ST. JOSEPH'S INSTITUTION INTERNATIONAL MALAYSIA

CHEMISTRY HANDBOOK

Why Study CHEMISTRY?

Chemistry is an experimental science that combines academic study with the acquisition of practical and investigational skills. Chemical principles underpin both the physical environment in which we live and all biological systems. Chemistry is often a prerequisite for many other courses in higher education, such as medicine, biological science and environmental science.

All students undertake both theory and practical work as they complement one another naturally, both in school and in the wider scientific community. The DP Chemistry course allows students to develop a wide range of practical skills and to increase facility in the use of Mathematics. It also allows students to develop interpersonal and information technology skills, which are essential to life in the 21st Century.

By studying Chemistry students will become aware of how scientists work and communicate with each other. While the scientific method may take on a wide variety of forms, it is the emphasis on a practical approach through experimental work that characterises the subject. Teachers provide students with opportunities to develop manipulative skills, design investigations, collect data, analyse results and evaluate and communicate their findings.

At SJII Malaysia, Chemistry is offered at both higher level (HL) and standard level (SL).

A background in Chemistry at IB level aids a successful pursuit of a variety of studies, including medicine, dentistry, pharmacy, biological sciences, agriculture, food technology and dietetics, environmental studies, material sciences and physics. To enter certain courses, it may be required that Chemistry be studied in the IBDP, (i.e. Biology).

Approaches to Teaching and Learning in Chemistry

The Chemistry course is “concept based”. That means that it is based on a number of “Essential Ideas”. Some examples include:

- Organic chemistry focuses on the chemistry of compounds containing carbon
- The arrangement of elements in the periodic table helps to predict their electron configuration
- Lewis (electron dot) structures show the electron domains in the valence shell and are used to predict molecular shape

Learning to learn in the context of the Essential Ideas, rather than thinking every lesson is separate, is a very empowering way of appreciating learning in general.

In addition, the Chemistry course considers the very Nature of Science and asks students to think about these deeply. For example:

- Obtain evidence for scientific theories by making and testing predictions based on them.
- Use theories to explain natural phenomena.
- Use scientific models to represent the real world.

Thus, the teacher will not expect you to simply learn information then repeat it in an examination. The teacher will expect you to take responsibility for your own learning. This is the same in all IB DP subjects, not just Chemistry.

This means that we expect you to develop a **broad set of skills**. How these skills can relate to Chemistry is outlined below.

Research Skills	How to look up information and find things out for yourself in constructive ways, how to tell if information you have found is trustworthy and how to use information honestly. For example, you may want to research the effect of carbon chain length on the enthalpy of combustion.
Communication Skills	This means expressing your judgements and views distinctly, writing responses to questions succinctly, and writing your individual assessment report well. Many students do not realise that even answering questions clearly in class is a communication skill!
Social Skills	In Chemistry, students often work in groups, for example during practical work. You are expected to participate fully, but also listen to and encourage the participation of others.
Thinking Skills	These skills are required in Chemistry in every lesson! You must be prepared to learn how to analyse, explain, evaluate, discuss, make links and see the "big picture".
Self-Management Skills	These are crucial to success in the IB Diploma, because you will be studying a lot of subjects and participating in a lot of activities. You must be able to work independently, effectively and in an organised manner.

This means that your teacher will also use a **broad set of approaches**, including:

Inquiry	Whilst teachers know that they have to give students information, they know that students finding things out and coming to conclusions by themselves rather than always being told is very good. You will be expected to find things out AND ask questions throughout your Chemistry course.
Emphasising Concepts	Teachers will try to encourage you to see the big pictures, like some of the ideas above, rather than expect you to see each lesson as an individual entity that can be pushed to one side as soon as it is over.
Differentiation	Teachers will use a variety of teaching strategies and approaches so that everyone's different needs and preferred ways of learning can be addressed.
Development of Independence	Your teacher will set challenging tasks to do on your own, and have high expectations of you, so they will help you to develop their self-management skills
Assessment	Your teacher will use a variety of assessment methods and give feedback in different ways; he or she will also expect you to be able to assess your own and your classmates' work in a useful way. The aim is that you will not simply be looking to see what marks you have got – but what you need to do next in order to improve.

Chemistry and the IB Learner Profile

While you progress through your diploma programme studies and activities, you will develop a number of attributes. The IB calls this the IB “learner profile”. This table shows you what the learner profile attributes are and some examples of how Chemistry can help you develop these, qualities...

