IB Chemistry HL Course Outline

This two-year course balances academic study with practical work, using the scientific method to design investigations, critically analyze results, and collaboratively evaluate conclusions. Students will develop creative thinking, reflecting on how diverse knowledge evolves from atomic history to bonding theories. With nature of science as overarching theme, learners will appreciate the global international context of chemical study from many different approaches. Students will become principled risk-takers, inquiring how chemistry has both contributed to society, and occasionally raised issues with ethical implications to examine from multiple perspectives. Findings will be communicated with open-mindedness, applying understanding to care for the environment with Green initiatives.

Science and Theory of Knowledge

Theory of knowledge (TOK) is fundamentally about critical thinking and inquiry into the process of knowing rather than about learning a specific body of knowledge. It examines the nature of knowledge and how we know what we claim to know by encouraging students to analyse knowledge claims and explore questions about the construction of knowledge. It emphasizes connections between areas of shared knowledge and link them to personal knowledge in such a way that an individual becomes more aware of their own perspectives and how they might differ from others. Students explore the means of producing knowledge within the core theme of "knowledge and the knower" as well as various optional themes (knowledge and technology, politics, language, religion, indigenous societies) and areas of knowledge AOK (the arts, natural and human sciences, history, and mathematics).

Many aspects of chemistry lend themselves to reflect on the nature, scope and limitations of knowledge and the process of knowing through the exploration of knowledge questions. During teaching and learning, teachers and students evaluate knowledge claims by exploring questions concerning their validity, reliability, credibility, and certainty, as well as individual and cultural perspectives on them. Exploration of the relationship between knowledge and TOK concepts can help students deepen their understanding and make connections between disciplines. For example, while discussing the depletion of energy sources and the constant need for new energy resources to meet energy demands, students can explore the concepts of responsibility, power, and justification.

Approaches to Teaching and Learning

Approaches to teaching and approaches to learning (ATL) across the Diploma Programme (DP) refers to deliberate strategies, skills and attitudes that permeate the teaching and learning environment. These approaches and tools, intrinsically linked with the learner profile attributes, enhance student learning and assist student preparation for the DP assessment and beyond. Developing the five ATL skills (thinking, social, communication, self-management, and research) along with the six approaches to teaching (inquiry-based, conceptually focused, contextualized, collaborative, differentiated and informed by assessment) encompass the key values and principles that underpin IB pedagogy.

Experimental Programme

Integral to the student experience of chemistry is the learning that takes place through scientific inquiry within the classroom or laboratory. Experimentation through a variety of forms can be used to introduce a topic, address a phenomenon, or allow students to consider and examine authentic questions and curiosities. A school's experimental programme allows students to experience the full breadth and depth of the course, develop scientific skills and demonstrate safe, competent, and methodical use of a range of tools, techniques and equipment. Students are therefore encouraged to develop investigations to support their learning through open-ended inquiry with a focus on laboratory experiments, databases, simulations, and modelling.

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Practical Work	40 hours
Collaborative Sciences Project	10 hours
Scientific Investigation	10 hours

Conceptual Learning

Concept-based teaching and learning is encouraged across the continuum of IB programmes. Concepts are mental representations of categories, varying in their level of abstraction and universality. They are constructed, modified, and activated by the learner through learning experiences. Concepts do not exist in isolation but are interrelated. Conceptual understanding is always a work in progress—it is continually being developed and refined. Conceptual understanding is therefore an outcome of a non-linear, ongoing process of evolving understandings, adapting previous understandings, and identifying and dispelling misconceptions. It consists of making connections between prior and new knowledge to construct and build an awareness of this network of knowledge.

Tools		**Inquiry Process**	
Tool 1: Experimental techniques	Addressing safety of self, others, and the environment (ethical)	**Inquiry 1:** Exploring and designing	Exploring (independent thinking, source variety, sufficient/relevant, predictions)
	Measuring variables (mass, volume, time, temperature, length, pH, current, potential)		Designing (investigations, experiments, databases, simulations, molecular modelling, variables, range/quantity, methodologies)
	Applying techniques (standardization, dilutions, drying/recrystallization, titration, distillation/reflux, chromatography/separation, calorimetry, electrochemical cells, melting point determination, spectrophotometry)		Controlling variables (calibration, environmental, insulate heat loss/gain)
Tool 2: Technology	Applying technology to collect data (sensors, databases, simulations)	**Inquiry 2:** Collecting and processing data	Collecting data (qualitative, quantitative, issues)
	Applying technology to process data (spreadsheets, graphs, computer modelling)		Processing data (relevant/accurate)
			Interpreting results (diagrams, graphs, charts, patterns, trends, relationships, outliers, accuracy/precision, reliability/validity)
Tool 3: Mathematics	Applying general mathematics (arithmetic/algebraic, rates, mean/range, scientific notation, approximation/estimation, proportionality, percent change/difference, error/uncertainty, continuous/discrete)	**Inquiry 3:** Concluding and evaluating	Concluding (justify, compare, relate, impact of uncertainties)
	Using units, symbols and numerical values (SI, significant figures, decimal places)		Evaluating (hypotheses, random/systematic errors, methodological weaknesses/limitations, assumptions, realistic/relevant improvements)
	Processing uncertainties (significance, propagation, coefficient of determination R^2)		
	Graphing (sketch, interpret tables/charts, bar/histograms/scatter/line/curved, best fit, gradient, error bars, extrapolate/interpolate)		

