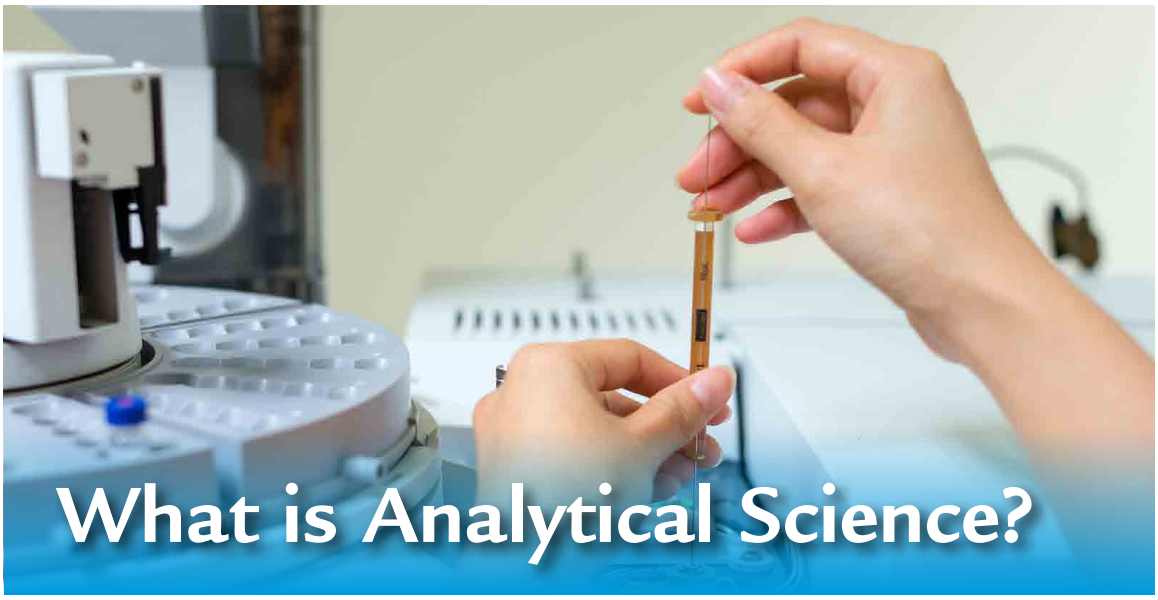
Zoe Ayres

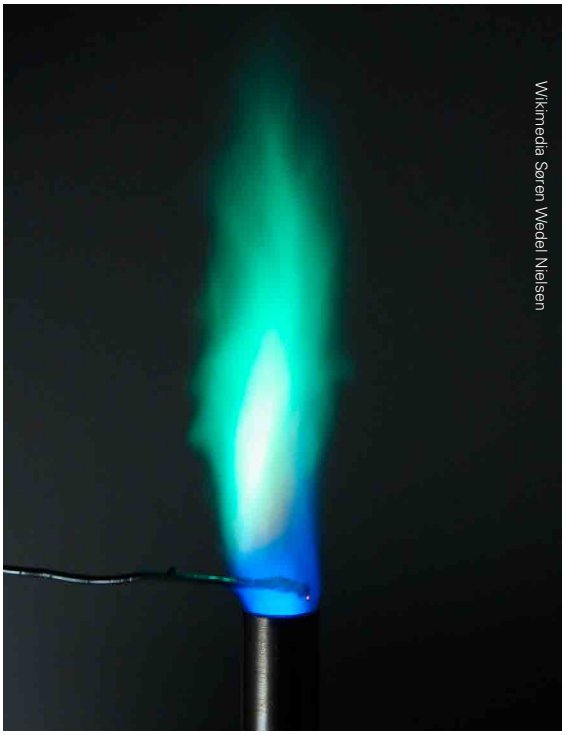


What is Analytical Science?

In some labs analysis is automated but analysts still put the samples in the machines and interpret the results.

*Analytical scientists use a variety of methods and instruments to try to answer two basic questions: what have I got? and how much of it do I have? **Zoe Ayres** of the University of Warwick explains how they set about finding the answers.*

Analytical science is essential for many other scientific areas including healthcare, environmental monitoring, forensics, chemical biology, and synthetic chemistry. The development of new analytical techniques is often led by public interest. For example, analytical scientists develop cheap, simple and portable sensors for early diagnosis in disease epidemics. Such sensors were critical in helping to contain the 2015 Ebola outbreak in Africa.



