EXPERIMENT-3

To study the interaction of metals with salt solutions of other metals and arrange them according to their reactivity. Metals and salts may be selected from the metals like Mg, Zn, Fe, Sn, Pb, Cu and Al, and their salts.

3.1 OBJECTIVES

After performing this experiment, you should be able to :

- *identify the change that is taking place during reaction (colour change, change in colour intensity, etc.);*
- *interpret the observations in terms of the chemical reactions taking place;*
- *write chemical equations of the reactions involved;*
- *differentiate between a less active metal from a more active metal;*
- *list the given metals in the order of their increasing activity ; and*
- *predict the probable changes on reacting a known metal with a known salt solution.*

3.2 WHAT YOU SHOULD KNOW

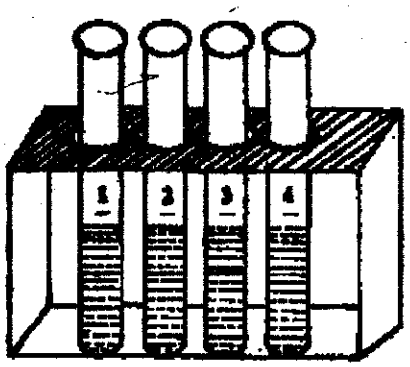
Compounds are ionic or covalent in nature. Salts are ionic compounds which dissolve in water to give cations (positively charged ions) and anions (negatively charged ions). When a metal piece is dipped in an aqueous solution of salt of another metal, the cation of the salt may be replaced by cation of the metal which is dipped in it if it is more active. The displaced cation would change to metal atom and deposit on the dipped metal.

3.3 MATERIALS REQUIRED

(1) Apparatus	(2) Chemicals
Test tube stand, Test tubes, Burner, Beaker, Tripod stand, Wire gauze, Glass rod	Mg, Zn, Fe, Sn, Pb, and Cu metals and their water soluble salts. $MgCl_2$, $Mg(NO_3)_2$, $Zn(NO_3)_2$, $ZnCl_2$, $Pb(NO_3)_2$, $CuSo_4$, $Cu(NO_3)_2$

3.4 How to perform the Experiment ?

Take four test tubes and mark them (1), (2), (3) and (4). Fill them half with 10% solution of a magnesium salt. Place them in the test tube stand as shown in Fig. 3.1.



Add a small piece of magnesium ribbon to the first test tube, a small quantity of zinc granules to the second, iron filings to the third and copper filings to the fourth test tube. Observe the test tube carefully and record the observation in Table 3.1.

Fig. 3 .1 : *Study of activity of different metals*

Repeat the same experiment using the solutions of salts of Cu, Fe (ferrous) and Zn respectively with the four metals as done earlier. In each case, observe carefully and record your observations in Table 3.1.

Mark tick (✓) for the reaction taking place between the metal and the salt solution and cross (×) for the reaction not taking place by observing change in any property of solution.

3.5 PRECAUTIONS

1. The pieces of the metals should be clean.
2. Do not use very active metals like sodium, potassium, lithium or calcium.
3. Aluminium may be avoided as it forms a protective layer which makes the metal passive, whereas the metal is not passive.

3.6 OBSERVATIONS

Record your observations in the following table :

Table 3.1

Solid Metal	Metal ions in solution				Remarks if any
	Mg^{2+}	Cu^{2+}	Fe^{2+}	Zn^{2+}	
Mg	—				
Cu		—			
Fe			—		
Zn				—	

3.7 CONCLUSION

If the reaction takes place, it indicates that the metal added is more active than the metal in solution. We show it by marking (✓) sign. If the reaction does not take place, we conclude that the metal added is less reactive than the metal in solution. We show this by marking (×) in the table.

A metal having maximum no. of (✓) marks is the most active. Number of (✓) marks shows the extent of activity.

Thus a list of metals in order of their decreasing activity may be prepared.

The order of activity of the metals is .....> .....> .....>.....

3.8 CHECK YOUR UNDERSTANDING

1. *State a necessary condition for the reaction of a metal with the solution of salt of another metal.*

   .....

2. *State the hazard involved in using a very reactive metal like potassium in a displacement reaction.*

   .....

3. *List the probable observations from which you conclude that the reaction has taken place.*

   .....

4. *Write the chemical equations for the reactions taking place when magnesium ribbon is dipped in (i) zinc nitrate solution (ii) copper nitrate solution and (iii) iron (II) sulphate solution.*

   1. .....

   2. .....

   3. .....

3.9 NOTE FOR THE TEACHERS

As far as possible the four metals and their salts should be carefully selected to show a difference of activity. Metals having very close activity should not be given. Highly active metals such as sodium should not be used in this experiment. Although the procedure mentions Cu, Fe, Zn and Mg metals, you may select any four out of the given list and suitably modify the procedure and observation table.

Students should be helped to draw conclusions on the basis of the recorded data. Projects can be assigned to students to record observations of such reactivities in daily life. The importance of such reactions in daily life should be highlighted.

3.10 CHECK YOUR ANSWERS

Ans. 1. The dipped metal should be more reactive of the two.

Ans. 2. Very active metals, such as sodium and potassium, react with water vigorously and may even catch fire with an explosion.

Ans. 3. (a) Development of colour

(b) Disappearance of colour

(c) Change in colour intensity

Ans.4. $Mg\,(s) + Zn\,(NO_3)_2\,(aq) \longrightarrow Mg\,(NO_3)_2\,(aq) + Zn\,(s)$

$Mg\,(s) + Cu\,(NO_3)_2\,(aq) \longrightarrow Mg\,(NO_3)_2\,(aq) + Cu\,(s)$

$Mg\,(s) + Fe\,SO_4\,(aq) \longrightarrow Mg\,SO_4\,(aq) + Fe\,(s)$