

$\text{CuSO}_4(\text{aq})$
This means that copper can displace silver from its solution, but silver cannot displace copper from its solution. Thus, *copper is more reactive than silver.*

REACTIVITY SERIES OF METALS

We have learnt that some metals are chemically very reactive while others are less reactive or do not react at all. We have also learnt that zinc metal can displace copper from its solution while copper cannot displace zinc from its solution. These observations raise some questions in our mind :

1. *Why are some metals chemically very reactive while others are less reactive ?*
2. *Which metal can displace another metal from its solution ?*

On the basis of reactivity of different metals with oxygen, water and acids as well as displacement reactions, the metals have been arranged in the decreasing order of their reactivities.

The arrangement of metals in order of decreasing reactivities is called reactivity series or activity series of metals.

The activity series of some common metals is given in Table 1. In this table, the **most reactive metal** is placed at the **top** whereas the **least reactive metal** is placed at the **bottom**. As we go down the series the chemical reactivity of metals decreases.

Reasons for Different Reactivities

In the activity series of metals, the basis of reactivity is the tendency of metals to lose electrons. If a metal can lose electrons easily to form positive ions, it will react readily with other substances. Therefore, it will be reactive metal. On the other hand, if a metal loses electrons less rapidly to form a positive ion, it will react slowly with the other substances. Therefore, such a metal will be less reactive. For example, alkali metals such as sodium and potassium lose electrons very readily to form alkali metal ions, therefore, they are very reactive.

It may be noted that hydrogen is not a metal but even then it has been placed in the reactivity series. This is due to the fact that

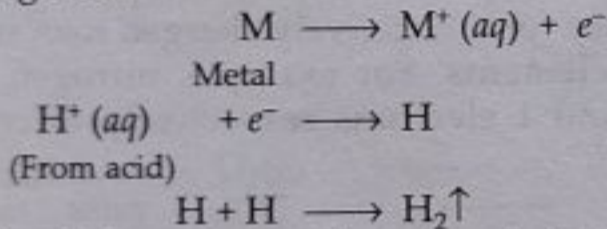
- (i) Hydrogen can also lose electron and form positive ion, H^+ .
- (ii) Hydrogen has also been included in the series to compare the reactivities of metals with respect to it.

Table 1. Reactivity series of metals

<p>Metals more reactive than hydrogen</p>	Potassium	K	<p>(Most reactive metal)</p>		
	Sodium	Na			
	Calcium	Ca			
	Magnesium	Mg			
	Aluminium	Al			
	Zinc	Zn			
	Iron	Fe			
	Nickel	Ni			
	Tin	Sn			
	Lead	Pb			
	Hydrogen	H			
	Metals less reactive than hydrogen	Copper		Cu	
		Mercury		Hg	
		Silver		Ag	
	Gold	Au			
	Platinum	Pt	(Least reactive metal)		

Displacement of Hydrogen from Acids by Metals

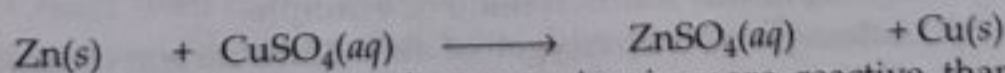
Let us consider, displacement of hydrogen from acids by metals. All metals above hydrogen in the reactivity series (*i.e.*, more active than hydrogen) like zinc, magnesium, nickel can liberate hydrogen from acids like HCl and H₂SO₄. These metals have greater tendency to lose electrons than hydrogen. Therefore, the H⁺ ions in the acids will accept electrons and give hydrogen gas as :



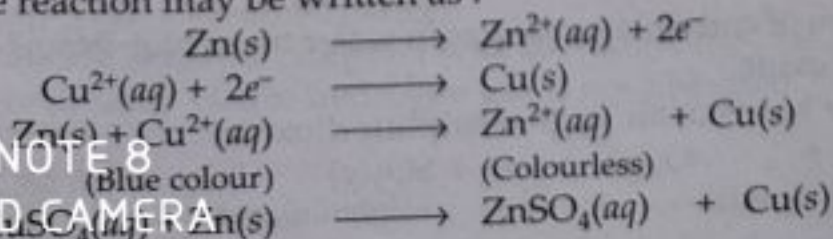
The metals which are below hydrogen in the reactivity series (*i.e.*, less reactive than hydrogen) like copper, silver, gold cannot liberate hydrogen from acids like HCl, H₂SO₄, etc. These metals have lesser tendency to lose electrons than hydrogen. Therefore, they cannot lose electrons to H⁺ ions.

Reactivity Series and Displacement Reactions

The reactivity series can also explain **displacement reactions**. In general, a more reactive metal (placed higher in the activity series) can displace the less reactive metal from its solution. For example, zinc displaces copper from its solution.



This displacement reaction occurs because zinc is more reactive than copper and can readily lose electrons. These electrons are accepted by copper ions and form copper metal, which gets deposited on the zinc strip. Since the Cu²⁺ ions which give blue colour to the solution are gradually replaced by Zn²⁺ ions, the blue colour of the solution fades. As a result, the solution becomes colourless. The reaction may be written as :



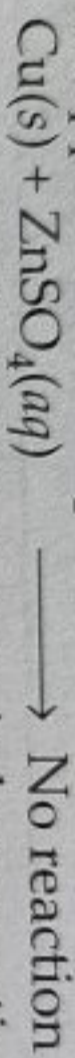
REMEMBER

- All metals which are placed above hydrogen in the activity series can lose electrons more readily than hydrogen. These are called *metals more reactive than hydrogen*.

For example, potassium, sodium, calcium, magnesium, aluminium, zinc, iron, tin, lead etc. are **more active** than hydrogen.

- On the other hand, all metals which are placed below hydrogen in the reactivity series lose electrons less readily than hydrogen and hence they are regarded as *metals less reactive than hydrogen*. For example, copper, mercury, silver and gold are **less active** metals.

However, copper cannot displace zinc from ZnSO_4 .



This is due to the fact that copper is less reactive than zinc. Therefore, copper cannot lose electrons in preference to zinc and the above reaction cannot occur.

USEFULNESS OF ACTIVITY SERIES

The activity series is very useful and it gives the following informations:

- (i) The metal which is higher in the activity series is more reactive than the other. **Potassium is most reactive and platinum is least reactive.**
- (ii) The metals which have been placed above hydrogen are more reactive than hydrogen and these can displace hydrogen from its compounds like water and acids to liberate hydrogen gas.
- (iii) The metals which are placed below hydrogen are less reactive than hydrogen and these cannot displace hydrogen from its compounds like water and acids.
- (iv) A more reactive metal (placed higher in the activity series) can displace the less reactive metal from its solution.
- (v) Metals at the top of the series are very reactive and, therefore, they do not occur free in nature. The metals at the bottom of the series are least reactive and, therefore, they normally occur free in nature. For example, gold, the last element of the series is found almost as free element.