Diploma Programme subject outline—Group 4: sciences

School name	Haganässkolan IB Diploma Programme	**School code**	5621
Name of the DP subject	Chemistry SL/HL		
Level *(indicate with X)*	Higher: x; Standard completed in two years: x; Standard completed in one year *:		
Name of the teacher who completed this outline	Benjamin Devadoss, Etienne Stefansson	**Date of IB training**	May 11, 2016, June-July 2019
Date when outline was completed	2017-02-28, last updated 2021-06-15	**Name of workshop** *(indicate name of subject and workshop category)*	IBO Chemistry Cat 2 online workshop, June 2019

* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

1. Course outline

	Topic/unit (as identified in the IB subject guide) *State the topics/units in the order you are planning to teach them.*	Contents	Allocated time One 60 minutes. In 3 classes.	Assessment instruments to be used	Resources *List the main resources to be used, including information technology if applicable.*
Year 1	Topic 1: Stoichiometric Relationships • Chemical change and equations • The mole concept and Avogadro's constant • Mass and gaseous volume relationships in chemical reactions	The use of chemical equations to represent atomic processes will first be established before discussing the mole concept and its role in allowing stoichiometric calculations. The importance of stoichiometry will also be discussed with reference to combustion efficiency and minimising carbon emissions. Students will be able to convert between mass, moles, particles and volume. Gas laws (Ideal and Combined) will also be covered.	6 weeks 13.5 hrs CW 4.5 hrs PRAC	Examination or Paper	Chemistry for the IB Diploma (2nd Edition), Cambridge University Press Kognity
	Topic 11: Measuring and Data Processing • Uncertainty and error in measurement • Uncertainties in calculated results • Graphical techniques	Instruction on measuring, significant figures, error and uncertainty will occur prior to quantitative labs. Techniques for representing data graphically will not be introduced here, but will be presented throughout the course as applicable.	10 hrs (SL CW) 3 weeks +1	N/A	

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	Topic 2: Atomic Structure • The atom • Mass spectrometer • Electron arrangement	This course will start with an introduction to the elements and the significance of elements and their compounds as driving factors in economics, conflict, and the progress of society. Theories of the atom, atomic structure, isotopes, electron configuration and applicable instrumentation (mass spec) will also be covered	3 weeks + 1 8 hrs CW 2 hrs PRAC	Formative assessment tools: - Partner quizzes - Sample exam question feedback - Questioning + classwork - Preparatory lab reports Summative assessment tools - Tests of various length and focus - Calculation, SAQ, MCQs - Essay	https://phet.colorado.edu/ http://www.simbucket.com/welcome-to-simbucket/ https://pogil.org/resources/curriculum-materials/high-school-chemistry-activities http://www.rsc.org/learn-chemistry/wiki/Lab:List_of_advanced_level_Practical_Chemistry_experiments http://www.thinkib.net/chemistry/page/16598/mandatory-laboratory-components http://ibchem.com/htm/syllabus2016.htm
	Topic 3: Periodicity • Periodic table • Periodic trends: physical and chemical properties • D-block elements • Coloured compounds	Periodicity between elements and physical and chemical properties will be identified in lab situations as well as in pencil/paper activities.	4 weeks 10 hrs CW 2 hrs PRAC	Formative assessment: - Classwork Summative assessment: - Lab report - Essay - Exam (with topic 4)	

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Topic 4: Bonding • Ionic bonding • Covalent bonding • Formulas • Molecular polarity • Intermolecular forces • Metallic bonding • Physical properties of bond types • Electron domain and molecular geometries • Hybridization	Periodicity and electron configuration will be used to explain ion formation, leading to the study of ionic bonding and finally covalent bonding. Lewis diagrams and electronegativity will lead to molecular polarity. Properties of various bond types will be identified experimentally and explained theoretically.	8 weeks 24 hrs 20.5 hrs CW 3.5 hrs PRAC	Formative assessment: - Classwork - Presentation (ICT) Summative assessment: - Lab report - Essay - Exam (with topic 4)	
Topic 9: Oxidation and Reduction • Introduction to oxidation and reduction • Redox equations • Activity series • Voltaic cells • Electrolytic cells	A look back at ion formation will introduce reduction and oxidation. The activity series will be deduced experimentally and then applied to voltaic cells. A lab using electrolytic cells will complete this topic.	6 weeks +1 14 hrs CW 5 hrs PRAC	Formative assessment: - Classwork - Labs Summative assessment: - Lab reports - Exam (mock-style)	

