



## Reactivity series and Electrochemistry

Some metals engage in chemical reactions vigorously, certain others react sluggishly in the same reaction.

### ♥♥♥Reaction of Metals with Water

1. Take three beakers having the same quantity of water. Take pieces of sodium, magnesium and copper of same size and drop each one to each beaker. Observe the reactions.

#### Observation

Metal	In cold water	In hot water
Sodium	Reacts vigorously with the evolution of a gas	
Magnesium	No reaction	Reaction occurs. A gas evolves
Copper	No reaction	No reaction

#### The gas formed is hydrogen

2. Based on the above observations, arrange the these metals in the decreasing order of reactivity

Answer : Sodium > Magnesium > Copper

### ♥♥♥Reaction of Metals with Air

3. Cut a piece of sodium using a knife. Observe the freshly cut portion. Give reason

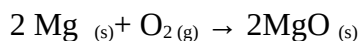
Answer : This is due to the conversion of sodium into its compounds by reacting with oxygen, moisture and carbon dioxide in the atmosphere.

4. A fresh magnesium ribbon losing its lustre when kept exposed in the air for some days.

Give reason?

This is also due the formation of magnesium oxide by the reaction with atmospheric air.

This will act as a black coating over magnesium



Aluminium vessels diminishes as time passes by. In the case of copper vessels, it takes months for the loss of its lustre by the formation of verdigris. These are examples of reaction of metals with air But the shining of gold does not fade even after a long time .Gold does not react with air. This indicates that metals react with air at different rates.

5.(a) Which metal among magnesium, copper, gold, sodium and aluminium, loses its lustre at a faster rate?

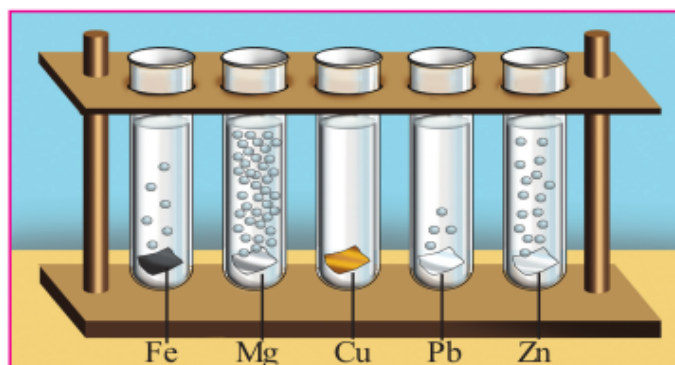
Sodium

(b) List the above metals in the decreasing order of their reactivity with air and thereby losing lustre.

Sodium > Magnesium > Aluminium > Copper > Gold

### ♥♥♥ Reaction of Metals with Acids

The image given below shows the reaction of some metals with dilute HCl



**This indicates that metals react with dilute HCl at different rates.**

6. ♥♥♥ What is reactivity series?

The series obtained by arranging the metals in the decreasing order of their reactivity is known as the reactivity series.

Note that hydrogen is also included in this series for the sake of comparison of chemical reactivity.

Potassium	K	↑	React with dil acids and displace hydrogen
Sodium	Na		
Calcium	Ca		
Magnesium	Mg		
Aluminium	Al		
Zinc	Zn		
Iron	Fe		
Nickel	Ni		
Tin	Sn		
Lead	Pb		
Hydrogen	H	↓	Do not displace hydrogen from dil. acids
Copper	Cu		
Silver	Ag		
Gold	Au		

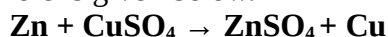
**♥♥♥Reactivity series and displacement reactions**

7.♥♥♥Prepare some CuSO<sub>4</sub> solution in a beaker and dip a Zn rod in it. Observe the changes after sometime and write down the observations.

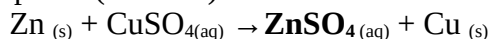


Observation	Before the experiment	After the experiment
Colour of Zinc rod	Grey	Covered with copper
Colour of CuSO <sub>4</sub> solution	Blue	<b>Colourless</b>

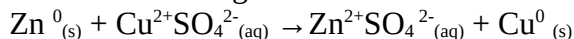
The blue colour of CuSO<sub>4</sub> solution is due to the presence of Cu<sup>2+</sup> ions. When the Zn rod is dipped in CuSO<sub>4</sub> solution, the Cu<sup>2+</sup> ions in the solution get deposited at the Zn rod as Cu atoms. The chemical reaction taking place here is given below.



