens to the iron object and the copper rod.



⑪  $\text{CuSO}_4$  i.e. Copper sulphate solution is preferred as electrolyte

⑫ The copper anode dissolves in the solution and is replaced periodically. The electrolyte dissociates into  $\text{Cu}^{2+}$  ions and migrates towards iron object, which is taken as the cathode and deposited as neutral copper atom on cathode.

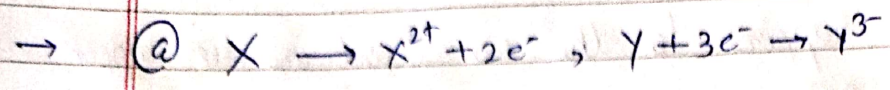
⑬ Element X is a metal with valency 2. Element Y is a non-metal with valency 3.

⑭ Write equations to show how X and Y form ions?

⑮ If Y is a diatomic gas, write the equation for direct combination of X and Y to form a compound.

⑯ If the compound formed between X & Y is melted and an electric current passed through the molten compound, the element X will be obtained at the \_\_\_\_\_ and Y at the \_\_\_\_\_ of electrolytic cell.

6



(c) Cathode, anode

(5) Write two applications of electrolysis in which the anode diminishes in mass

→ Two applications of electrolysis in which anodes are diminished are

(i) electrorefining of metals and

(ii) electroplating of metals.

(6) (a) What kind of particles will be found in a liquid compound which is a non-electrolyte

(b) If HX is a weak acid, what particles will be present in its dilute solution apart from those of water?

(c) Cations are formed by \_\_\_\_\_ (loss/gain) of electrons and anions are formed by \_\_\_\_\_ (loss/gain) of electrons. (Choose the correct word to fill in the blanks)

→ (a) They contain molecules.

(b) If HX is a weak acid, the particles present in its aqueous solution apart from water  $H^+$  &  $X^-$  ions

(c) Cations are formed by loss of electrons and

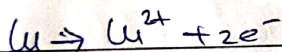
(6)  
anions are formed by gain of electrons.

① A strip of copper is placed in four different colourless salt solutions. They are  $KNO_3$ ,  $AgNO_3$ ,  $Zn(NO_3)_2$ ,  $Ca(NO_3)_2$ . Which one of the solutions will finally turn blue?

→  $AgNO_3$  solution will finally turn blue, when a strip of copper is placed in it.

2008

⑨ 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?

⑩ A solution contains magnesium ion ( $Mg^{2+}$ ), iron(II) ion ( $Fe^{2+}$ ) and copper ion ( $Cu^{2+}$ ). On passing an electric current through this solution, which ion will be first to be discharged at the cathode? Write the equation for the cathode reaction.

⑪ Why is carbon tetrachloride, which is a liquid, a non-electrolyte?

⑫ During the electrolysis of molten lead bromide, which of the following take place?

- 
- Ⓐ Bromine is released at the cathode
  - Ⓑ lead is deposited at the anode
  - Ⓒ Bromine ions gain electrons
  - Ⓓ lead is deposited at the cathode
- 
- Ⓐ Reaction takes place at anode. It is an example of oxidation reaction

Ⓑ  $\text{Cu}^{2+}$  ion will be discharged at cathode  
 Reaction at cathode is  

$$\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$$

Ⓓ Carbon tetrachloride is a covalent compound. It doesn't form ions hence it is a non-electrolyte

Ⓒ During the process of electrolysis of lead bromide,  
 lead is deposited at cathode

— x —

2009  
 Ⓐ Select the correct answer

The aqueous solution of the compound which contains both ions and molecules is

- Ⓐ  $\text{H}_2\text{SO}_4$
- Ⓑ  $\text{HCl}$
- Ⓒ  $\text{HNO}_3$
- Ⓓ  $\text{CH}_3\text{COOH}$

(b) Correct the following statement  
lead bromide conducts electricity

(c) 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

(d) Aqueous solution of nickel sulphate contains  $\text{Ni}^{2+}$  and  $\text{SO}_4^{2-}$  ions

(i) Which ion moves towards the cathode

(ii) What is the product at the anode

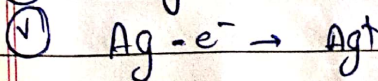
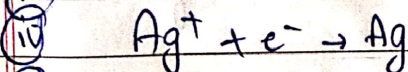
(a)  $\text{CH}_3\text{COOH}$

(b) Molten lead bromide / lead bromide in aqueous state conducts electricity.

