

29.4.24

TENDER HEART HIGH SCHOOL, SEC-33B, CHD

CLASS - X
CHAPTER - 6

SUBJECT - CHEMISTRY
TEACHER - MOHINISHA THAKUR

Good morning to all the students!

Students this lesson is for class - X for the subject of chemistry, Topic :- 'Electrochemical Series' which is covered in chapter - 6 'Electrolysis' starting on page no-107 of your text book titled Concise Chemistry by 'Selina Publication' and is being submitted to you on 2nd May, 2022.

This lesson is of Mohinisha Thakur

All students may now please open page no-107 of your notebook in front of you.

If all students are ready then let us start with this chapter. All students may now please listen carefully.

Electrochemical Series :-

Metals lose electrons to form cations (positive ions). Some metals lose electrons more easily compared to other metals, like sodium converts into Na^+ more easily than zinc converts to Zn^{2+} .

Based on the ease with which atoms of metals lose electrons to form positively charged ions, they are arranged in a series known as electrochemical series.

(P.T.O)

Metals Cations

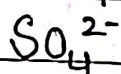
Important points

K	K^+
Ca	Ca^{2+}
Na	Na^+
Mg	Mg^{2+}
Al	Al^{3+}
Zn	Zn^{2+}
Fe	Fe^{3+}
Ni	Ni^{2+}
Sn	Sn^{4+}
Pb	Pb^{2+}
[H]	H^+
Cu	Cu^{2+}
Hg	Hg^{2+}
Ag	Ag^+
Au	Au^{3+}
Pt	Pt^{4+}

- 1) A metal higher in the series will lose electron more easily compared to lower one, therefore it can displace lower one.
- 2) During electrolysis, cations move towards cathode and get reduced (discharged). The lower elements get discharged more easily. Ex:- Cu^{2+} will gain two electrons and change back to Cu easily because it is low in the series.
- 3) Metal atoms which form ions more easily by losing electrons, will accept electrons with great difficulty to form atoms again.
- 4) Hydrogen is placed in this series although it is not a metal because it can lose electron to form cation just like metals.

Electrochemical Series of anions :-

During electrolysis the cations move to cathode and the anions or negative charged ions move to anode. Here they lose electrons and get discharged. Like Cl^- will lose one electron and become Cl. Based on their tendency to lose electrons and get discharged at the anode, the anions are arranged in the electrochemical series.

Anion Series

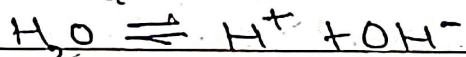
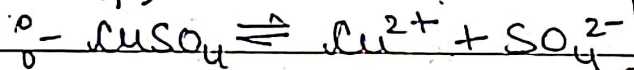
The ions lower in the series will get discharged more easily at anode compared to the ions higher in the series.

Preferential or Selective discharge of ions at electrodes:- When two or more ions

are present in the electrolytic solution, then only one of them gets preferentially discharged. This selective discharge of ions depends on three factors:-

FACTORS:-

- (a) The relative position of ions in the electrochemical series:- If two or more same charge ions are present in the electrolyte, then the ion lower in the electrochemical series gets discharged at the electrode. e.g - If the electrolyte is a solution of CuSO_4 , then the ions present will be



There are two cations Cu^{2+} and H^+ but the position of Cu^{2+} is lower in the series, $\therefore$ Only Cu^{2+} will get reduced at cathode and not H^+ . The reaction at cathode will be:- $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

There are two anions SO_4^{2-} and OH^- , but OH^- being lower in the series will get discharged at anode.

Reaction at anode, $\text{OH}^- \rightarrow \text{OH} \cdot$, $4\text{OH} \cdot \rightarrow 2\text{H}_2\text{O} + \text{O}_2$

- (b) Concentration of ions in the electrolyte:- If two or more ions of same charge are present and the concentration (P.T.O)

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If a particular ion is much higher than the others, then that particular ion will be discharged at the cathode or anode even if its position is higher in the electrochemical series.

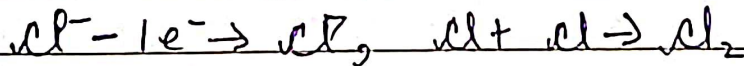
E.g:- Electrolysis of concentrated NaCl solution.

Ions produced will be $\text{NaCl} \rightleftharpoons \text{Na}^+ + \text{Cl}^-$

$\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$ [The amount of water is less, $\therefore \text{H}^+$ & OH^- ions are very few in the electrolyte.]

