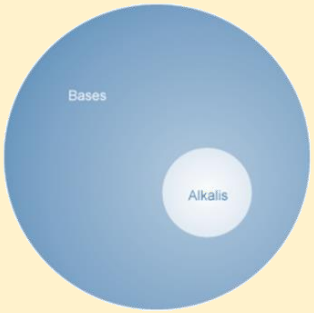
ACIDS, BASES AND SALTS

What are acids, bases and alkalis?

Acids = Substances which donate protons/ H^+ ions
Bases are substances that will react with acids by accepting a proton (H^+) ion to produce (a salt and) water.
An alkali is a base that dissolves in water to produce hydroxide ions, $OH^-_{(aq)}$.



Many bases are insoluble but not all. Bases that dissolve in water are called alkalis. All alkalis are bases but not all bases are alkalis. *Common bases: metal oxides, metal hydroxides, metal carbonates or metal hydrogen carbonates.*

Some alkalis such as NaOH or KOH, already contain hydroxide ions:
e.g. $NaOH_{(aq)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

Others, such as sodium carbonate, Na_2CO_3 and ammonia, NH_3, form hydroxide ions when they react with water.

e.g $CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$
$NH_{3(l)} + H_2O_{l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$

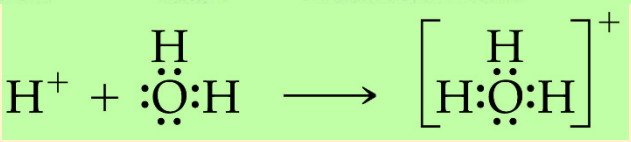
Some bases are harder to see immediately:
Take ammonia……

$$HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$$

Ammonium chloride is a white salt. Suspended white particles/a white cloud will be seen. HCl donates a proton (acid) and ammonia accepts a proton (base).

The theory of H^+ transfer is known as the Bronsted-Lowry theory of acids and bases. In every solution of acid, the oxonium ion is present. The oxonium ion is responsible for acidic properties of solutions. The acid donates a H^+ ion to water to from it….

$$HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$
acid base oxonium ion



The enthalpy change of neutralisation involving acid's and alkalis will always be the same, no matter which acid and alkali react.
This is because the enthalpy change of neutralisation is defined per mole of H_2O formed:
"The enthalpy change when one mole of hydrogen ions reacts with one mole of hydroxide ions under standard conditions and in solutions containing 1 moldm^{-3}"

Ionic equation representing acid solution formations:

$$H^+(aq) + OH^- \rightarrow H_2O \qquad \Delta H^\ominus = -58\,kJ\,mol^{-1}$$

General procedures to make salts

1. Acid + Base → Salt + Water *(acid-base or neutralisation)*
2. Acid + Alkali → Salt + water *(neutralisation)*
3. Acid + Metal carbonate → Carbon dioxide + Salt + Water *(neutralisation)*
4. Acid + Metal → Salt + Hydrogen *(neutralisation)*
5. *Soluble salt 1 + soluble salt 2 → Insoluble salt + soluble salt* *(double displacement or precipitation)*

Note: Water will also dissociate into H^+ and OH^- ions. This could also be represented in terms of the oxonium ion

H_2O <----> $H^+ + OH^-$ **OR** **$2H_2O$ <----> $H_3O^+ + OH^-$**

Water is a very weak acid/base. It will not neutralise either acids or bases. Adding water will simply dilute the acid/base.

If diluting sulfuric acid, water should be added to the acid, not the counter, since it can boil and spit (exothermic), causing burn to the skin.

Water is less dense than sulfuric acid; pouring water onto the acid results in the reaction occurring on top of the liquid. If you add the acid to the water, it flows down into the flask and mixes much better reducing likely hood of spitting.

$$H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^-$$

Some common acids

HCl Hydrochloric acid

$HC_2H_3O_2$ Ethanoic acid

H_2SO_4 Sulfuric (VI) acid

$H_3C_6H_5O_7$ Citric acid

HNO_3 Nitric (V) acid

H_3PO_4 Phosphoric (V) acid

H_2CO_3 Carbonic acid

H_2SO_3
Sulfurous acid OR
Sulfuric (IV) acid

HClO
Hypochlorous acid OR
Chloric (I) acid