Syllabus Roadmap

Skills in the study of chemistry Structure determines reactivity, which in turn transforms structure			
Structure **Structure refers to the nature of matter from simple to more complex forms**		**Reactivity** **Reactivity refers to how and why chemical reactions occur**	
Structure 1. Models of the particulate nature of matter	Structure 1.1—Introduction to the particulate nature of matter	**Reactivity 1. What drives chemical reactions?**	Reactivity 1.1—Measuring enthalpy changes
	Structure 1.2—The nuclear atom		Reactivity 1.2—Energy cycles in reactions
	Structure 1.3—Electron configurations		Reactivity 1.3—Energy from fuels
	Structure 1.4—Counting particles by mass: The mole		Reactivity 1.4—Entropy and spontaneity (Additional higher level)
	Structure 1.5—Ideal gases		
Structure 2. Models of bonding and structure	Structure 2.1—The ionic model	**Reactivity 2. How much, how fast and how far?**	Reactivity 2.1—How much? The amount of chemical change
	Structure 2.2—The covalent model		Reactivity 2.2—How fast? The rate of chemical change
	Structure 2.3—The metallic model		Reactivity 2.3—How far? The extent of chemical change
	Structure 2.4—From models to materials		
Structure 3. Classification of matter	Structure 3.1—The periodic table: Classification of elements	**Reactivity 3. What are the mechanisms of chemical change?**	Reactivity 3.1—Proton transfer reactions
	Structure 3.2—Functional groups: Classification of organic compounds		Reactivity 3.2—Electron transfer reactions
			Reactivity 3.3—Electron sharing reactions
			Reactivity 3.4—Electron-pair sharing reactions

IB Chemistry 11 HL	**IB Chemistry 12 HL**
Topic 11: Measurement And Data Processing	Topic 6/16: Chemical Kinetics
Topic 1: Stoichiometric Relationships	Topic 7/17: Equilibrium
Topic 2/12: Atomic Structure	Topic 8/18: Acids And Bases
Topic 3/13: Periodicity/Transition Metals	Topic 9/19: Redox Processes
Topic 4/14: Chemical Bonding And Structure	Topic 10/20: Organic Chemistry
Topic 5/15: Energetics/Thermochemistry	Topic 21: Measurement And Analysis

Collaborative Sciences Project

The collaborative sciences project is an interdisciplinary sciences project, addressing real-world problems that can be explored through the sciences. The nature of the challenge allows students to integrate factual, procedural and conceptual knowledge developed through the study of their disciplines. Through the identification and research of complex issues, students can develop an understanding of how interrelated systems, mechanisms and processes impact a problem. Students will then apply their collective understanding to develop solution-focused strategies that address the issue. With a critical lens they will evaluate and reflect on the inherent complexity of solving real-world problems. Students will develop an understanding of the extent of global interconnectedness between regional, national, and local communities, which will empower them to become active and engaged citizens of the world.

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While addressing local and global issues, students will appreciate that the issues of today exist across national boundaries and can only be solved through collective action and international cooperation. The collaborative sciences project supports the development of students' ATL skills, including teambuilding, negotiation and leadership. It facilitates an appreciation of the environment, and the social and ethical implications of science and technology.

Assessment Outline–HL

Component	Details	Weighting	Duration
External Assessment Paper 1 Paper 1A and 1B presented as two separate booklets, completed together without interruptions	Paper 1A—40 Multiple-choice questions No marks deducted for incorrect answers Calculator use permitted; data booklet provided Paper 1B—Data-based questions Questions on experimental work Calculator use permitted; data booklet provided	**36%** (Marks: 75)	**2 hours**
External Assessment Paper 2	Short-answer and extended-response questions Calculator use permitted; data booklet provided	**44%** (Marks: 90)	**2.5 hours**
Internal assessment	The internal assessment consists of one task: the scientific investigation. This component is internally assessed by the teacher and externally moderated by the IB at the end of the course.	**20%** (Marks: 24)	**10 hours**

IB Grade Markbands	UBC % Equivalent
7 (Excellent)	98-100
6 (Very Good)	96-97
5 (Good)	90-95
4 (Satisfactory)	86-89
3 (Mediocre)	76-85
2 (Poor)	70-75
1 (Very Poor)	50-69

Internal Assessment Criteria

Criteria	Details	Maximum Marks (Weighting %)
Research Design	Assesses the extent to which the student effectively communicates the methodology (purpose and practice) used to address the research question.	6 (25%)
Data Analysis	Assesses the extent to which the student's report provides evidence that the student has recorded, processed and presented the data in ways that are relevant to the research question.	6 (25%)
Conclusion	Assesses the extent to which the student successfully answers their research question with regard to their analysis and the accepted scientific context.	6 (25%)
Evaluation	Assesses the extent to which the student's report provides evidence of evaluation of the investigation methodology and has suggested improvements.	6 (25%)