In cations Na^+ and H^+ , although the concentration of Na^+ is higher than H^+ , the ion reduced at cathode is H^+ only as its reducing capacity is more than Na^+ . At cathode the reaction is:- $\text{H}^+ + \text{e}^- \rightarrow \text{H}$, $\text{H} + \text{H} \rightarrow \text{H}_2$

However at anode, OH^- is not discharged although it lies lower in the series. Since the concentration of Cl^- is much more than OH^- in the electrolyte, it will only get oxidised at anode.



(c) Nature of the electrode used:- The discharge of ions on electrodes also depends upon the material used for making electrodes. If the electrodes are made of graphite or platinum which are unreactive in nature they do not interfere or disturb the normal electrode reactions. But if the electrodes are made of some reactive metal like Cu, Ni or Ag then this metal starts oxidising and the electrolytic reaction is different. This factor will be explained again in the electrolysis of CuSO_4 solution.

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Electrolysis of Acidified water :-Electrolyte :- Acidified water (water + dilute H_2SO_4)[Pure water contains only molecules, we add dil. H_2SO_4 to make it ionise. Dilute H_2SO_4 is preferred over dil. HCl and dil. HNO_3 as they are volatile acids.]

Electrodes :- Platinum foils

Ions produced :- $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$ $H_2O \rightleftharpoons H^+ + OH^-$ Reaction at cathode :- Only H^+ ions are present, so it will get discharged $H^+ + 1e^- \rightarrow H$ $H + H \rightarrow H_2$

Hydrogen gas is produced at cathode.

Reaction at Anode :- SO_4^{2-} and OH^- ions are present OH^- is having lower position in the electrochemical series, $\therefore$ it will get discharged at anode $OH^- + 1e^- \rightarrow OH$, $4OH \rightarrow 2H_2O + O_2$

Oxygen gas is produced at anode.

Ratio of Hydrogen to Oxygen produced is 2:1 by volume :- As you see that $4OH^-$ will lose $4e^-$ to produce one O_2 molecule. Now we have to show that same number of electrons are lost and gained at cathode and anode. So 4 electrons are lost and 4 electrons are gained at anode and cathode respectively.

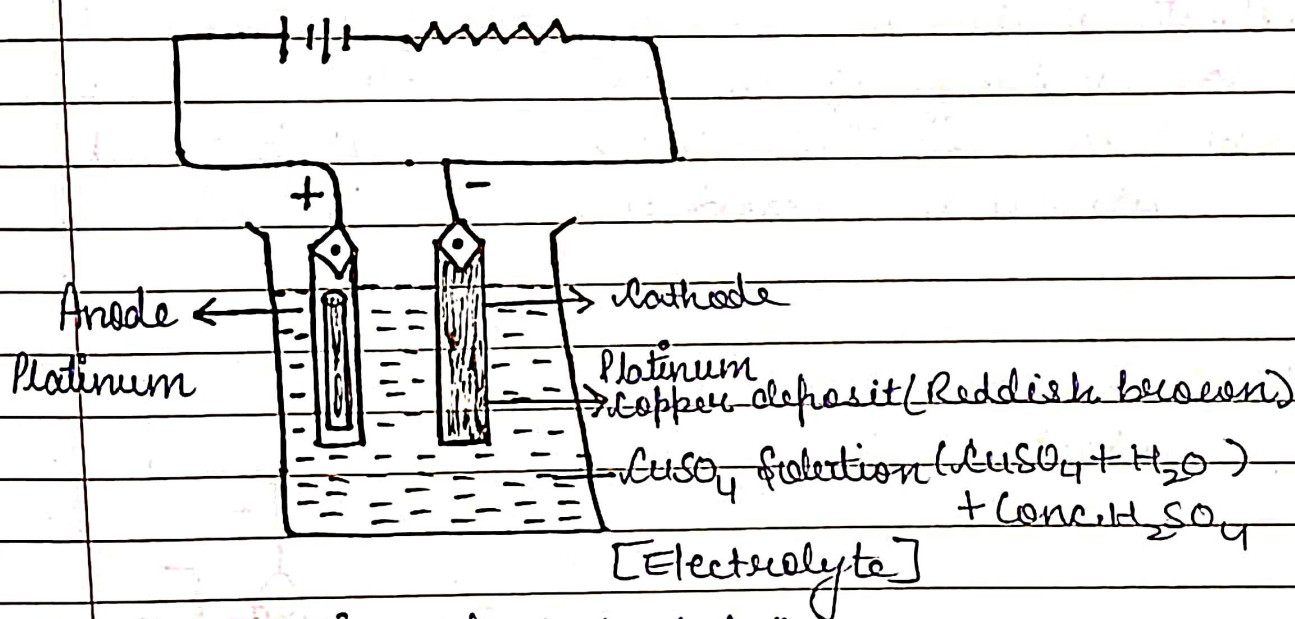
Cathode	Anode
$4H^+ + 4e^- \rightarrow 4H$	$4OH^- - 4e^- \rightarrow 4OH$
$4H \rightarrow 2H_2$	$4OH \rightarrow 2H_2O + O_2$
Result :- $2H_2$	O_2
Ratio is 2:1	

Next, we will discuss the topic which is 'Electrolysis of copper sulphate solution'.

