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Acids and Bases

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History of Chemistry

In modern chemistry, we have a sound understanding of acids and bases (also called alkalis). Acids and bases pervade our lives, from the laboratory to the kitchen, and these crucial substances are used as laboratory reagents, industrial catalysts, food additives, and in cleaning products. However, over the course of the history of chemistry, it took centuries to understand these substances fully.

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Ancient Science - Vinegar and Soap

During the time of the Ancient Greeks, the properties of acids and bases were only vaguely understood. During their attempts to categorize substances and try to bring balance, harmony, and perfection to the universe, they used a variety of tests to distinguish compounds. One of these was taste, and they divided substances according to whether they were sour, bitter, salty or sweet. As the Greek influence waned and their knowledge passed on to the Romans, they began to refer to sour substances, such as vinegar or lemon juice, as acids. The words 'acid' and 'acetic,' are both derived from the Latin word for 'sour-tasting,' *acere*. Bases, by contrast, were not as well studied, although they were recognized as substances that would neutralize acids, something that fitted well with the desire of the ancients to find balance and harmony in everything. The easiest way for the ancients to create bases was to take ashes

from a fire, a process well known to the Greeks, who mixed ashes with animal fat to make soap. Many Greeks still use a similar process, using ashes and olive oil to make fine homemade soap. Bases are also referred to as alkalis, a word derived from the Arabic word for 'roasting', although why they later became called bases is unclear. Both words are perfectly acceptable and are often interchanged.

Acids and Bases - The Playthings of Alchemists

As science moved on through the Islamic Golden Age and the Renaissance, alchemists started to understand more about acids, discovering that stronger solutions could speed up the corrosion of metal and dissolve certain rocks. Medieval and Islamic alchemists had a range of acids and alkalis to choose from:

- Soda (sodium carbonate)
- Potash (Potassium carbonate)
- Ammonia
- Hydrochloric acid
- Sulfuric acid
- Acetic acid
- Citric acid
- Sulfuric acid
- Aqua regia, a mixture of nitric and hydrochloric acid that could even dissolve gold

In about 1300, a Spanish scholar, Arnaldus de Villa Nova, began to use litmus for studying acids and bases. This compound, extracted from a lichen, had been used as a dye since at least the time of the Vikings, but he was the first known scholar to use it as a test of acidity. This idea was expanded by Robert Boyle (25 January 1627 - 31 December 1691), who found that certain plant derived substances changed color in the presence of acids or bases. One example was syrup of violets, which is blue in a pH neutral environment but turns green when exposed to bases, and red when mixed with acid. These testing compounds opened up a realm of possibility, and chemists could work out which proportion of acids and bases would neutralize each other, allowing them to compare crudely the relative strengths of these substances. During most of the 18^{th} century, when the thermodynamic Theory of Phlogiston held sway, the idea that heat was a separate element contained within combustible materials. Georg Ernst Stahl (October 22, 1659 - May 24, 1734) proposed that acids were all derived from sulphur and that the strength was dictated by the amount of phlogiston; this view would be shattered by the end of the century.

The Enlightenment - Classifying Acids and Alkalis

It was not until the time of Antoine Lavoisier (26 August 1743 - 8 May 1794), a brilliant French chemist who attempted to classify elements and understand the nature of heat, that a more systematic study of acids and bases took place. At this time, chemists began to define bases as substances that could neutralize acids to form water and a salt. In 1776, influenced by studies into the properties of gases, Lavoisier tried to isolate the compound in acids responsible for their unique properties. Incorrectly, he proposed that a substance called oxygen was responsible, but his observations led to further studies. The British scientist, Humphrey Davy (1778-1829), better known for his studies into gases, tested the theories of

Lavoisier and discovered that oxygen was not the element responsible for the properties of acids. Many acids did not contain oxygen, so he proposed that something else must be responsible. During the Age of Enlightenment, scholars from many different countries contributed to the explosion in scientific endeavor, and the study of acids was no different. In Germany, Justus Frieherr von Liebig (1803-1873), another innovative chemist, instead isolated hydrogen as the element responsible, reasoning that it was the only element common to all acids. The Swedish chemist, Svante Arrhenius (1859-1927), was the next chemist to study acids and bases, proposing that acids and bases gained their properties because of the action of ions in the solution. Despite being shunted aside by his peers as a crank, he was awarded the Nobel Prize in 1903, in a perfect example of how fringe scientists can play a huge role in paradigm shifts. One of the buildings at Stockholm University is named after this great chemist, a fitting tribute. Arrhenius stated that acids are simply substances that add hydrogen cations, H^+ to water. For example, Hydrochloric acid, HCl, adds H^+ and Cl^- ions to water. Conversely, alkalis add hydroxyl ions, OH^-. For example, sodium hydroxide, adds Na^+ and OH^- to the water. The reason that acids and bases cancel each other out is because the H^+ and OH^- ions react to form water, leaving salts behind: HCl + NaOH ? NaCl (Table Salt) + $H_2$0 This definition was fairly sound and research into these substances continued.

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Acids and Bases Lecture

Acids and Bases Lesson 1

Properties of Acids

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