(c) (i) It is a complex salt

(ii) When silver nitrate is used the deposition is very fast and not smooth as it is a strong electrolyte.

(iii) A current should be used for a longer time



(d) (i)  $\text{Ni}^{2+}$  ions

(ii) Oxygen gas, when an inert electrode is used



2016

(a) Select the correct answer - A compound which during electrolysis in its molten state, liberates a reddish brown gas at the anode.

(i) Sodium chloride

(ii) Copper(II) oxide

(iii) Copper(II) sulphate

(iv) Lead(II) bromide

(b)

(i)

During electroplating of an article with nickel

(i) Name

A. The electrolyte

B. The cathode

C. The ~~anode~~ anode

(ii) Give the reaction of the electrolysis at

A. The cathode

B. The anode

(c) A, B and C are three electrolytic cells, connected in different circuits. Cell 'A' contains NaCl solution and the bulb in the circuit glow brightly, when the circuit is completed. Cell 'B' contains acetic acid and the bulb glow dimly. Cell 'C' contains sugar solution and the bulb does not glow. Give reason for each observation.

(a) (iv) Lead bromide

(b) (i) Aqueous solution of nickel sulphate with drops of dil sulphuric acid

(B) Article to be plated

(C) Nickel

(ii) (A)  $Ni^{2+} + 2e^- \rightarrow Ni$  at cathode

(B)  $Ni - 2e^- \rightarrow Ni^{2+}$

2011

(a) Give reason - The electrolysis of acidulated water is considered to be an example of catalysis

(b) During the electrolysis of copper (II) sulphate solution using platinum at cathode and carbon as anode

(i) state what observations you observe at the cathode and at the anode

(ii) state the change noticed in the electrolyte

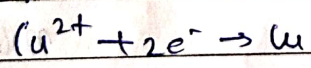
(iii) Write the reactions at the cathode and at the anode

(c) Differentiate between electrical conductivity of copper sulphate solution and of copper metal.

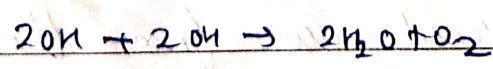
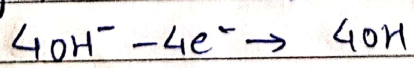
→

(a) Dilute sulphuric acid undergoes dissociation and it catalyses, therefore electrolysis of acidulated water is considered to be an example of catalysis

(b) (i) Copper ions discharge in preference to  $(H^+)$  ions, to form neutral copper atoms



$SO_4^{2-}$  and  $OH^-$  ions both migrate towards anode.  $OH^-$  being lower in electrochemical series than  $SO_4^{2-}$ , it is discharged at anode to form neutral atoms  $OH$



(ii) Reaction at cathode -  $Cu^{2+} + 2e^- \rightarrow Cu$

Reaction at anode -  $4OH^- - 4e^- \rightarrow 4OH$

(iii) The blue colour of electrolyte turns colourless.

Copper sulphate sol<sup>n</sup>

Copper metal

- |  |  |
|--|--|
| (iii) ① Electricity is conducted due to flow of ions | ① Electricity is conducted due to flow of electrons. |
| ② Chemical change is seen                            | ② Chemical change is not seen                        |
| ③ It is ionic in aqueous solution                    | ③ It remains metal in aqueous solution               |

2012

(a) Identify the weak electrolyte from the following

- (i) Sodium chloride solution
- (ii) Dilute hydrochloric acid
- (iii) Dilute sulphuric acid
- (iv) Aq. acetic acid

(b) Match the following in column A with correct answer from the choices given in column B

Column A

Column B

① Ammonium hydroxide

① contains only ions

② Dilute hydrochloric acid

② contains molecules only

③ Carbon tetrachloride

③ contains ions and molecules

(c) Give reason: An aqueous solution of sodium chloride conducts electricity.