We hope you will become …	Examples in Chemistry
Inquirers	Students will **find out** how manufacturing has changed over the last century to take into account efficiencies, energy consumption and atom economies.
Knowledgeable	Students will **build up knowledge** based on factual content related to the detection of substances through spectrometry, trends of the periodic table, physical properties of materials and the particulate nature of matter.
Thinkers	Students will need to **understand** concepts such as atomic structure and acid-base theories, as well as **develop meaningful action** whilst learning.
Communicators	Students will **verbally communicate** ideas, research findings, opinions and judgements. They will **write** reports of investigations e.g. to establish whether there is a relationship between two experimental variables and **keep written records** of investigations e.g. how to calculate the percentage of ammonia in a window cleaner. They will also **respond to problems** including a written data analysis exercise specifically requiring students to respond in full to questions.
Principled	Students will form and keep to their **own views** on issues such as recycling, reduction of waste, conservation of resources, atom economy, etc.
Open-Minded	In connection with the above, students will learn to **respect others’ views** even though they feel others may not be right and/or they do not agree with them.
Caring	Students will learn how to respect and **care for the environment**.
Risk-Takers	Students will need to uphold the principles they have developed **even though this may generate disagreement** with their peers.
Balanced	The topic contributes to the students’ **whole IB education**.
Reflective	In particular, students will be able to **evaluate** their experimental procedures and theories such as, Kekulé deducing the structure of Benzene through a dream.

Topics Studied

Core (SL)

- 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

Additional higher level (AHL)

- Atomic structure
- The periodic table - the transition metals
- Chemical bonding and structure
- Energetics/thermochemistry
- Chemical kinetics
- Equilibrium
- Acids and bases
- Redox processes
- Organic chemistry
- Measurement and analysis

Option (Choice of one out of four)

- Materials
- Biochemistry
- Energy
- Medicinal chemistry

Chemistry in the timetable at SJIIM

The IB requires 240 hours of teaching for Higher Level (HL) and 150 hours of teaching for Standard Level (SL). At SJIIM, HL Chemistry is allocated three double lessons per week and SL Chemistry is allocated two double lessons per week.

It sometimes happens that HL and SL Chemistry are taught in the same class. In this case, the teacher will let the SL students know when they do not need to come to lessons. Sometimes students will find they need to go to all three lessons in a week; sometimes they will only attend one or two of the lessons in a week and sometimes there will be periods of time when they will not be required to attend at all.

The IB Chemistry Course

Chemistry, like all IB DP subjects, consists of two “components”.

The first of these is the theory and practical work taught during lessons, and which may be examined in the examination papers at the end of the course. Completed examination papers are sent to IB and marked by IB examiners.

The second of these is the ‘coursework’. In Chemistry, this in an individual investigation occupying about 10 hours of work, that each student must complete. The student, with the teacher’s advice, chooses his or her own topic. The investigation is marked by the teacher according to a set of criteria, then uploaded to the IB servers to be checked by the IB moderators.

Assessment Criteria for the Chemistry Individual Investigation

So, that you have some idea of what will be expected of you in advance, these are the criteria that teachers use to mark the individual investigation.

CRITERION	EVIDENCE
Personal Engagement	Have I chosen a novel investigation? Have I shown that I have incorporated my own ideas and hypothesis? Have I designed or modified apparatus to use?
Exploration	Have I planned my investigation well, in accordance with scientific method?
Analysis	Have I looked at my results thoroughly, and have I processed them well into graphs etc., that make it easy to see what the results show?
Evaluation	Have I considered errors and weaknesses in my method and how it could be improved for next time??
Communication	Is my report clear and readable? Have I used the correct terminology? Have I referred to and cited sources of information correctly?

Final Assessment in Chemistry

An overview of how you will be assessed on the final set of skills and knowledge that you have acquired is as follows.

LEVEL	ASSESSMENT	WEIGHTING (%)
Higher	3 exam papers	80
Standard	3 exam papers	80
All	Individual Investigation	20

Chemistry Course Outline

This table reflects the topics covered but not necessarily the order in which they will be taught.

IBDP Chemistry Curriculum Overview Yr12
(Topics 12-21 are HL and in **bold**)

