

7 Acid, bases and salts

7.1

Acids and bases

LEARNING OUTCOMES

At the end of this topic you should be able to:

- define acid, acid anhydride, alkali, base and salt
- explain acids and bases in terms of replaceable hydrogen and proton transfer.



Figure 7.1.1 All these household products contain acids.

EXAM TIP

The sign $\longrightarrow$ is used when the reaction goes to completion. For strong acids and bases, the reaction always goes to completion. The sign $\rightleftharpoons$ is used when the reaction does not go to completion and both reactants and products are present (see 7.2). This applies to weak acids and bases.

What are acids and bases?

Acids usually have a sour taste, change blue litmus to red, and are corrosive. The commonest inorganic acids are hydrochloric acid, HCl(aq) , sulfuric acid, $\text{H}_2\text{SO}_4\text{(aq)}$ and nitric acid, $\text{HNO}_3\text{(aq)}$. A simple definition of an acid is that it is a substance that neutralises a **base** to form a salt and water. For example:



Acids have one or more **replaceable hydrogen** atoms. The hydrogen is replaced by a metal or ammonium ion, NH_4^+ . In the reaction above, the hydrogen in the acid is replaced by the calcium ion.

- Monobasic acids have one replaceable hydrogen atom, e.g. HCl .
- Dibasic acids have two replaceable hydrogen atoms, e.g. sulfuric acid:



- Tribasic acids, e.g. H_3PO_4 , have three replaceable hydrogen atoms.

A **base** is a substance that neutralises an acid to form a salt and water. Bases are often oxides and hydroxides of metals.

A base that is soluble in water is called an **alkali**. The hydroxides of the Group I metals, e.g. NaOH , and aqueous ammonia, $\text{NH}_3\text{(aq)}$, are alkalis.

Salts

A **salt** is a compound formed when the hydrogen in an acid is replaced by a metal or ammonium ion.

- Chloride salts are formed from hydrochloric acid. For example, calcium chloride:



- Sulfates are formed from sulfuric acid. For example, sodium sulfate:



- Nitrates are formed from nitric acid. For example, potassium nitrate:



Proton transfer in acids and bases

When an acid dissolves in water, it ionises (splits up into ions). Hydrogen ions are formed. The equation below shows hydrogen chloride gas ionising in water (aq).



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