(d) Select the correct answers from the list of brackets

(i) A aqueous electrolyte consists of the ions mentioned in the list. The ion which would be discharged most readily during electrolysis  $[Fe^{2+}, Cu^{2+}, H^+]$

(12)

- (ii) The metallic electrode which is discharged at the anode 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 solution using copper electrodes as anode and cathode. [ $\text{Cu}^{2+}$ ,  $\text{OH}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{H}^+$ ]
- (iv) When dilute sodium chloride is electrolysed using graphite electrodes, the cation which is discharged at the cathode most readily. [ $\text{Na}^+$ ,  $\text{OH}^-$ ,  $\text{H}^+$ ,  $\text{Cl}^-$ ]
- (v) During silver plating of an article using potassium argentocyanide as an electrolyte, the anode material should be. [Cu, Ag, Pt, Fe]

→ (a) Aq. acetic acid

(b)

Column A

Column B

- |                            |   |                             |
|----------------------------|---|-----------------------------|
| ① Ammonium hydroxide       | — | Contains ions and molecules |
| ② Dilute hydrochloric acid | — | Contains only ions          |
| ③ Carbon tetrachloride     | — | Contains only molecules     |

④ In aqueous <sup>or</sup> molten state ions of sodium chloride are freely moving and hence can conduct electricity. Ions are separated in the form of  $\text{Na}^+$  &  $\text{Cl}^-$  hence it conducts electricity in aqueous state.

- (d) (i)  $\text{Cu}^{2+}$   
(ii) Pt

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(ii)  $\text{Cu}^{2+}$ (iv)  $\text{H}^+$ 

(v) Ag

2013

(a) State one appropriate observation for electricity is passed through molten lead bromide.

(b) State which of these will act as a non-electrolyte.

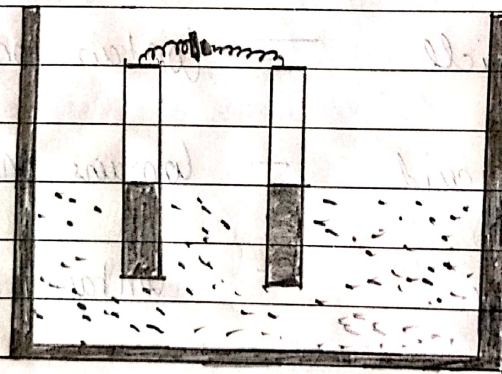
(i) liquid carbon tetrachloride.

(ii) Acetic acid

(iii) Sodium hydroxide aqueous solution

(iv) Potassium chloride aqueous solution

(c) Copper sulphate solution is electrolysed using copper electrodes



(i) Which electrode to your left or right is known as the anodising electrode and why?

(ii) Write the equation representing the reaction that occurs.

(iii) State two appropriate observations for the above electrolysis reaction.

(14)

(17) Identify: A gas which does not conduct electricity in the liquid state but conducts electricity when dissolved in water.

→ (a) Reddish brown fumes of bromine evolve at anode and greyish white lead is formed at cathode.

(b) (i) liquid carbon tetrachloride.

(c) (i) Right electrode is oxidising electrode and is an anode.  
 $Cu \rightarrow Cu^{2+} + 2e^-$

(ii) Reaction at anode  $\rightarrow Cu \rightarrow Cu^{2+} + 2e^-$   
 Reaction at cathode  $\rightarrow Cu^{2+} + 2e^- \rightarrow Cu$

(iii) Anode is dissolved in this process and the metal present is recovered from it.

2016

(9) The observation seen when fused lead bromide is electrolysed is:

(i) A silvery grey deposit at anode and a reddish brown deposit at cathode.

(ii) A silvery grey deposit at cathode and a reddish brown deposit at anode.

(iii) A silvery grey deposit at cathode and reddish brown fumes at anode.

anode  
(iv) silvery grey fumes at anode and reddish brown fumes at cathode

(b) During electroplating an article with silver, the electrolyte used is

- (i) silver nitrate solution
- (ii) silver cyanide solution
- (iii) sodium argentocyanide solution
- (iv) nickel sulphate solution

(c) Give one word or phrase for:  
Electrolytic deposition of a superior metal on a baser metal

(d) State your observation. At the cathode when acidified aqueous copper sulphate solution is electrolysed with copper electrodes.

