Topic 9 : Reactions of Acids

Revised April 1995

All acids contain Hydrogen and can produce H^+. Water, due to its ionisation, is therefore a very weak acid :

$$H_2O \rightleftharpoons H^+ + OH^-$$

Bases are compounds which accept H^+. Acids, therefore, react with bases.

There are three important bases :

Hydroxide ion	OH^-
Oxide ion	O^{2-}
Carbonate ion	CO_3^{2-}

Reaction of bases with Water

Bases which dissolve in Water form alkalis :

Example 1 :

$$(Na^+)_2O^{2-} + H_2O \rightarrow 2\ Na^+OH^-$$

Example 2 :

$$(Na^+)_2CO_3^{2-} + H_2O \rightarrow Na^+OH^- + Na^+HCO_3^-$$

Reaction of bases with Acids

In general the reactions are :

$$OH^- + H^+ \rightarrow H_2O$$

$$O^{2-} + 2\ H^+ \rightarrow H_2O$$

$$CO_3^{2-} + 2\ H^+ \rightarrow CO_2 + H_2O$$

Examples :

1. Hydroxide ion

Example 1 :

$$Na^+OH^- + H^+Cl^- \rightarrow Na^+Cl^- + H_2O$$

Sodium chloride

Example 2 :

$2\ K^+OH^-$ + $(H^+)_2SO_4^{2-}$ -> $(K^+)_2SO_4^{2-}$ + $2\ H_2O$

Potassium sulphate

Example 3 :

Na^+OH^- + $H^+NO_3^-$ -> $Na^+NO_3^-$ + H_2O

Sodium nitrate

2. Oxide ion

Example 4 :

$Cu^{2+}O^{2-}$ + $2\ H^+NO_3^-$ -> $Cu^{2+}(NO_3^-)_2$ + H_2O

Copper(II) nitrate

3. Carbonate ion

Example 5 :

$Mg^{2+}CO_3^{2-}$ + $2\ H^+Cl^-$ -> $Mg^{2+}(Cl^-)_2$ + CO_2 + H_2O

Magnesium chloride

Example 6 :

$Cu^{2+}CO_3^{2-}$ + $(H^+)_2SO_4^{2-}$ -> $Cu^{2+}SO_4^{2-}$ + CO_2 + H_2O

Copper(II) sulphate

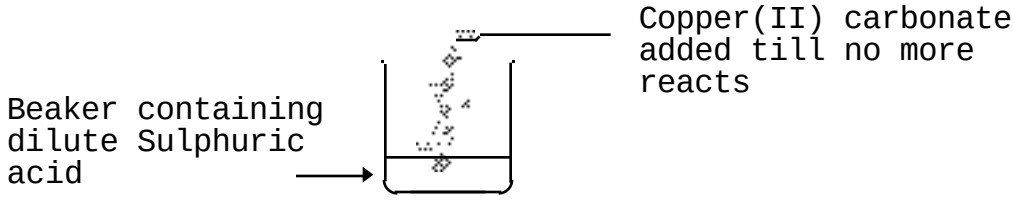
Example 7 :

$(Na^+)_2CO_3^{2-}$ + $2\ H^+NO_3^-$ -> $2\ Na^+NO_3^-$ + CO_2 + H_2O

Sodium nitrate

Acid rain attacks rocks containing limestone and buildings made from marble, both impure forms of Calcium carbonate.

Experiment : To prepare Copper(II) sulphate by the reaction in example 6.



When the reaction is over (no more bubbles of Carbon dioxide) the excess Copper(II) carbonate can be filtered off since it is **not** soluble in Water. The Copper(II) sulphate is obtained by evaporation of the filtrate.

A similar procedure could not be used if the carbonate was soluble in Water. In example 7, Sodium carbonate is soluble in Water and the excess would dissolve contaminating the Sodium nitrate solution.

Reactions of acids with metals

Example 8 :

$Mg + 2\ H^+Cl^- \rightarrow Mg^{2+}(Cl^-)_2 + H_2$

Magnesium chloride — Hydrogen gas

The metal loses electrons : $Mg \rightarrow Mg^{2+} + 2e$

The H+ ions gain them : $2\ H^+ + 2e \rightarrow H_2$

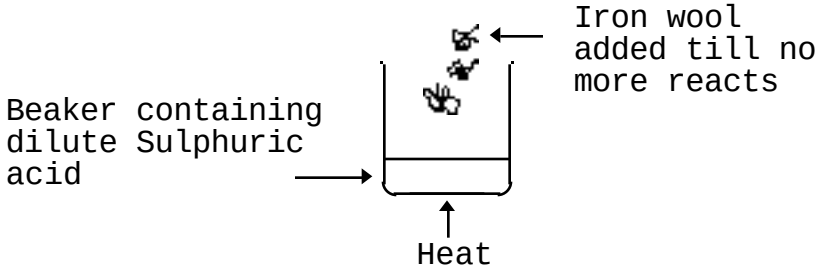
Example 9 :

$Fe + (H^+)_2SO_4^{2-} \rightarrow Fe^{2+}SO_4^{2-} + H_2$

Iron(II) sulphate — Hydrogen gas

Structures made from Iron are rapidly attacked by acid rain.

Experiment : To prepare Iron(II) sulphate by the reaction in example 9.



The Hydrogen burns with a 'POP'. This is the test for Hydrogen. When the reaction is over (no more bubbles of Hydrogen) the excess Iron can be filtered off and the Iron(II) sulphate obtained by evaporation of the filtrate.

Neutralisation (making the pH = 7)

In each of the examples (1-9) the acid is neutralised : H^+ ions are removed, reducing their concentration and moving the pH towards 7.

The compound formed as a result of replacing the H^+ ion of an acid by another positive ion is called a **Salt**. In examples 1-9 the salts are named : Sodium chloride, Potassium sulphate etc.

Everyday examples of neutralisation

1. Calcium hydroxide (lime) is added to soils to reduce acidity.
2. Lime is also added to lochs to reduce acidity caused by acid rain.
3. Acid in the stomach causes indigestion and can be neutralised by drinking Magnesium hydroxide solution (Milk of Magnesia).

Preparation of INSOLUBLE salts

Insoluble salts **cannot** be prepared by the methods of neutralisation described above : the salt would coat reactant surfaces and prevent attack by the acid.

Insoluble salts are prepared by **PRECIPITATION**. Two solutions are mixed to give an insoluble product called a **precipitate**.

Example : preparation of Lead(II) chromate $Pb^{2+}CrO_4^{2-}$

$Pb^{2+}(NO_3^-)_2$	+	$(Na+)_2CrO_4^{2-}$	->	$Pb^{2+}CrO_4^{2-}$	+	$2Na^+NO_3^-$
Lead(II) nitrate		Sodium chromate		Lead(II) chromate		Sodium nitrate
Sol.		Sol.		Insoluble precipitate		Sol.

Lead(II) chromate forms an insoluble, yellow precipitate which can be filtered off.

In preparing salts, then, we must first decide if the salt is soluble or insoluble. If soluble, we can choose one of the neutralisation reactions (Examples 1-9) ; if insoluble, we must use a precipitation reaction.