Chemistry

Chemistry is the study of what things are made of and how they work, including how they change or react when they come into contact with other things. It includes everything from elements, the basic building blocks of life, to the role chemicals play in the oceans and atmosphere. People with knowledge of chemistry work in a very wide range of areas. They develop our knowledge of the world, solve problems, improve safety and create new products and processes.

At *GCSE*, you can study this subject in a number of ways, depending on your school and what your teacher thinks is best for you. You might be able to take GCSE Chemistry. Otherwise, you can study chemistry alongside the other sciences, for example, through GCSE Science (and Additional Science or Additional Applied Science, if you want to go on to *A- level*).

You could then go on to take Chemistry A-level. After that, there are university courses such as *degrees*, *foundation degrees* and *HNDs* in chemistry and related subjects. Alternatives to GCSEs and A levels include Edexcel (BTEC) level 2 *Firsts* and level 3 *Nationals* in Applied Science, and *Cambridge Nationals* in Science.

Where is chemistry useful?

- teaching
- pharmacy and pharmacology
- analytical chemistry/analytical science
- working in industry
- health and medicine
- biological sciences
- Earth sciences
- materials/science technology
- agriculture, horticulture and animals.

Chemistry Laboratory Technician	Chemistry laboratory technicians work in a wide variety of industries that involve chemistry, including *pharmaceuticals*, colour technology, textiles, plastics, cosmetics, food and drink, and oil and gas. They are responsible for the day-to-day running of the laboratory. This involves duties such as • Managing equipment stocks, ordering replacements when necessary. • Disposing of laboratory waste. • Preparing and maintaining equipment. • Taking and testing samples. • Recording and analysing experiment results. Technicians carry out routine experiments, often using computers and *automated* systems, and report their findings to the scientist. To become a chemistry laboratory technician, you usually need four/five *GCSEs* at grade C or above. Entrants often have higher qualifications, such as *A levels* or equivalent. Training is usually on-the-job, sometimes with day-release to college.
Teaching	Science is one of the statutory subjects in the *National Curriculum* at Key Stage 4, meaning all pupils study it up to the age of 16. It covers biology, chemistry and physics, but students might be able to study these as separate subjects, depending on their school. Science teachers teach pupils about how science is relevant to their everyday lives and the natural world around them. They study scientific theories, and topics such as global warming, *genetic modification*, *radioactive* substances, how to keep healthy and how drugs affect the body. Teaching methods include group and project work, doing experiments, and using interactive whiteboards, audio-visual materials and the internet, as well as more traditional teaching sessions. To become a science teacher, you'll need a *degree* that leads to Qualified Teacher Status (QTS), or to follow a relevant degree with *postgraduate* training leading to QTS. It's possible to take a *PGCE* in combined science or in chemistry.
Analytical science	**Analytical scientists** investigate substances to see which chemicals they contain. Apart from chemistry, analytical science combines biology, physics, maths and engineering. Their findings help to ensure the safety and quality of food and drink, develop drugs and medicines, protect public safety and the environment, *diagnose* disease, and increase the efficiency and safety of manufacturing processes. Analytical scientists use a wide variety of methods and technologies in their analyses. For some tests, they can use *automated* testing machines to analyse hundreds of samples at once. Other tests are more time-consuming, such as using gas chromatography to separate *compounds* in a sample. Usual entry is with a relevant *degree*. Specialist degrees in analytical chemistry/analytical science are available. **Forensic scientists** use analytical chemistry to examine evidence found at the scene of a crime. Evidence includes bloodstains and traces of soil, glass or paint found on suspects' clothing. They can also analyse burnt debris, to find out if petrol was used to start a fire. After their investigations, forensic scientists write reports, and can appear in court to give evidence. Entrants usually have relevant first degrees (such as biology or chemistry) or a *postgraduate* qualification in forensic science. **Food scientists/technologists** also use analytical chemistry. They study how foods can be processed, stored and preserved, and apply this knowledge to making new food products. They make sure food is safe, for example, by detecting contamination from toxic chemicals, or the presence of harmful micro-organisms that cause illnesses such as Salmonella and Listeria. Usual entry is with a degree, higher national qualification or foundation degree in food science or technology.

