Chemistry

The subject

Chemistry is a group 4 subject and as such an *experimental science*. Along with the other sciences (physics, biology and environmental systems and societies) chemistry contributes to students knowledge of the overarching theme called *Nature of Science* (NOS). Chemistry combines academic study with the acquisition of practical and investigational skills. It is often called *the central science*, as chemical principles underpin both the physical environment in which we live and all biological systems. Apart from being a subject worthy of study in its own right, chemistry is a prerequisite for many other courses in higher education, such as medicine, biological science and environmental science, and serves as useful preparation for employment. Through studying chemistry, students become aware of how scientists work and communicate with each other.

The Diploma Programme chemistry course includes the essential principles of the subject (*the core material*) but also, through selection of an *option*, allows teachers some flexibility to tailor the course to meet the needs of their students. The course is available at both standard level (SL) and higher level (HL), and therefore accommodates students who wish to study chemistry as their major subject in higher education and those who do not. The emphasis is on a practical approach through experimental work that supports the theories learnt by the students in classes.

Students at standard level (SL) and higher level (HL) undertake a common core syllabus, a common internal assessment (IA) scheme and have some overlapping elements in the option studied. While the skills and activities of group 4 science subjects are common to students at both SL and HL, students at HL are required to study some topics in greater depth, in the additional higher level (AHL) material and in the common options. The distinction between SL and HL is one of breadth and depth.

The teachers

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Chemistry and theory of knowledge

The theory of knowledge (TOK) course engages students in reflection on the nature of knowledge and on how we know what we claim to know. The course identifies eight ways of knowing: reason, emotion, language, sense perception, intuition, imagination, faith and memory. Students explore these means of producing knowledge within the context of various areas of knowledge: the natural sciences, the social sciences, the arts, ethics, history, mathematics, religious knowledge systems and indigenous knowledge systems. The course also requires students to make comparisons between the different areas of knowledge, reflecting on how knowledge is arrived at in the various disciplines, what the disciplines have in common, and the differences between them.

In this way there are rich opportunities for students to make links between their science and TOK courses. One way is by drawing students' attention to knowledge questions which arise from their subject content. Knowledge questions are open-ended questions about knowledge, and include questions such as:

- How do we distinguish science from pseudoscience?
- When performing experiments, what is the relationship between a scientist's expectation and their perception?
- How does scientific knowledge progress?
- What is the role of imagination and intuition in the sciences?
- What are the similarities and differences in methods in the natural sciences and the human sciences?

Chemistry and international mindedness

Science itself is an international endeavour—the exchange of information and ideas across national boundaries has been essential to the progress of science. This exchange is not a new phenomenon but it has accelerated in recent times with the development of information and communication technologies. The scientific method in its widest sense, with its emphasis on peer review, open-mindedness and freedom of thought, transcends politics, religion, gender and nationality.

The facilities for large-scale research in, for example, particle physics and the Human Genome Project are expensive, and only joint ventures involving funding from many countries allow this to take place. The data from such research is shared by scientists worldwide.

Increasingly there is a recognition that many scientific problems are international in nature and this has led to a global approach to research in many areas. The reports of the Intergovernmental Panel on Climate Change are a prime example of this. On a practical level, the group 4 project (which all science students must undertake) mirrors the work of real scientists by encouraging collaboration between schools across the regions.

Skills and toolkit (ATL)	Topics	Assessments objectives
• Thinking skills • Communication skills • Social skills • Self-management skills • Research skills	• Stoichiometric relationships • Atomic structure • Periodicity • Chemical bonding and structure • Energetics/thermochemistry • Chemical kinetics • Equilibrium • Acids and bases • Redox processes • Organic chemistry • Measurement and data processing Options: • Material • Biochemistry • Energy • Medicinal chemistry	Demonstrate knowledge and understanding of: a. facts, concepts, and terminology b. methodologies and techniques c. communicating scientific information. Apply: a. facts, concepts, and terminology b. methodologies and techniques c. methods of communicating scientific information. Formulate, analyse and evaluate: a. hypotheses, research questions and predictions b. methodologies and techniques c. primary and secondary data d. scientific explanations. Demonstrate the appropriate research, experimental, and personal skills necessary to carry out insightful and ethical investigations.

Examples of concepts and conceptual understanding in chemistry

Spectra: Emission spectra are produced when photons are emitted from atoms as excited electrons return to a lower energy level. The line emission spectrum of hydrogen provides evidence for the existence of electrons in discrete energy levels, which converge at higher energies. Emission spectra are widely used in astronomy to analyse light from stars.

Redox: Oxidation and reduction can be considered in terms of oxygen gain/hydrogen loss, electron transfer or change in oxidation number. Driving under the influence of alcohol is a global problem which results in serious road accidents. A redox reaction is the basis of the breathalyser test.

Acids and bases: A Brønsted–Lowry acid is a proton/H+ donor and a Brønsted–Lowry base is a proton/H+ acceptor. • Amphiprotic species can act as both Brønsted–Lowry acids and bases. A number of acids and bases are used in our everyday life from rust removers to oven cleaners, from foods to toothpastes, from treatments for bee stings to treatment of wasp stings.

Organic chemistry: Isomers are compounds with the same molecular formula but different arrangements of atoms. Organic chemistry focuses on the chemistry of compounds containing carbon. Even small changes in atomic arrangement can change the properties of the compound a lot allowing for almost endless number of compounds to be synthesized and tested for medicinal activity.

Link to IBO subject brief

https://www.ibo.org/globalassets/publications/recognition/chemistrysl2016englishw.pdf