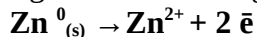
Zinc is more reactive than copper. Hence zinc will displace copper from the solution. As a result, ZnSO<sub>4</sub> and Copper are formed. The blue colour of the solution diminishes and disappears. The displaced copper gets deposited at the zinc rod.(The colour of the solution changes to the colour of the newly formed compound(solution)).



The ionic form of the above reaction is given below.

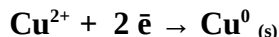


Here Zinc undergoes the following reaction,



Each **Zinc atom loses two electrons** . That is , **Zinc undergoes Oxidation** .

At the same time ,Cu<sup>2+</sup> ions receive two electrons to become Cu atoms



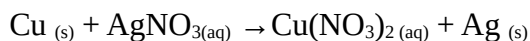
Each **Zinc Copper ion gains two electrons** . That is , Copper ions **undergo Reduction**.

Since oxidation and redox reactions occur simultaneously , this is a redox reaction.

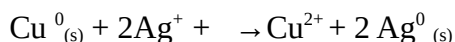
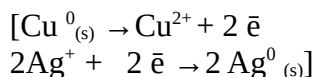
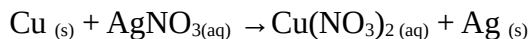
8.♥♥♥ A copper plate is immersed in AgNO<sub>3</sub> solution,

(a) Identify and record the changes.

**Answer:** Copper is more reactive than Silver. Hence copper will displace silver from silver nitrate solution. Silver gets deposited at the copper plate. Since copper nitrate solution is formed, the colour of the solution becomes blue.



(b)Write the reaction in ionic form to show that it is a redox reaction



**Each Copper atom loses two electrons** . That is , **Copper undergoes Oxidation** .

Each Ag<sup>+</sup> ion gains one electron . Hence Silver ions **undergo Reduction**.

Since oxidation and redox reactions occur simultaneously , this is a redox reaction.

**FOCUS AREA 2021-22 Chemistry - Class 10-EM Unit 3**

**♥♥♥ Displacement reactions**

Highly reactive metals can displace less reactive metals from their salt solutions . Such reactions are called displacement reactions. **Displacement reactions are redox reactions.**

**9.♥♥♥** Certain metals and the salt solutions in which they are dipped are given below. Identify displacement reaction occurs.

Metal/ Solution	Mg	Cu	Zn	Fe	Ag	Al
Magnesium sulphate						
Copper sulphate						
Zinc sulphate						
Ferrous sulphate						
Silver nitrate						
Aluminium nitrate						

**Answer:**

Metal/ Solution	Mg	Cu	Zn	Fe	Ag	Al
Magnesium sulphate	No reaction	No reaction	No reaction	No reaction	No reaction	No reaction
Copper sulphate	Reaction occurs	No reaction	Reaction occurs	Reaction occurs	No reaction	Reaction occurs
Zinc sulphate	Reaction occurs	No reaction	No reaction	പ്രവർത്തനമില്ല	No reaction	Reaction occurs
Ferrous sulphate	Reaction occurs	No reaction	Reaction occurs	പ്രവർത്തനമില്ല	No reaction	Reaction occurs
Silver nitrate	Reaction occurs	Reaction occurs	Reaction occurs	Reaction occurs	No reaction	Reaction occurs
Aluminium nitrate	Reaction occurs	No reaction	No reaction	No reaction	No reaction	No reaction

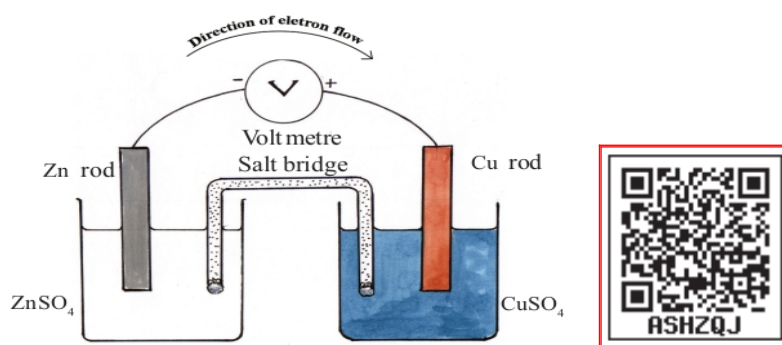
**10. ♥♥♥** Arrange the above metals in the decreasing order of their reactivity.