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Year 2	Topic 6: Kinetics • Rates of reaction • Collision theory • Rate expression and reaction mechanism • Activation energy	Students will begin this year using the classic Zn + HCl → H_2 + $ZnCl_2$ lab to investigate the factors that affect the rate of this reaction. Then we will apply the collision theory to explain and extend their results.	5 weeks 13 hrs (2)	Formative assessment: - Classwork, Exam-style questions - Labs - QnA-sessions Summative assessment: - Exam (mock-style) - Essay - Scientific Poster	
	Topic 5: Energetics • Exothermic and endothermic reactions • Bond enthalpies • Calculations of enthalpy changes • Hess's Law • Energy cycles • Entropy and spontaneity	We will look at enthalpy changes in endothermic and exothermic reactions both mathematically and graphically. At first bond enthalpies will be used to calculate the change in enthalpy. Then we will advance to using Hess's law for that.	6 weeks + 1 16 hrs (3)		
	Topic 7: Equilibrium • Dynamic equilibrium • The position of equilibrium	Dynamic equilibrium will be explored through demos and guided inquiry lessons. Le Chatlier's Principal will be introduced both through lecture and through lab.	3 weeks +1 8.5 hrs (1.5)		

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Topic 8: Acids and Bases • Theories of acids and bases • Properties of acids and bases • Strong and weak acids and bases • The pH scale • Acid deposition • Lewis Acids and bases • Calculations • pH curves	This unit will begin with reactions and properties of acids and bases. Arrhenius and Bronsted-Lowry acids will be introduced along with conjugate acids –base pairs. Equilibrium constants will inform students understanding of strong vs. weak acids and bases. Students will learn to calculate pH and use pH to identify whether a substance is an acid or a base.	7 weeks +1 16.5 hrs (5.5)		
Topic 10: Organic Chemistry • Introduction • Alkanes • Alkenes • Alcohols • Halogenoalkanes • Reaction pathways • Types of organic reactions • Synthetic routes • Stereoisomerism	IUPAC nomenclature will be taught and students will learn to identify common functional groups. A study of basic organic reactions will allow students to solidify their knowledge of nomenclature and functional groups.	10 weeks +1 23 hrs (8)	As above.	

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	Option D: Medicinal Chemistry • Pharmaceutical products and drug action • Aspirin and penicillin • Opiates • Anti-viral medications • Environmental impact of some medications • Taxol • Nuclear medicine • Drug detection and analysis	pH regulation of the stomach will be covered in Topic 8	9 weeks +1 25 hrs (3)	As above.	

1. The group 4 project

As the IB guides say, “The group 4 project is a collaborative activity where students from different group 4 subjects work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to ‘encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method.’” Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

Group 4 was organized in 2018, but in 2019 and 2020, the Group 4-Project was not a required component for examination.

IB practical work and the internal assessment requirement to be completed during the course

As you know, students should undergo 40 hours (at standard level) or 60 hours (at higher level) of practical work related to the syllabus. Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus.

An example is given. Add as many rows as necessary.

Name of the topic	**Experiment**	**Any ICT used?** *Remember you must use all five within your programme.*
Acids and bases	Titration	Yes
Topic 2: Atomic Structure	Melting point lab Flame test lab	Yes – Spreadsheet and word processing No
Topic 3: Periodicity	Periodicity lab	No
Topic 4: Bonding	Conductivity lab Comparison of bond type lab	Yes – Vernier conductivity probes No
Topic 11: Measurement	Measuring lab	No

Name of the topic	Experiment	Any ICT used? *Remember you must use all five within your programme.*
Topic 1: Stoichiometry	Types of reactions lab MgO lab Hydrate lab OPT: Mining lab OPT: % yield lab Gas law labs Molar mass of gas	No Yes (Spreadsheet and word processing) Yes (Spreadsheet and word processing) No No No No
Topic 9: Redox	Activity series lab Iron's transitions Electrochemical cell lab The Chemistry of copper plating Coin battery KMnO4 Redox titration (hydrogen peroxide analysis TI activity)	No No Yes - Multimeter Yes - Multimeter No No
Topic 6: Kinetics	Kinetics lab The red shift Starch Iodine Clock reaction Rate determination and activation energy	Yes - PowerPoint style presentations with graphs made with graphing software. Yes – Vernier spectrometers stopwatch Yes - Vernier lab with Vernier spectrometers
Topic 5: Thermochemistry	A very cold investigation Change in enthalpy lab	No No
Topic 7: Equilibrium	Le Chatlier's principle lab	No
Topic 8: Acids and Bases	Acid/base titration (HCl, and/or vitamin C and/or aspirin) Eggshell back-titration	Yes, Vernier pH probes

Name of the topic	Experiment	Any ICT used? *Remember you must use all five within your programme.*
Topic 10: Organic chemistry	Isomer modelling activity Condensation lab – making esters 3-D modelling of organic compounds	No No Yes – online modelling software
Option A: Materials	Metallic bonding lab Zinc/copper alloy lab Amazing Modern Materials (nanotech and liquid crystals) Polyurethane resin casts Small scale synthesis of polymers lab (synthesis of polyester, polyurethane foam, nylon synthesis, sodium alginate) Plastics recycling lab Decomposition of Hydrogen Peroxide (Vernier)	No No No No No No Yes – Vernier gas pressure probe

2. Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

Fully equipped upper secondary Chemistry lab.

