

Activity 5

To study the reactivity of metals with acids

Take equal amounts of small pieces of magnesium, aluminium, zinc, iron and copper. Clean their surfaces by rubbing with a sand paper. Place these metals in separate test tubes. Add about 10 mL of dilute HCl to each tube and note the observations.

What do you observe?

The acid will react with metals to liberate hydrogen gas. The hydrogen gas will rise through the liquid and bubbles of H_2 gas will be seen. Observe carefully the rate of hydrogen bubbles coming out of the test tubes. Record the temperature of each test tube by suspending a thermometer in the test tubes.

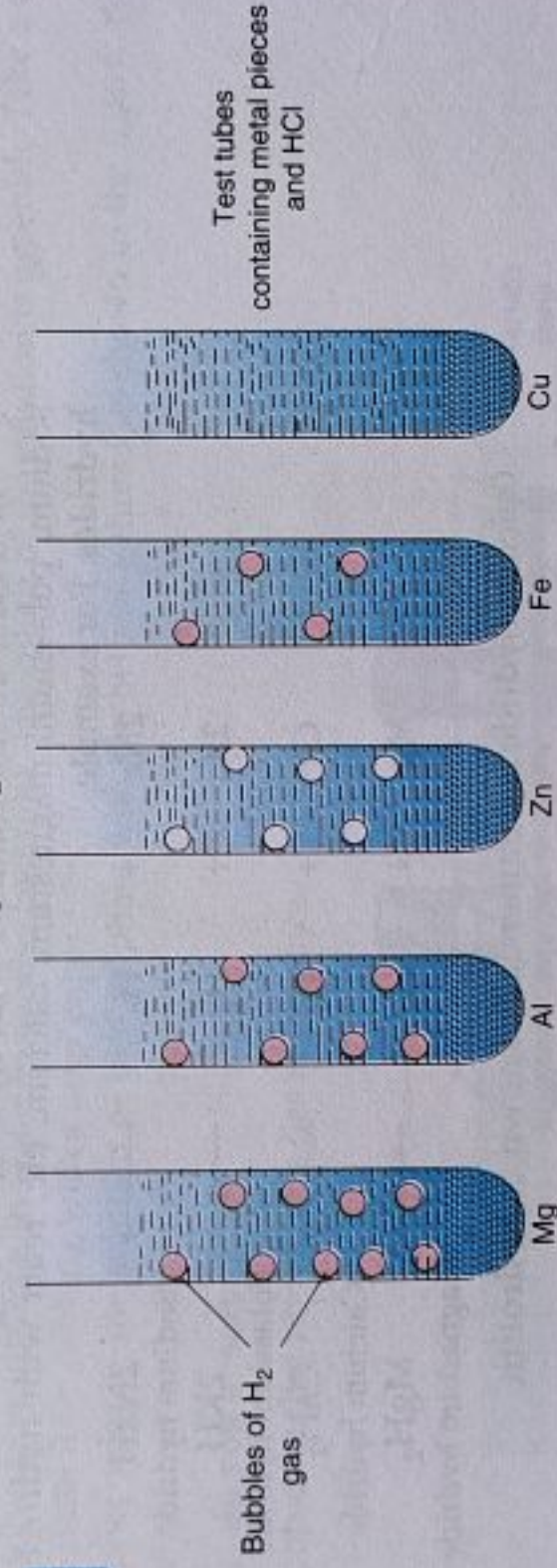
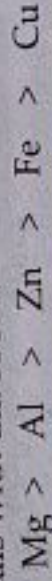


Fig. 4. Demonstration of reactivity of metals with dil. HCl.

It will be seen that the hydrogen bubbles will appear in test tube containing magnesium very rapidly and rate of evolution of H_2 bubbles will decrease successively in case of Al, Zn and Fe ($Al > Zn > Fe$). However, no bubbles will be seen coming out of the tube containing copper pieces.

This indicates that the reaction of magnesium with HCl is most rapid and it decreases from Al to Zn and then to Fe but Cu has no reaction.