**Answer: Mg > Al > Zn > Fe > Cu > Ag**

♥♥♥ **Galvanic cell**

We have learned that metals differ in their reactivity. Galvanic cell is an arrangement in which the difference in reactivity of metals is used to produce electricity.

Arrange the apparatus as shown in the picture. Take two beakers, one containing 100mL ZnSO<sub>4</sub> solution and the second containing the same amount of CuSO<sub>4</sub> solution with the same concentration.



Connection details

Zn rod in ZnSO<sub>4</sub> solution , Cu rod in CuSO<sub>4</sub> solution.

Negative terminal of voltmeter is connected to the Zn rod and the positive terminal to the Cu rod.

Two solutions in the beakers are connected using a salt bridge

(A long filter paper moistened with KCl solution can be used instead of salt bridge).

Observation

The reading of the voltmeter changes. We can produce electricity using such arrangements.

Here electricity is produced due to chemical change.

***Galvanic cell or voltaic cell is an arrangement in which chemical energy is converted into electrical energy by means of a redox reaction.***

11. ♥♥♥ We have understood from the reactivity series that Zn has higher reactivity than Cu.

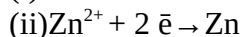
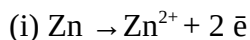
a. Which electrode has the ability to donate electrons in a cell constructed using these metals?

Answer: Zn

b. Which one can gain electrons?

Answer: Cu

c. Identify the chemical reaction that takes place at the Zn electrode.



Answer: **(i)  $\text{Zn} \rightarrow \text{Zn}^{2+} + 2 \bar{e}$**

d. Which reaction takes place here? Oxidation/Reduction

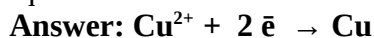
Answer: Oxidation

That is, Zn loses two electrons and becomes Zn<sup>2+</sup>. This process is known as oxidation.

An electrode at which oxidation occurs is called anode. **Anode has negative charge in this case.**

The electrons liberated from Zn rod reach the copper electrode through the external circuit. These electrons are received by copper ions in the solution changing them into copper.

a. Write the chemical equation for the reaction taking place at the Cu electrode.



b. Which reaction takes place here? Oxidation/Reduction

**Answer: Reduction**

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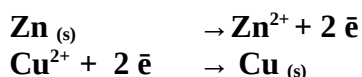
That is, Cu gains two electrons and becomes Cu .  
An electrode at which reduction occurs is called cathode.

**Cathode has positive charge in this case.**

**Normally highly reactive metals donate electrons**

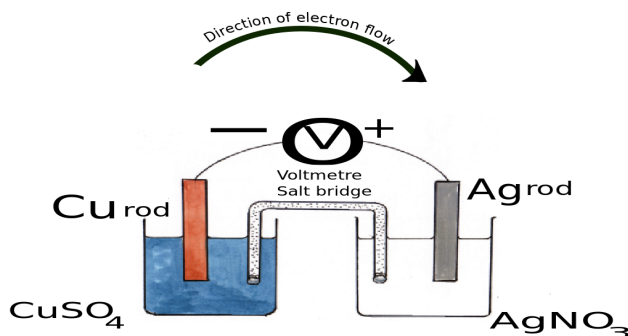
The electrode at which **oxidation** occurs is the **anode** and that at which **reduction** occurs is the **cathode**. **Anode** attains **negative** charge and **cathode** gets **positive** charge.

This redox reaction can be written as



Since oxidation and reduction occur at the same time, it is a redox reaction.  
The transfer of electrons produced by this redox reaction causes the flow of electric current in the cell. The direction of electron flow is from anode to cathode.

12. ♥♥♥ Construct a galvanic cell using silver and copper electrodes.



<b>Anode</b>	Cu	Cu is more reactive than Ag
<b>Cathode</b>	Ag	
<b>Reaction at anode</b>	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\bar{e}$	2 Ag <sup>+</sup> ions receive the <b>two</b> electrons
<b>Reaction at cathode</b>	$\text{Ag}^+ + \bar{e} \rightarrow \text{Ag}$	

13. ♥♥♥ How many cells can be constructed using Zn , Cu and Ag ?

Find the cathode and anode of the cell.

**Answer:**

Cell	Anode	Cathode
Zn – Cu	Zn	Cu
Zn – Ag	Zn	Ag
Ag - Cu	Cu	Ag