Health and medicine	For many professional-level jobs related to medicine and dentistry, you will need science subjects at A level. It is usually essential to have Chemistry A level to train to become a doctor or dentist through the relevant degree courses. **Biomedical scientists** analyse samples of things such as blood and tissue collected from patients by a doctor or nurse. They try to work out, from studying the sample, which illness or disease the patient has. Biology A level is usually the specified subject for entry to courses. Chemistry A level might also be specified. Chemistry A level can be useful if you're applying for degree courses in nursing, midwifery, physiotherapy, diagnostic or therapeutic radiography, orthoptics, optometry, dietetics or podiatry.
Earth sciences	Earth scientists study the Earth and its atmosphere. There are several jobs in this area where you'll need knowledge of chemistry. **Geochemists** study the type and distribution of chemicals that make up the Earth, for example, in rocks, soil and water. Their knowledge can help companies to find natural resources such as oil, coal, gas and minerals. You need a relevant degree to become a geochemist. Many entrants also have a relevant postgraduate qualification. **Soil scientist's** survey and map soils, and produce information on soil qualities and properties. They use their research to support the best use of available land. People can use their work in a variety of areas, such as agriculture, forestry, land recovery, waste disposal and civil engineering. They find out about the qualities and properties of soil by examining sites, taking soil samples for laboratory analysis, and using computers to make maps and models. The most direct route into this career is a degree in soil science, or one that includes a substantial amount of soil science. **Geologists** study the structure, origin and evolution of the Earth and its natural resources. They can find out about the Earth by studying features such as rocks, minerals, crystals, sediments and fossils. Geologists apply their knowledge to areas such as oil and gas exploration, mining and quarrying, civil engineering, hydrogeology, geological surveying, and education and research. To become a geologist, you'll need a first degree in geology, geoscience or Earth sciences. Many entrants also have a postgraduate qualification. Some **oceanographers** study chemical processes that occur in the sea. For example, they analyse water, marine organisms and sea floor sediments, to monitor the spread and effect of chemical pollutants. To become an oceanographer, you'll need a relevant degree. Many people also have a postgraduate qualification in oceanography.

Agriculture, horticulture and animals	You'll need knowledge of chemistry and biology for many jobs in agriculture and *horticulture*. **Agricultural advisers/consultants** give advice and support to farmers and other people involved in agricultural issues. They advise on the technical aspects of running a farm, such as crop nutrition and *livestock* management, as well as the business side, such as how to plan and *budget*. To enter this career, you'll usually need a *degree* in agriculture or a closely-related subject. **Agricultural research scientists** develop knowledge and test methods to improve agriculture. They carry out research to solve problems in planting, harvesting and cultivating crops, and investigate better ways to house, feed and care for livestock. They explore issues such as pest control, animal and plant diseases, and the environmental impact of chemicals used in agriculture. Entrants usually have degrees in subjects such as biological sciences, biochemistry, chemistry, agricultural science and other sciences relevant to agriculture. **Horticultural scientists** do a similar job but specialise in the efficient production of crops, including vegetables, fruit and cereals. For a degree course in horticulture, Chemistry and/or Biology can be preferred or essential subjects. **Veterinary surgeons** *diagnose* and treat animal diseases and injuries. To enter an approved degree course, Biology and/or Chemistry *A level* will usually be essential.

Pharmacy and pharmacology	**Pharmacology** is the study of drugs and how they work on the body. It is an experimental science, concerned with the development of new medicines. **Pharmacy** is to do with the preparation of drugs and medicines, and dispensing them to the public. However, there is an overlap between the two, in that both pharmacologists and industrial pharmacists research and develop new medicines. **Hospital pharmacists** make sure patients receive the right medicines and take these medicines safely. They work closely with doctors, nurses, pharmacy technicians and other medical staff to ensure that patients receive the best treatment. They give advice to doctors on the most appropriate drug treatments, the correct dosage, and any likely reactions between different treatments or foods that the patient is taking. In most hospitals, pharmacists have direct contact with patients on the ward, checking their medical history, giving advice on how to take medicines and monitoring for side-effects. There are a number of specialist areas, including cancer care, older adults, palliative care (terminally ill patients) and outpatient care (patients who don't have to stay in the hospital overnight). Hospital pharmacists usually supervise a team of technicians who are responsible for routine tasks such as counting out tablets and putting labels on medicines. **Community pharmacists** supply and sell medicines to patients on prescription. They also sell 'over-the-counter' medicines and remedies that people can buy without needing a prescription. Community pharmacists work in places such as high street chemists' shops, rural pharmacies, supermarket pharmacy counters and health centres. They advise people on how to use medicines safely. They also give advice on general health issues such as healthy eating, family planning and giving up smoking. Most medicines arrive at the pharmacy ready-made, although the pharmacist might sometimes have to mix ingredients to make things like tablets, powders and ointments. Community pharmacists often supervise technicians who do routine work such as counting out tablets and labelling medicines. Companies that make drugs employ industrial pharmacists. They research and develop safe and effective medicines, and look at ways to produce these on a large scale. To become a pharmacist, you need a degree in pharmacy, followed by further training and an exam. **Pharmacologists** study the effects of drugs, medicines and other chemicals on humans and animals. They research new medicines, and develop these through a long process of experiments and analysis. You will usually need a degree to become a pharmacologist. The subject is available as a single honours degree or in combination with subjects such as chemistry, biochemistry and immunology. Many **clinical research associates** work for drugs companies, carrying out the final stages of drug testing. They usually have at least a degree in a subject such as biological science, chemistry, pharmacy, pharmacology, medicine or nursing.