(e) State which electrode: anode or cathode is the oxidising electrode. Give a reason for the same.

(f) Name the kind of particle present in

- (i) sodium hydroxide solution
- (ii) carbonic acid
- (iii) sugar solution

(g)  $M_2O$  is the oxide of a metal 'M' which is above hydrogen in the activity series.  $M_2O$  when dissolved in water forms the corresponding hydroxide which is good conductor of electricity.

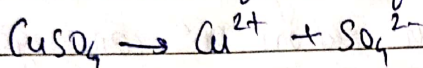
- (i) State the reaction taking place at the cathode
- (ii) Name the product at anode.

→ @ (iii) A silvery grey deposit at cathode and reddish brown fumes at anode.

(b) (iii) Sodium argentocyanide solution

(c) Galvanisation

(d) The electrolysis of aqueous copper sulphate solution using copper electrodes, results in transfer of metal from anode to cathode. Copper sulphate exists in aqueous solution. The chemical equation for it is



$\text{Cu}^{2+}$  migrates to cathode, where it gains  $2e^-$  to form copper atoms.

Hence, the colour of copper sulphate changes from blue to colourless.

(e) Anode is oxidising electrode, because ions are loosed to form neutral atom, due to loss of  $e^-$  they are said to be oxidised.

(f) (i) +ve sodium ion and -ve hydroxide ion, (ii)  $\text{H}^+$  ions and  $\text{OH}^-$  ions

(iii) glucose, fructose, galactose

(g) (i) At cathode:  $\text{M}^+ + e^- \rightarrow \text{M}$ , (ii) At anode: oxygen gas

2015

(a) State the observations at anode when aqueous copper sulphate solution is electrolysed using copper electrodes.

(b) During electrolysis of molten lead bromide, graphite anode is preferred to other electrodes. Give reason.

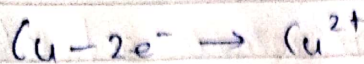
(c) Electrolysis of molten lead bromide is considered to be a redox reaction. Give reason.

(d)

→ (a) Copper anode ionises to give  $\text{Cu}^{2+}$  ions

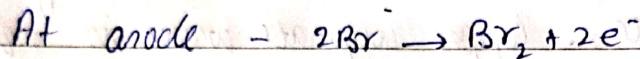
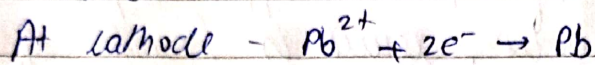


(17)



(b) Graphite remains unaffected by reactive bromine vapours which are released at anode. Therefore during electrolysis of molten lead bromide, graphite anode is preferred.

(c) The following reaction takes place in electrolysis of molten lead bromide



Lead ions get attracted to negative electrode and  $\text{Pb}^{2+}$  are forced to accept two electrons.  $\text{Pb}^{2+}$  ions get reduced. Bromide ions get attracted towards positive electrode and they are forced to lose their extra electrons to form bromine atoms. Thus bromide ions get oxidised. Simultaneous oxidation and reduction is called redox reaction.

2016

Give reasons why:

(a) Sodium chloride will conduct electricity only in fused or aqueous solution state.

(b) In the electroplating of an article with silver, the electrolyte sodium argento-cyanide solution is preferred over silver nitrate solution.

(c) Although copper is a good conductor of electricity, it is a non-electrolyte.

→

lockwise →

18

Electrostatic force of attraction is very strong. These forces weaken in molten state or when in solution state. Therefore sodium chloride will conduct electricity only if it is fused or aqueous solution state.

Deposition of silver is not smooth and uniform, if silver nitrate solution is used directly in place of sodium cyanide, and deposition of silver is also very fast.

Copper doesn't have mobile electrons in solid state. Hence it doesn't dissociate in oppositely charged ions for the conduction of electricity. Therefore, copper is a non-electrolyte.