3. Other resources

Indicate what other resources the school has to support the implementation of the subject and what plans there are to improve them, if needed.

Additional privately owned materials and chemicals, electronics and thermal camera.

4. Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

Topic	Link with TOK (including description of lesson plan)
Atomic structure	Evolution of our understanding of atomic structure – how and why do we make changes to our representations of atoms? Students will start from the Greek model of the atom. They will then receive original data and observations (or simulations of such experiments) and modify their representations of the atom accordingly, eventually reaching Chadwick's contributions to the atom.

5. International mindedness

Every IB course should contribute to the development of international mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness (including resources you will use)
• Elements	• Students will research various metals mined throughout the world. Numerous international perspectives will become apparent such as: ○ Rare Earth metals: Trade between China and US – the two largest reserves of these metals are in China and in the U.S. Currently, the cost of these metals is not high enough for U.S. workers to be paid to mine them. However, China, realizing that it has a monopoly on these metals, has raised their price. If China raises the price high enough, it will become economical to open the U.S. mines, employing U.S. workers. ○ South Africa during the apartheid years – the decision to support apartheid by purchasing Cr and Mn at lower prices vs. obtaining "apartheid-free" metals at higher prices ○ Tantalum free cell phones – tantalum mines in Congo and the civil wars that affected the mines. Tantalum mines (and cobalt, gold, diamonds, copper, tungsten and tin) are often controlled by warlords who operate the mines under negligible safety considerations in addition to using children as mine workers as well. ○ Venezuala chose to mainly develop their petroleum resources and are now suffering from world-wide depression in oil prices, however, they also have rich deposits in bauxite (aluminium) and iron ore. ○ If nothing else, mapping out world supplies of various metals (and researching the uses of those metals) will make it apparent to them how international the world's supply of these elements is.
• Chemical symbols and equation, IUPAC system	• International organisation to standard to allow scientists around the world to communicate
• Carbon dioxide, pressure, gas solubility	• "Killer lakes" of Cameroon: Lakes Nyos and Monoun http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/killer_lakes/killer_lakes.html

6. Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
All topics – Guided Inquiry instruction	I teach using guided inquiry lessons. Students learn to connect ideas, evaluate their own work and that of others and communicate their questions and ideas. Students work both independently and cooperatively to create knowledge from models illustrating chemical principles. This fits into the IB learner profile components: inquiry, knowledgeable, thinkers, communicators, open-minded, risk-takers and reflective.

This portion of the course outline <u>highlights</u> our IB practices. Each section gives a taste or example of how we meet the IB standards and practices in our program.

Inquiry (Approaches to Teaching 1)

You will be given opportunities to follow your interests, actively explore, or make your own choices in certain circumstances:

Yes, heavily! Students are always encouraged to "go out and look" for applications that are relevant to them, and to request them discusses/explained/demonstrated in class. Chemistry allows some flexibility in this regard, and students are always encouraged to work on their own projects during the IA.

If you are very interested in this subject, you might wish to have certain CAS experiences that are quite connected to this subject. Some examples are:

Creativity: Students have historically found exploring their own scientific questions intriguing, designing and conducting your own scientific experiments do confer a great deal of creativity, representing your findings in interesting ways graphically is a great skill.

Activity: Coming up with Activity-project in the sciences might be difficult – but incorporating scientific principles in your activities might be easier. For example: Combine a vigorous exercise session with quantifying weight loss, and calculate the amount of glucose or adipose deposits consumed during the process, Oxygen taken in, and Carbon Dioxide emitted, alternatively; how can you ascertain what mass you lost consists of water?

Service: For many people engaged in the scientific processes, the goal of the process is a positive outcome, ranging from individual humans to global populations of any species. Service can (perhaps optimistically) be considered the goal of the field. Setting up experiments to measure our pollution, or devising ideas to solve some of it, locally, could be considered service if justified.

Conceptual focus (Approaches to Teaching 2)

Research shows that when learning focuses on conceptual understanding, the learning is richer and more sustained. Here are some examples of places in the course where we work rather explicitly to develop conceptual understanding:

Lab Safety

Is of course paramount, and demonstrations in lab safety are carried out routinely to show how and why safety is important.

Demonstrations of noxious interactions (e.g. Acids and oxidants) are shown in fume hoods, conceptual understanding comes quickly when safety gloves are set on fire with concentrated nitric acid.