Working in industry	The chemical industry is one of the largest in the UK, producing a huge variety of products, from medicine to paint. **Industrial chemists** research new ways of making products. They may also try to devise better products for their company to make. Most entrants are *graduates*; there are many *degrees* of relevance to industrial chemists. **Biotechnologists** combine biology, the science of living things, with industry, technology and chemical engineering. They research and develop the use of biology to develop new products and improve processes in health care, the food and drink industry, agriculture and environmental protection. Biotechnologists are usually graduates; entry might also be possible with an *HND* or *foundation degree*, usually as a technician. **Process development scientists** test the discoveries made by other scientists to see if they will work on a larger scale. They monitor and observe production processes, and try to solve any problems. Entry is usually with a relevant degree. It can also be possible to enter with a foundation degree or HND (although this will often be into a technician-level post). **Chemical engineers** understand how to change the chemical, biochemical or physical state of a substance to create fuels and products that we want, need or depend on, including food and drink, oil and gas, drugs and medicines, artificial fibres and plastics. They design and operate the processes by which these products are developed, taking into account factors such as cost, safety and the need to protect the environment. **Biochemical engineering** is an offshoot of chemical engineering. Biochemical engineers are concerned with the biological changes that can be very important in the production and processing of *pharmaceuticals* and foodstuffs, and the treatment of waste. Biochemical engineers work in a wide range of areas, especially health care, nutrition, environmental protection and advanced chemicals. For example, they help to research and develop drugs and medicines, food processing techniques and methods to protect and improve crops. The usual requirement for these careers is a relevant degree or HND. **Fuel** and **energy engineers** research and develop ways to improve the efficient use of energy and to minimise environmental damage from its conversion into usable forms. Many industries employ them to assess environmental impact and to manage energy usage. They also work in fuel production industries, manufacturing companies (boilers, *furnaces*, gas *turbines* and engines), or as *consultants*. The usual qualification for entry into this career is a relevant degree or HND. **Gas engineers** are responsible for extracting and treating gas, and installing and maintaining the gas network from source to customer. Gas engineers have a wide variety of roles, although some specialise in the exploration, transmission, distribution or use of gas. The usual requirement for this career is a relevant degree or HND.

Materials science/technology	**Materials scientists/technologists** study the qualities, characteristics and uses of materials. They research and develop new materials and improve the use of existing ones. They test how materials react to conditions such as temperature, pressure and stress, and tackle problems such as corrosion and metal fatigue. To become a materials scientist/technologist, you'll usually need a relevant degree. Specialist degrees in materials science/technology are available. You can also enter after completing a first degree in a related subject, such as physics, chemistry or engineering, possibly followed by a postgraduate qualification in materials science. **Metallurgists** study metals and alloys, including their structure, production and uses. They specialise in chemical, physical or process metallurgy. Apart from working in quarrying and mining, metallurgists research and develop the use of metals in a number of areas, including civil engineering, and the aircraft, motor and defence industries. **Chemical metallurgists** extract metals from their ores. They research and develop improved techniques, either to get more metal from the ore, or to reduce the amount of energy used in the extraction process. **Physical metallurgists** examine how metals react to different conditions, including temperature and stress. They test metals for signs of corrosion and the effects of stress (metal fatigue). **Process metallurgists** control shaping methods such as casting, and joining processes, such as welding and soldering. To become a metallurgist, you'll usually need a relevant degree, usually in metallurgy or materials science.