pH, Acidity and Basicity

The word **acid** comes from the Latin 'acidus' which means sour and **alkali** from the Arabic word 'al qaly' which means **calcined ashes** which are ashes from burnt plant material. The ashes were seen to reverse the effects of acids and also made salts when combined with acids, so alkalis were seen as the opposite of acids. However, it was also noticed that some substances which were not alkalis (**insoluble** substances) also acted like alkalis by reversing acids and making salts. Guillaume François Rouelle (a French chemist) was the first person to use the term 'base' (to encompass all substances that acted upon acids to neutralise them). He saw that substances that combined with acids formed a 'base' for the salt to be made. He used the word in terms of its English meaning which is 'the bottom support of anything; that on which a thing stands or rests: a metal base for the table'.

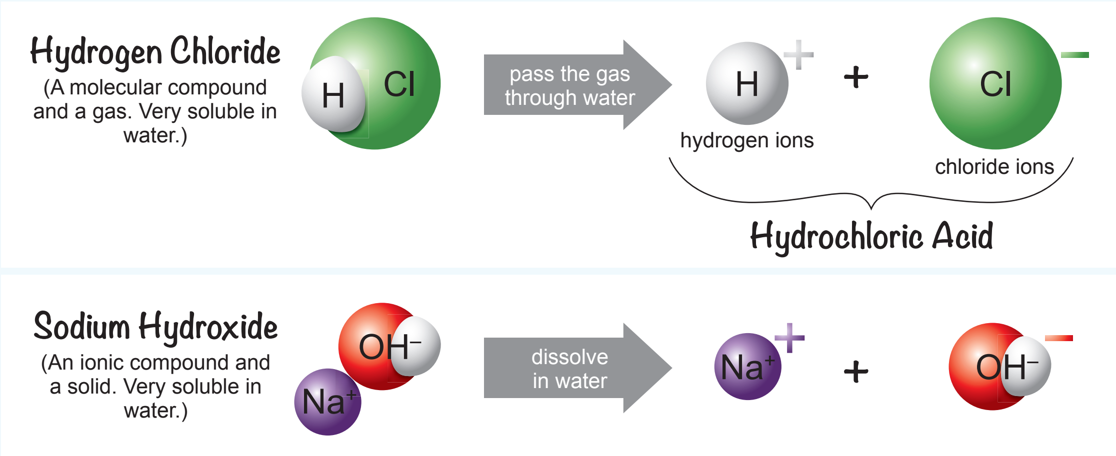

Figure 1: Dissociation of Acids and Bases

When acids and alkalis are put into water, the compounds break down and release hydrogen ions or hydroxide ions, depending on whether they are an acid or alkali. This breaking apart is called **dissociation** because the components of the compound separate and are no longer associated with each other.

Acids and bases/alkalis can vary in their strengths due to the number of H^+ or OH^- ions they dissociate into when they are dissolved in water. This is simply illustrated in the diagram below for acids and bases of the same concentration.