The "big idea" I want you to learn: Small-scale tests whenever possible. Always assume unknown reactions are violent etc. Always research reactions first.

Assays & Syntheses

In the latter half of the course, several chemical assays and syntheses are performed on real-life scenarios and discoveries. Assays are performed to ascertain quantitative values (such as pH, concentrations, TDS) on foods. During the COVID-situation, students were encouraged to investigate acid-base indicators already in their previous experience (e.g. tea & red cabbage) in cooking.

The "big idea" I want you to learn: You have most likely already experienced several chemical concepts. Chemistry is applicable and ubiquitous.

Local and/or Global links (Approaches to Teaching 3)

Global relevance is at the heart of the DP curriculum, within nearly every subject guide, the content is already baked in. But here are some of the local links we will make in our subject:

Local links are regularly made to both nature and artificial operations nearby. Forests and lakes offer sampling real-world environments. A local aluminium recycling center offers educational opportunities.

(if you'd like to highlight global links, go for it)

Collaboration (Approaches to Teaching 4)

Sometimes what you will be learning will be linked to another subject area and sometimes we as teachers like to collaborate to articulate those links for you, we find it can make learning more meaningful. How we do this may vary from year to year, but here is an example of places in the curriculum where you might find that we will work in an interdisciplinary fashion:

Interdisciplinary connections are a vital part of the IBDP experience, parallels are constantly drawn between the curricula of Chemistry and Biology, such as biochemical systems and interactions for example, in Topics 5 and 6: Roles and interactions of biological catalysts (enzymes) are discussed in detail. A great many parallels with Math and Physics are drawn in most topics, we're supposed to give an interdisciplinary appreciation for the scientific endeavors.

We will also collaborate, you and I as the teacher on certain parts of the course. Some examples are:

Due to the course load (especially at HL) and nature of the subject this course requires careful following of a plan. That said, I greatly appreciate student power and democratic ideals, both your implicit- and explicit input as to the structuring of the course is always welcome, and as far as the course, schedule and externalities allow, I will always take your points into consideration.

Where we at times can offer greater flexibility is methods of examination, and choice between non-PSOW-labs. There is usually flexibility between which forms of formative- and summative assessments we can have, and I have historically taken your overall needs, wishes, and overall DP-load into account.

There is a certain amount of choice regarding the teaching style, to the freedom-under-responsibility afforded during the IA-phase. During repetition, the majority of the time is devoted to re-learning forgotten components and topics of the course, along with develop new methods, mnemonics, and collabs to understand the course content.

And there will be times you collaborate with your classmates, such as:

You will actively engage and study together with your classmates, you will do peer-assessment, and collaborative learning exercises. Due to the course load, this is highly advised!

Removal of barriers to learning: (Approaches to Teaching 5)

We all have our strengths and areas to develop. If you are experiencing some form of barrier to your learning, here's what I expect you will do:

We are constantly on the lookout for your areas to develop and try to improve those through your strengths. But please let me know as soon as you think there might be an issue, and we will work out a plan together. You should know up-front that this is not an easy course for most people, especially at HL, and some difficulties are to be expected. Should you fall behind, additional resources and opportunities will be made available where applicable. Any barriers are there to be overcome, and for you to grow as a person.

If I or another teacher detects that there might be a barrier to your learning, we will follow our [Inclusion Policy.]

Varied assessment (Approaches to Assessment 2)

These are the kinds of assessments used in this course *(prior to official IB assessments and including mocks)*:

Formative assessments:

Formative assessments are manifold and varied; Socratic learning and classroom discussions feature prominently and form the heart of the subject. These discussions are guided towards the interests and wishes of the students and have historically been greatly appreciated. More mundane Formative assessments are also available, including quizzes, Kahoots, and talks one-on-one.

Summative assessments allow for you to **consolidate your learning,** some examples of summative assessments in this course are:

Summative assessments are as varied as we can reasonably make them, traditional exams and papers are considered "classic", but we also try to do more dynamic tasks, such as presentations, exhibitions, and practical examinations.

Here is some information about how your work will be marked or assessed:

I strive to assess pretty much everything anonymously, similar to the process at many universities, meaning that I do not know who is the author of a piece of work before the grade is reached. We also standardize both in-house and externally with other schools.

Feedback (Approaches to Assessment 1)

You can expect to receive feedback from me on formative and summative assessments in this way:

Written feedback on most submitted tasks. Constructive and kind oral feedback constantly in class. Detailed annotated IA-feedback is always given on a first draft, minor oral feedback on later revisions.

You will also have an opportunity to give feedback to me in this subject, here is how:

***(this may be something we co-create so wait on this one for a minute)*

To get to know our Assessment Policy in better detail, you can find it here.