STRONG AND WEAK ALKALIS

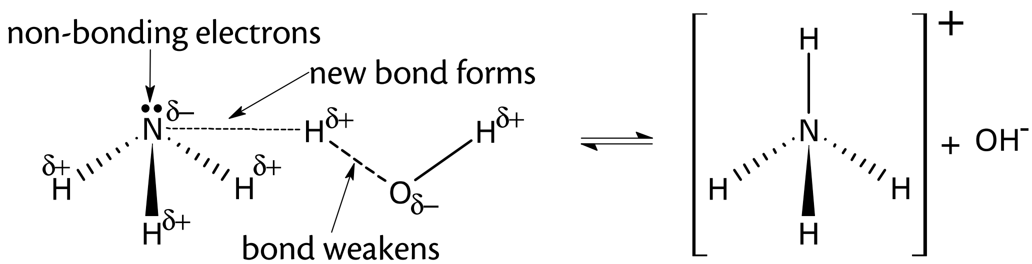
A strong alkali like NaOH or KOH is fully dissociated into ions in aqueous solution.

$$NaOH_{(s)} \longrightarrow Na^{+}_{(aq)} + OH^{-}_{(aq)}$$

Ammonia gas is very soluble in water. The solution is a weak alkali because it is not fully dissociated into its ions in aqueous solution.

$$NH_{3(g)} + H_2O_{(l)} \longrightarrow NH_4OH_{(aq)} \rightleftharpoons NH_4^{+}{}_{(aq)} + OH^{-}_{(aq)}$$

The equation below shows why an ammonia solution is alkaline – the lone pair of electrons on the nitrogen attract the δ+ hydrogen on the water molecules.



ammonia

ammonium ion

Comparison of Strong and Weak Alkalis

The table below shows the results of comparing 0.1 mol l^{-1} sodium hydroxide and 0.1 mol l^{-1} ammonia solutions

	Sodium hydroxide	Ammonia
pH	13	11–12
Conductivity	High	Low

Strong and weak alkalis cannot be distinguished by comparing the amount of acid they neutralise. (This is exactly the same as we observed earlier with strong and weak acids.)

A weak base like ammonia is only slightly ionised so initially the $[OH^-]$ is low.

$$NH_4OH_{(aq)} \rightleftharpoons NH_4^{+}{}_{(aq)} + \underset{\text{removed by } H^{+}_{(aq)} \text{ to form water}}{\underbrace{OH^{-}_{(aq)}}}$$

As acid is added, the H^+ ions join with OH^- ions to form water. The equilibrium shifts to the right producing more OH^- ions which are in turn neutralised. Eventually all the ammonia solution dissociates and so neutralises the same amount of acid as a strong alkali.

Confusion of Strength and Concentration

Don't confuse strong and weak with concentrated and dilute.

Strong	Weak
fully dissociated in aqueous solution	not fully dissociated in aqueous solution

Concentrated	Dilute
a lot of solute in a little water eg 2 mol l^{-1}	a little solute in a lot of water eg 0.1 mol l^{-1}

Hydrolysis of Salts

When salts dissolve in water they become fully ionised. Sometimes these ions can disturb the water equilibrium giving an acidic or alkaline solution.

$$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

When there is an interaction between the water equilibrium and the ions from the salt we say that salt hydrolysis has taken place. Let's look at some examples.

Ammonium chloride solution

We have $$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons NH_4OH$$

and $$NH_4Cl_{(s)} \longrightarrow NH_4{}^+_{(aq)} + Cl^-_{(aq)}$$

The H^+ and Cl^- ions have no tendency to join because HCl is a strong acid and so is fully ionised. However NH$^{4+}_{(aq)}$ and $OH^-_{(aq)}$ are the ions of a weak base – they cannot remain totally free of each other. Some must associate to form NH_4OH molecules. This removes OH^- from the water equilibrium which shifts to the right to replace them; this results in an excess of H^+ ions. The solution is therefore acidic, with a pH less than 7.

Sodium ethanoate solution

We have $$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

and $$CH_3COONa_{(aq)} \longrightarrow CH_3COO^-_{(aq)} + Na^+_{(aq)}$$

$$CH_3COO^-_{(aq)} \rightleftharpoons CH_3COOH$$

The Na^+ and OH^- ions have no tendency to associate as NaOH is a strong alkali. However CH_3COO^- and H^+ are the ions of a weak acid and so cannot remain totally dissociated. Some must join to give CH_3COOH molecules. This of course removes H^+ ions from the water equilibrium which shifts to the right to replace those removed. This results in an excess of OH^- ions giving an alkaline solution, with pH greater than 7.

Potassium nitrate solution

We have $$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

and $$KNO_{3(s)} \longrightarrow K^+_{(aq)} + NO_3^-{}_{(aq)}$$

The H^+ and NO_3^- are the ions of a strong acid and the K^+ and OH^- are the ions of a strong alkali. Therefore none of the ions has any tendency to associate so the water equilibrium is not disturbed and the solution is neutral, with a pH of 7.

Soaps

Soaps, as we saw in Unit 2, are salts of long chain fatty acids

eg sodium stearate $C_{17}H_{35}COO^-Na^+$

Like sodium ethanoate, they are salts of a carboxylic acid. So they are salts of a weak acid and a strong alkali. As a result, their solutions in water will be alkaline.

To summarise

a. The salt of a weak acid and strong alkali gives an alkaline solution
   eg CH_3COONa, Na_2CO_3, Na_2SO_3, sodium stearate

b. The salt of a strong acid and a weak alkali gives an acidic solution.
   eg NH_4Cl, $FeCl_3$

c. The salt of a strong acid and a strong alkali gives a neutral solution
   eg $NaCl$, KNO_3, Na_2SO_4, $MgCl_2$, $CaCl_2$

Equilibrium in saturated solutions

A saturated solution in contact with undissolved solute is an example of a system in equilibrium

$$NaCl_{(s)} \longrightarrow Na^+_{(aq)} + Cl^-_{(aq)}$$

No further overall change occurs once saturation is reached. However solute continues to dissolve at a rate just balanced by the rate at which solid crystallises from the solution.

Source : http://ciseche10.files.wordpress.com/2013/12/4-chemical-equilibria.pdf