# Ideas about acids

Much of what we eat and drink is acidic; think orange juice or cola. Many foods naturally turn sour when they go off; think milk, or wine turning into vinegar. Alchemists were able to make strong acids for their experiments, but it was during the Enlightenment that scientists started to think about what acids are actually made of.

In 1774, Antoine Lavoisier first made oxygen. When he burnt elements in jars of oxygen and held litmus above the jar, the litmus turned red. He concluded that all acids contain oxygen. He first used the word ‘oxygen’, which comes from the Greek meaning ‘acid maker’. The English chemist Joseph Priestley discovered oxygen at the same time; he called it ‘dephlogisticated air’.

The great enlightenment chemist Humphry Davy investigated the electrolysis of many substances including acids. He concluded that acids contain hydrogen.

In 1870, the Swedish chemist Svante Arrhenius worked on charged particles in solutions of ions. He deduced that acids are actually sources of H+(aq) ions and alkalis are sources of OH–(aq) ions.

Soren Sorensen was a Danish chemist. In 1909, he devised the pH scale: pH = –log[H+]. He was also a great entrepreneur. He invented ways to measure pH: universal indicator, which gives all the colours of the rainbow depending on the pH; and the pH meter which is an electrochemical cell that gives a voltage dependent on the log of the hydrogen ion concentration.

In 1923 Brønsted and Lowry extended the concept of acids to define an acid as a proton donor and a base as a proton acceptor. They called them ‘conjugate acids’ and ‘conjugate bases’. This definition makes more substance bases than the Arrhenius definition.

Around the same time, the American chemist Gilbert Lewis extended the definition. ‘Lewis acids’ are defined as electron pair acceptors and ‘Lewis bases’ electron pair donors. A Lewis acid could therefore be a ligand or a nucleophile. This unites ideas about acid–base, transition metal and organic reactions.

## Questions about acids and bases

1. Why does wine turn into vinegar (ethanoic acid) when it goes off?
2. Lavoisier was a brilliant chemist, but his idea of what makes an acid was wrong. Give an example which disproves his theory.

Think about how he did his experiment, burning elements in oxygen and testing above the jar with litmus; why did he reach the wrong conclusion? If he burnt sulfur and magnesium how might he have tested the oxides to reach a correct conclusion?
3. What made Humphry Davy conclude that acids contain hydrogen? Can you explain his conclusion using an ionic equation?
4. Arrhenius’ idea of acids and bases also explains neutralisation. Can you show this with an ionic equation?
5. Sorensen not only defined pH but invented two ways of measuring it. What made him define it in the way he did?

Indicators usually have just one colour at low pH and a different colour at high pH. How did Sorensen make an indicator that gives all the colours of the rainbow at different pHs?
6. The extension from calling an acid a source of H+(aq) ions to Brønsted and Lowry’s definition as a proton donor is quite a small one; why did it take until 1923 to make it?
7. Write an equation for NH3 reacting with HC*l*. Identify the conjugate acid (proton donor) and the conjugate base (proton acceptor). Would these be considered Arrhenius acids and bases?
8. In what way is the Lewis definition of acid and base similar to the Brønsted–Lowry definition? In what way does it go further? Can you think of something which is a Lewis acid but not a Brønsted–Lowry acid?
9. A lot of learners ask what is the world’s strongest acid? Chloric(VII) acid is one of the strongest, but it is not much more exciting than other strong acids; can you explain why?