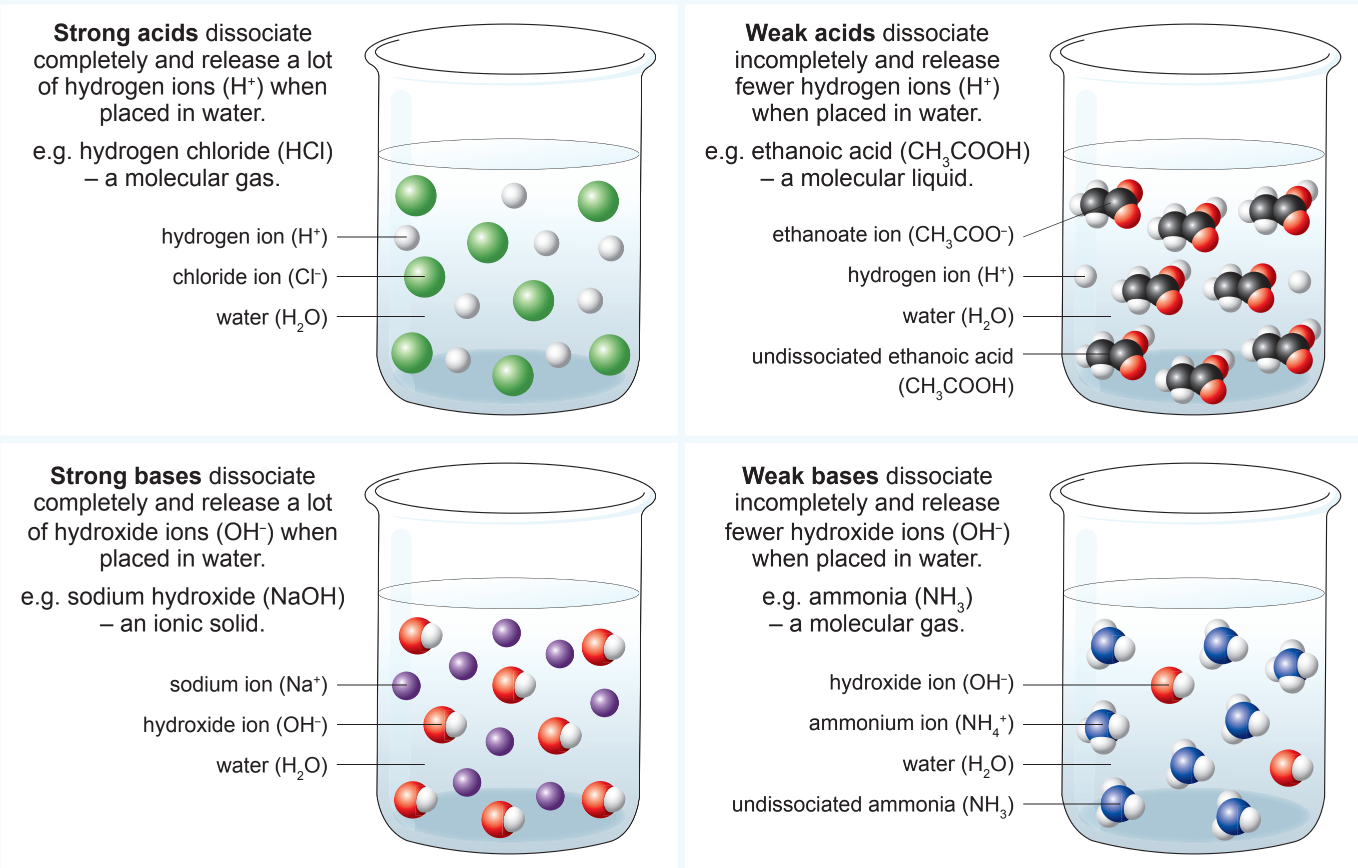

Figure 2: Strong and Weak Acids and Bases

If the acid/alkali doesn't dissociate (separate) fully when placed in water, then it produces fewer ions in solution . So for example, hydrogen chloride dissociates very easily and so is a relatively strong acid producing many hydrogen ions. Ethanoic acid (present in vinegar) doesn't produce many H^+ ions compared to hydrochloric acid.

The differing strengths of acids and bases are measured by the pH scale.

The term **pH** was first described by a Danish biochemist called Søren Peter Lauritz Sørenson in 1909. It was while he was studying the effect of ions on proteins that he realised the importance of hydrogen ions and so created the pH scale. While it is commonly disputed what it stands for, this author believes it is an abbreviation for the power of hydrogen with the p being power and the H for Hydrogen. The reason the H is a capital letter is because the element symbol for hydrogen is capital H.

pH is essentially a measure of the number of hydrogen ions (H^+) in a solution. Because of the mathematics involved in working out pH, the lower the pH number, the more H^+ ions so the more acidic the solution. The higher the pH number, the less H^+ ions so the more alkaline or basic the solution is. The scale usually goes from 0 to 14 and most substances that we encounter fall within this range. However, it is thought that the pH can go below 0 (even as low as -5) and above 14. It is calculated that each number below 7 on the scale is ten times more acidic than the value above it. For example, a pH of 3 is ten times more acidic than a pH of 4 and the difference between 2 and 4 is that pH 2 is 100 times greater. Whereas each pH number above 7 is ten times more alkaline than the one before it, so a pH of 12 is ten times less acidic than a pH of 11. If the pH is 7, then it is classed as **neutral** because the H^+ and OH^- ions are in equal concentrations. The pH scale can be written with colours that correspond to the indicators that are used to show what pH a substance is when tested.

The diagram below illustrates the colours, the pH numbers and the strengths of the acid or base. The wider ends of the bow tie symbolise the stronger acid or base and the narrower end nearer neutral symbolises the weaker acids and bases.