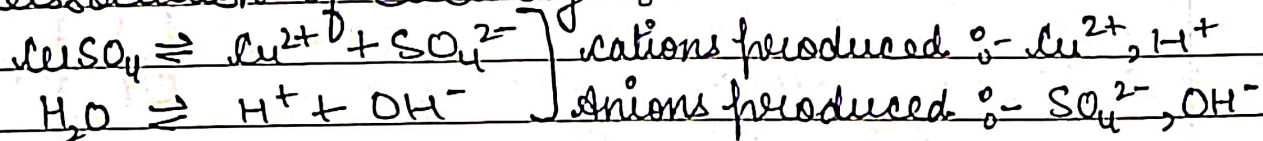
Electrolysis of copper sulphate solution :-

We will study electrolysis of copper sulphate solution using platinum electrodes and then by using copper electrodes.

Electrolysis of copper sulphate solution using platinum electrodes :-



Dissociation of electrolyte :-



Reaction at cathode :-

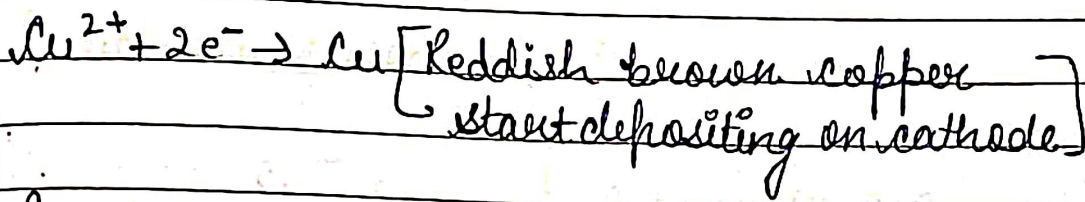
Cu²⁺ lies lower in the electrochemical series, so Cu²⁺ will get discharged at cathode in preference to H⁺

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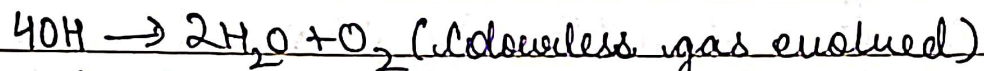
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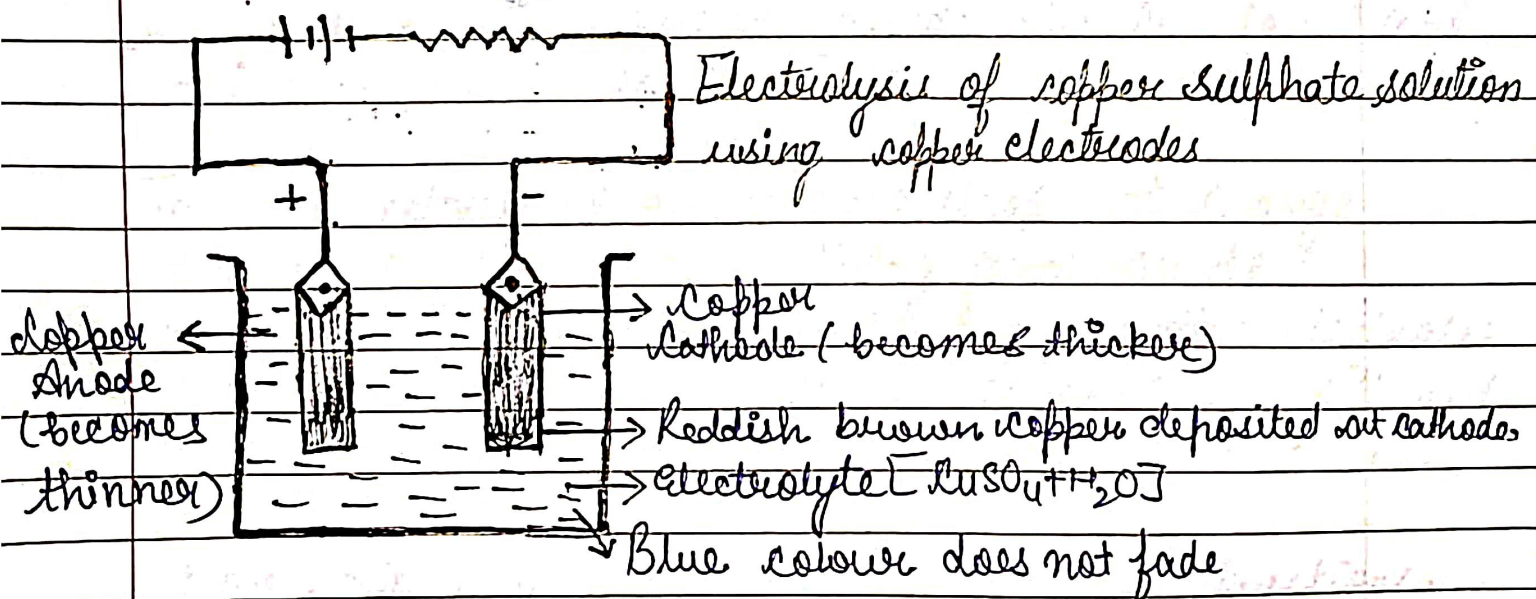