Flame tests can be used to find out which metal is in a sample but not how much – it is a qualitative test. A green flame indicates copper is present.

What do I have?

This is about identification of a substance (the substance to be analysed is called an analyte) and is called **qualitative analysis**. An example at school would be using flame test colours to identify metal ions. An analyst may receive a white powder sample from a crime scene and carry out tests to confirm if any illegal drugs are present.

There are many instruments and methods used to determine the identity of a substance. They use differences in structure and chemical composition to allow the identification. Chromatography is an example, where different inks can be identified based on the different rates that they move up the chromatography paper. The differences rates are caused by differences in structure which affect how the substances interact with the solution and the paper.

How much do I have?

This is about determining how much of an analyte is present and is called **quantitative analysis**. For example, for drink driving convictions it must be determined whether a person's blood alcohol level was above the legal limit when they were driving.

Accuracy is important. If the analytical scientist gives the wrong answer then a drink driver could be exonerated (let off) or an innocent person convicted. An analytical scientist must therefore always consider the reliability of their results, with possible errors arising from many different sources such as during sample preparation and from the actual analytical instruments themselves. To do this, both accuracy (the measure of how close the analytical measurement is to the true value) and precision (how close a set of measurements are to one another under the same experimental conditions) are assessed. Each analytical method must be validated, which means it must achieve a defined accuracy and precision target, usually more than 95%. This way analytical scientists can report their findings with strong confidence in their results.

On the next page we look at five examples of where analytical science is used.

Environment

A food quality analyst checks meat samples to ensure that the meat is safe and uncontaminated.

Monitoring of contamination is extremely important in order to protect our environment. Drinking water must be analysed for over 30 pollutants and over 100 chemicals to ensure that it is safe for public consumption. Fluoride and chlorine, which are added intentionally to drinking water, are prime examples of the need for water analysis. In small amounts, they help to reduce tooth decay and disinfect water, but in high concentrations they may cause health issues so it is important to ensure that the levels are correct.

Safety and security

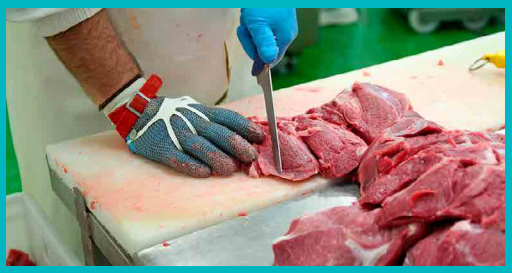
Airport security analysis needs to be accurate but also fast, to prevent large queues from building up

Analytical science plays a large role in ensuring public safety and security. For example, analytical instruments at airports are used to identify illegal drugs and dangerous substances such as explosives. These instruments must be carefully designed to ensure rapid, highly accurate analysis even if only a small (trace) amount of the substances are present.

Pharmaceuticals

Medicines must be analysed to ensure they are safe for human consumption. Tests must ensure that the drug products do not contain toxic heavy metals, which could come from the catalysts used to produce the medicines. It is also really important to confirm that the correct drug molecule has been produced as the wrong structure could have potentially devastating results. For example, in the mid-20th century it is thought that a small change in the structure of the drug thalidomide, given as a morning sickness remedy to pregnant women, caused severe birth defects.

Fraud detection



Analytical techniques are often used to fight fraud. For example, in 2013 there was a food scandal where several food products sold as beef actually contained horse meat. To identify the affected products, analytical scientists had to develop new methods of differentiating between horse meat and beef. Test kits have been designed to identify the presence of horse-specific proteins for quick analysis away from the lab, along with conventional DNA tests.

Healthcare diagnostics

Bioanalytical techniques for healthcare are present not only in hospitals and doctors surgeries but also in our homes. The most widely used examples are blood glucose meters for diabetes management and home pregnancy kits. Careful design of at-home healthcare sensors is required to ensure they are simple to use and as non-invasive as possible, yet are still accurate.

Zoe Ayres is a PhD researcher at the University of Warwick developing boron-doped diamond sensors for analytical applications. This article is written on behalf of the Analytical Division of the Royal Society of Chemistry with the aim of promoting the importance of analytical science to the wider community.