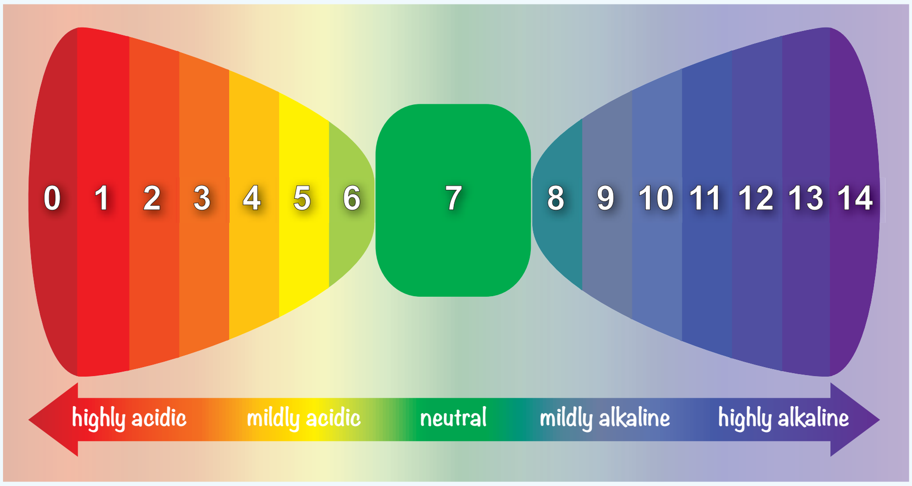

Figure 3: pH Scale Bow Tie (Universal indicator colours)

Water we get from rivers, streams and the oceans is mildly acidic because carbon dioxide from the air is absorbed and dissolved into it forming carbonic acid (H_2CO_3) which is what is found in fizzy drinks. As well as fizzy drinks and water, many other substances are either acidic or basic and the diagram below gives a few examples of things you probably encounter on a daily basis.

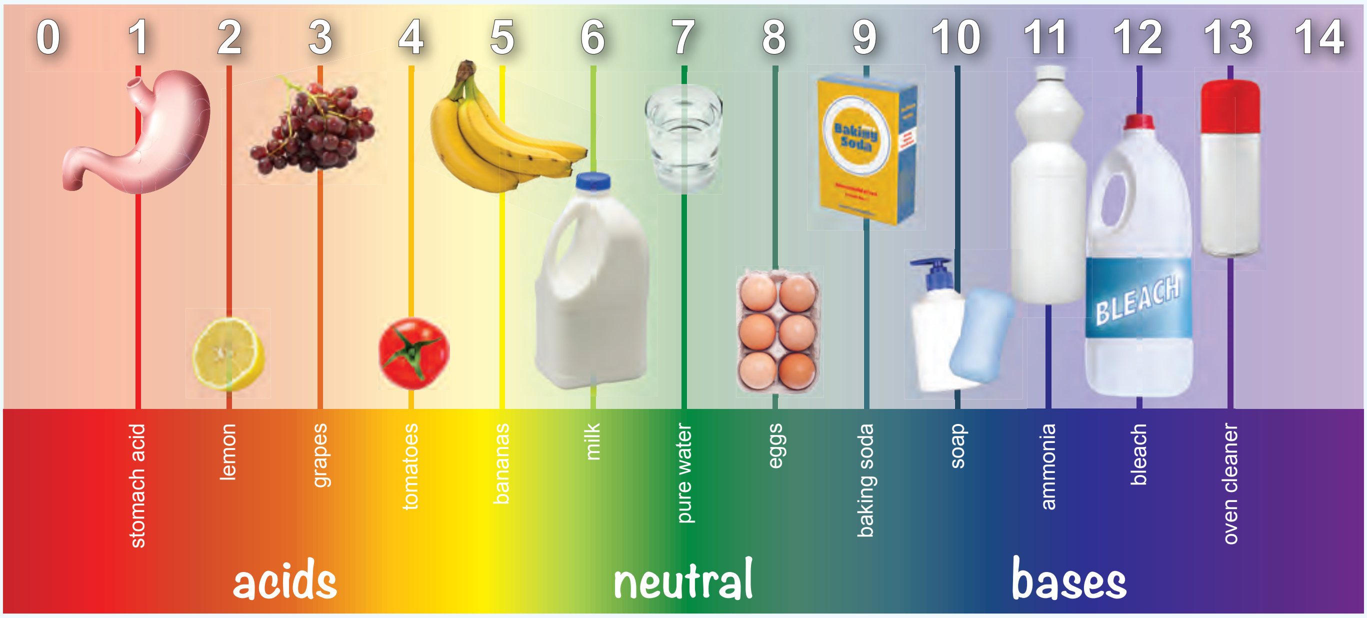

Figure 4: pH of Common Substances