Year	Term	Topics Learned	Content
1	1	**Foundation Chemistry.** This unit reinforces the essential concepts from IGCSE and uses experimental evidence to extend theoretical models further to allow understandings of more chemical reactions. **Key Areas:** Atomic Structure Stoichiometric Relationships Oxidation States Periodic Table Chemical Bonding & Structure	1.1 Introduction to the particulate nature of matter and chemical change, 1.2 The mole concept, 1.3 Reacting masses and volumes 2.1 The nuclear atom, 2.2 Electron configuration, **12.1 Electrons in atoms** 11.1 Uncertainties and errors in measurement and results 3.1 The Periodic Table 4.1 Ionic bonding and structure, 4.2 Covalent bonding, 4.3 Covalent structures, 4.4 Intermolecular forces, 4.5 Metallic bonding.
	2	**Introduction to Physical Organic Chemistry** This unit introduces the language and terminology of Organic Chemistry and builds upon term 1 knowledge of structures and IMForces. The functional group chemistry is used to provide a focus to the understanding of basic chemical thermodynamics. HL students then consider the importance of entropy in explaining why certain reactions occur. **Key Areas:** Organic Chemistry (PART) Energetics and Thermochemistry	10.1 Fundamentals of Organic Chemistry (PART), 10.2 Functional Group Chemistry (PART), 20.1 types of Organic Reactions (PART) 11.2 Graphical Techniques **14.1 Covalent bonding and electron domain and molecular geometries, 14.2 Hybridization** 5.1 Measuring energy changes, 5.2 Hess's Law, 5.3 Bond enthalpies, **15.1 Energy cycles, 15.2 Entropy and spontaneity**
	3	**Advanced Physical Chemistry** This unit looks at the other key aspects of Physical Chemistry, Chemical Kinetics (how fast) and Dynamic Equilibria (how far) and further develops knowledge of reaction mechanisms in Organic Chemistry. **Key Areas:** Chemical Kinetics Equilibrium Acids and Bases	6.1 Collision theory and rates of reaction, **16.1 Rate expression and reaction mechanism, 16.2 Activation energy** 7.1 Equilibrium, **17.1 The equilibrium law** 8.1 Theories of acids and bases, 8.2 Properties of acids and bases, 8.3 The

		Organic Chemistry (PART)	pH scale, 8.4 Strong and weak acids and bases, 8.5 Acid deposition, **18.2 Calculations involving acids and bases, 18.3 pH curves** 10.1 Fundamentals of Organic Chemistry (PART), 10.2 Functional Group Chemistry (PART), **20.1 types of Organic Reactions (PART)**

IBDP Chemistry Curriculum Overview Yr13

Year	Term	Topics Learned	Content
2	1	Chemical Kinetics	6.1 Collision theory and rates of reaction, **16.1 Rate expression and reaction mechanism, 16.2 Activation energy**
		Acids and Bases	8.1 Theories of acids and bases, 8.2 Properties of acids and bases, 8.3 The pH scale, 8.4 Strong and weak acids and bases, 8.5 Acid deposition, **18.1 Lewis acids and bases, 18.2 Calculations involving acids and bases, 18.3 pH curves**
		Redox Processes	9.1 Oxidation and reduction, 9.2 Electrochemical cells, **19.1 Electrochemical cells**
		Organic Chemistry (PART)	10.1 Fundamentals of Organic Chemistry (PART), 10.2 Functional Group Chemistry (PART), **20.1 types of Organic Reactions (PART)**
	2	Organic Chemistry (FINAL PART)	10.1 Fundamentals of Organic Chemistry (FINAL PART), 10.2 Functional Group Chemistry (FINAL PART), **20.1 types of Organic Reactions (FINAL PART), 20.2 Synthetic Routes, 20.3 Stereoisomerism** 11.3 Spectroscopic Identification of Organic Compounds, **21.1 Spectroscopic Identification of Organic Compounds**
		Measurement and Data Processing	
	3	Exam Preparation	External Examination

Chemistry Resources

Textbooks

The textbook we use is the Chemistry for the IB Diploma from Hodder. It is written by Christopher Talbot, Richard Harwood and Christopher Coates. (ISBN: 9781471829055).

This is a list of **other Chemistry textbooks** available for reference or loan in the school library:

Chemistry for the IB Diploma: Exam Preparation, by Steve Owen and Chris Martin IB
Science Skills: Chemistry, by Chris Conoley

This list is growing all the time so do keep a look out.

Books of Chemical Interest

There are **other books** of chemical interest too, such as “Extreme Science” by Phil Clarke; “The Science Delusion” by Curtis White; “A Short History of Nearly Everything” by Bill Bryson, “Bad Science” by Ben Goldacre and many more, which will broaden your appreciation of Chemistry and Science.

Chemistry Flash Cards

There is a boxed set of Chemistry flash cards available for reference in the library and Chemistry lab.

Websites and Apps

There are many websites and apps - not all of them reputable, so beware. Reputable and useful ones include:

Khan Academy (APP)
Doc Brown’s Chemistry http://www.docbrown.info/page19/IBchemistry.htm IB
Chemistry Web http://ibchem.com/
MSJ Chem http://www.msjchem.com/
InThinking: IB Chemistry http://www.thinkib.net/chemistry

YouTube Channels

Rich Thornley https://www.youtube.com/user/richthornley
Crash Course: Chemistry https://www.youtube.com/user/crashcourse
Fuse School https://www.youtube.com/user/virtualschooluk
TED Ed https://www.youtube.com/user/TEDEdu