Thus, order of reactivity of metals with dil. HCl is



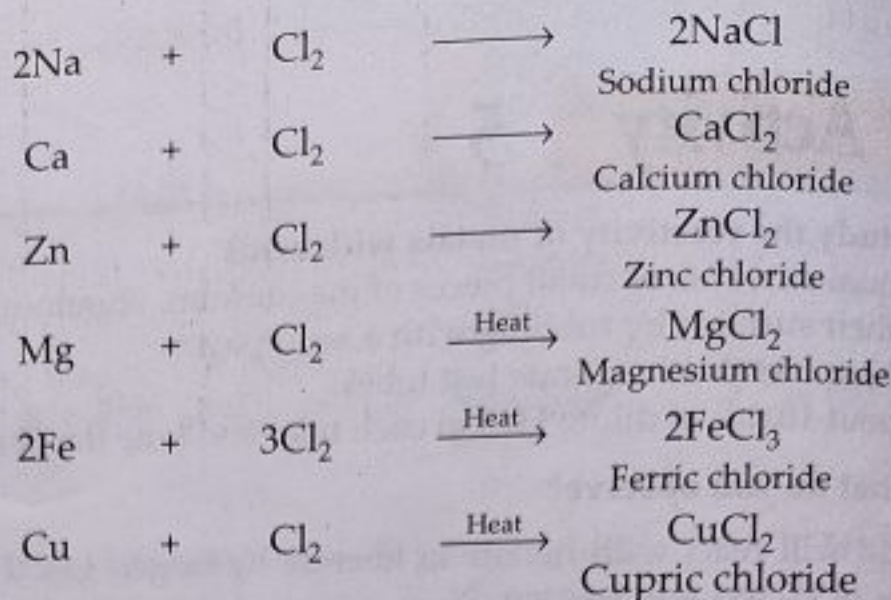
DO YOU KNOW?

Aqua regia

We know that noble metals such as platinum and gold do not dissolve in common acids. These are soluble in aqua regia. Aqua regia is a mixture of 3 parts of conc. hydrochloric acid (HCl) and one part of concentrated nitric acid (HNO_3). It can dissolve gold even though neither HCl nor HNO_3 can dissolve gold. Aqua regia (Latin word meaning *royal water*) is highly corrosive and fuming liquid. It is one of the best reagents to dissolve noble metals such as gold and platinum.

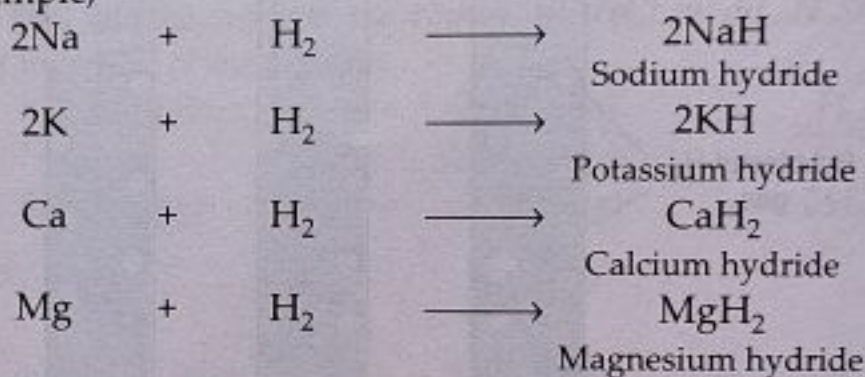
4. Reaction of metals with chlorine

Metals react with chlorine to form **metal chlorides**. They are solids having high melting and boiling points. They also conduct electricity in their molten state or when dissolved in water. The reactivity of metals with chlorine is also different. Sodium, magnesium, calcium, zinc, etc. react with chlorine readily while metals like iron, copper, etc. react with chlorine on heating.



5. Reaction of metals with hydrogen

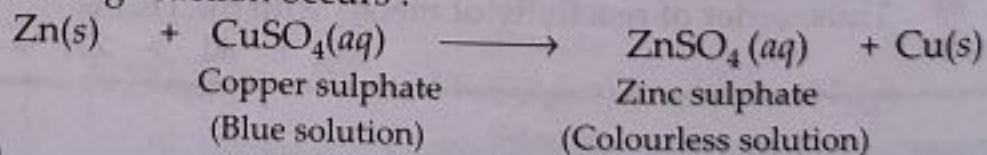
All metals do not combine with hydrogen. Only a few metals such as sodium, potassium, magnesium, calcium, etc. react with hydrogen to form hydrides. For example,



Calcium hydride is commercially known as **hydrolith**.