Reaction at Anode:-

SO_4^{2-} and OH^- , both the ions move towards anode but SO_4^{2-} does not get discharged. OH^- lies lower in the electrochemical series therefore it will only get discharged at anode.

Anode:- $\text{OH}^- - \text{e}^- \rightarrow \text{OH}$ 

The electrolyte CuSO_4 solution is blue in colour due to the presence of Cu^{2+} ions. The blue colour starts fading slowly as the Cu^{2+} ions are getting discharged at the cathode. When all the Cu^{2+} ions are reduced to Cu , the electrolyte becomes colourless.



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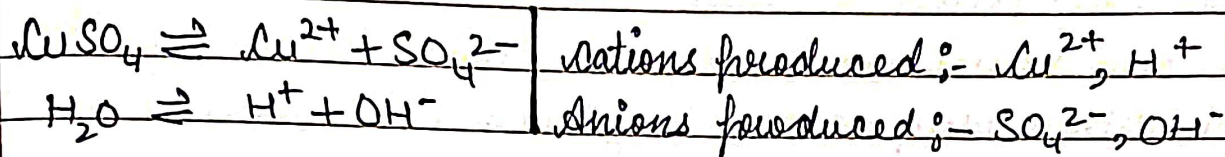
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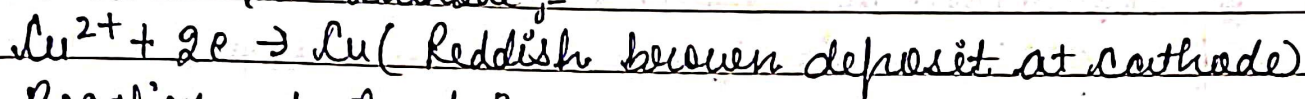
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Dissociation of electrolyte:-

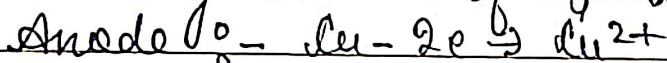


Reaction at cathode:-



Reaction at Anode:-

SO_4^{2-} and OH^- ion both migrate to anode but do not get oxidised. Here the anode is made of copper and the oxidising capacity of copper is greater than SO_4^{2-} and OH^- ions. Therefore the copper of anode starts oxidising instead of SO_4^{2-} and OH^- ions.



Since the copper from anode keeps dissolving by changing into Cu^{2+} ions, therefore the anode becomes thinner. At cathode, the Cu^{2+} ions are getting reduced to Cu, and at anode the Cu atoms are getting oxidised to Cu^{2+} ions.

The blue colour of electrolyte does not change because Cu^{2+} ions keep coming from anode.

Now it is clear that inert and active electrodes play an important role in electrolysis. Different products are produced in both the cases.

Now, I will give you three very short Questions. You will get a three minutes break to rewrite the answers in your chemistry notebook.

(P.T.O.)

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The Questions are:-

- Que 1:- Name the metal which higher in series will lose electron more easily compared to lower one.
- Que 2:- In electrolysis of acidified water pure water contains only molecules, we add _____ to make it ionize.
- Que 3:- What colour deposit at cathode in electrolysis of copper sulphate solution using platinum electrodes?

Students, now pause this audio for three minutes and write the answers in your chemistry notebook.

I hope you all have written the answers by now. Let us check the answers now.

Ans 1:- Potassium K^+

Ans 2:- dil H_2SO_4

Ans 3:- Reddish brown deposit

With this I am ending the lesson for today.

Instructions And Homework

1. Read the topic from book and the given notes at least twice.
2. From Intext Questions given on page 113 do Questions 1, 2, 3, 4, 5 and 6

(Last Page)