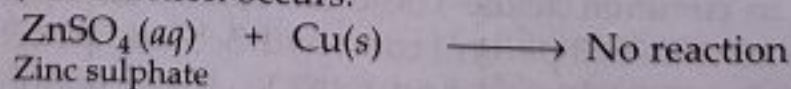
6. Reaction of metals with solutions of other metals

When a more reactive metal is placed in a salt solution of less reactive metal, then the more reactive metal displaces the less reactive metal from its salt solution. For example, take a solution of copper sulphate (blue coloured solution) and put a strip of zinc metal in the solution. It is observed that the blue colour of copper sulphate fades gradually and copper metal is deposited on the zinc strip. This means that the following reaction occurs :



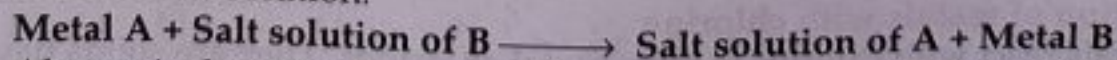
In other words, we can say that zinc displaces copper from its solution.

However, if we take zinc sulphate solution and put a strip of copper metal in this solution, no reaction occurs.



This means that copper cannot displace zinc metal from its solution. Thus, we can conclude that *zinc is more reactive than copper*. However, if we put gold or platinum strip in the copper sulphate solution, then copper is not displaced by gold or platinum. Thus, *gold and platinum are less reactive than copper*.

Thus, in general, if metal A is more reactive than metal B, then A displaces metal B from its solution.



Alternatively, we may say that if metal A displaces metal B from its solution, then metal A is more reactive than metal B.

The displacement reaction of a metal from its solution by another metal can be understood by performing simple experiment as described ahead :

Activity 6

To study that active metal can displace less active metal from its solution

Dissolve copper sulphate in water in a test tube. The colour of the copper sulphate solution is blue. Take an iron nail and clean it by rubbing with a sand paper. Its colour is greyish white. Place iron nail in the blue coloured copper sulphate solution with the help of a thread as shown in Fig. 5. Wait for sometime.

? What do you observe?

You will observe that some reaction has taken place in the test tube. The blue colour of copper sulphate solution has faded and became greenish. The green colour of the solution is due to the formation of ferrous sulphate. You will observe that a brownish coating is formed on the surface of the iron nail.

Now dissolve iron sulphate in water in another test tube. The colour of the solution is greenish. Take a copper wire and clean it by rubbing with a sand paper.

Place copper wire in the solution of iron sulphate with the help of a thread as shown in the figure. Wait for sometime.

? What do you observe?

You will observe that no reaction has taken place.

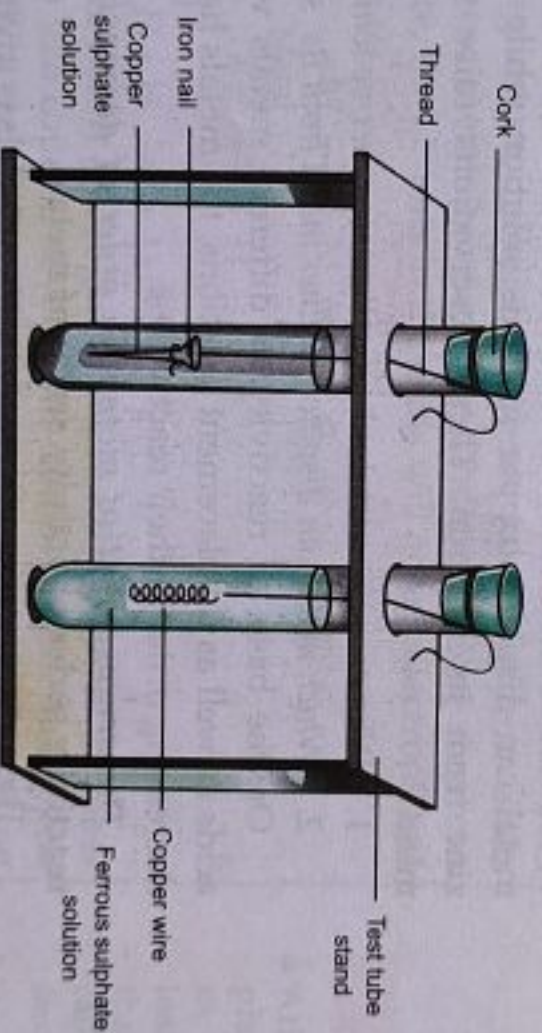
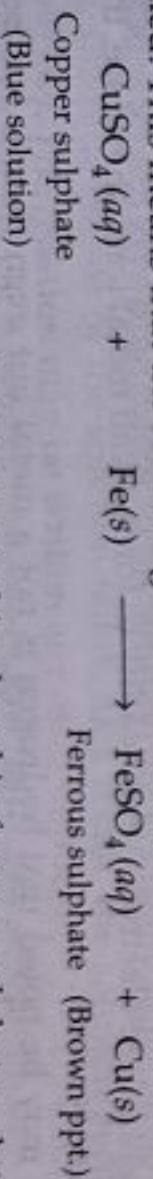


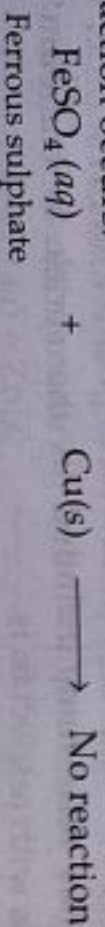
Fig. 5. Activity to study a displacement reaction.

- Thus, we can conclude from this activity that
 - iron can displace copper from its solution.
 - copper cannot displace iron from its solution.
- Therefore, iron is more reactive than copper.

Reaction of iron with copper sulphate solution. When a strip of iron metal or iron filings are placed in copper sulphate solution, then blue colour of copper sulphate fades gradually and red brown precipitate of copper is formed. This means that the following reaction occurs :



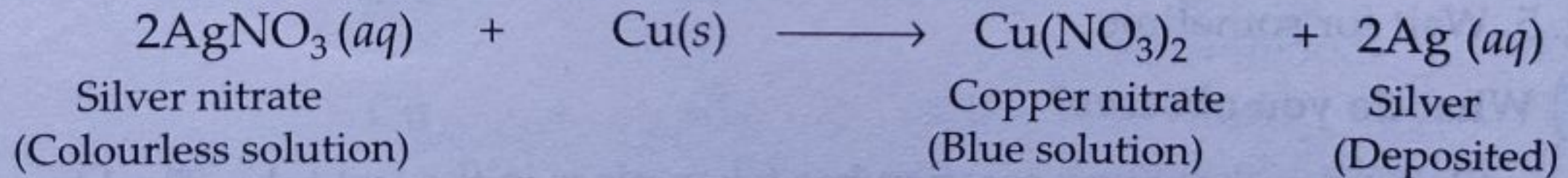
However, if a strip of copper metal is placed in ferrous sulphate solution, no reaction occurs.



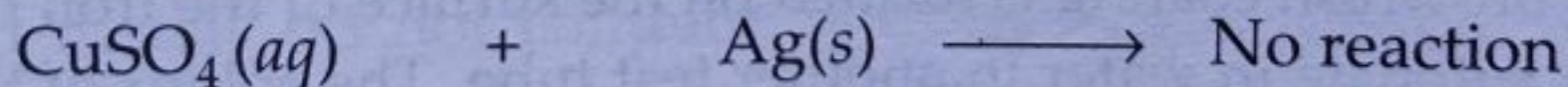
This means that *iron can displace copper from its solution but copper cannot displace iron from its solution*. In other words, ***iron is more reactive than copper***.

Let us consider one more displacement reaction :

Reaction of copper with silver nitrate solution. When a strip of copper metal is placed in a solution of silver nitrate, the solution becomes gradually blue and a shining coating of silver metal gets deposited on the copper strip. The reaction may be written as :



However, if we place silver wire in a copper sulphate solution no reaction occurs.



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***.