

## Study methods

This book has been written to provide you with all the information you need to gain the highest grade in Chemistry whether at SL or at HL. It is not intended as a 'teach yourself' book and is not a substitute for a good teacher nor for the practical work to support the theory. There is no magic solution which will compensate for a lack of knowledge or understanding but there are some pieces of advice that should ensure that you achieve to the best of your ability.

### DURING THE COURSE

The IB course for both SL and HL is scheduled to last for two years, although some schools do attempt to cover the whole course in one year. There is a tendency for some students to take it easy in the first year as the final exams seem a long way off. Don't be tempted to do this as it will be hard to catch up later. Equally do not try to simply learn all the information given about each topic. The exam does not particularly test recall, more how to apply your knowledge in different situations. Although there are some facts that must be learned, much of Chemistry is logical and knowledge about the subject tends to come much more from understanding than from 'rote learning'. During each lesson concentrate on trying to understand the content. A good teacher will encourage you to do this by challenging you to think. At the end of the lesson or in the evening go over your notes, add to them or rearrange them to ensure you have fully understood everything. Read what this book has to say on the subject and read around the topic in other books to increase your understanding. If there are parts you do not understand ask your teacher to explain them again. You can also benefit much by talking and working through problems with other students. You will only really know if you understand something if you have to explain it to someone else. You can test your understanding by attempting the problems at the end of each topic in this book.

Some of the early parts of the course involve basic calculations. Some students do find these hard initially. Persevere and see if you can identify exactly what the difficulty is and seek help. Most students find that as the course progresses and more examples are covered their confidence to handle numerical problems increases considerably. If you ensure that you do understand everything during the course then you will find that by the time it comes to the exam, learning the essential facts to support your understanding is much easier.

### MATHEMATICAL SKILLS

One big advantage of the IB is that all students study maths so the mathematical skills required for Chemistry should not present a problem. Essentially they concern numeracy rather than complex mathematical techniques. Make sure that you are confident in the following areas.

- Perform basic functions: addition, subtraction, multiplication and division.
- Carry out calculations involving means, decimals, fractions, percentages, ratios, approximations and reciprocals.
- Use standard notation (e.g.  $1.8 \times 10^5$ ).
- Use direct and indirect proportion.
- Solve simple algebraic equations.
- Plot graphs (with suitable scales and axes) and sketch graphs.
- Interpret graphs, including the significance of gradients, changes in gradient, intercepts, and areas.
- Interpret data presented in various forms (e.g. bar charts, histograms, pie charts etc.).

### USING YOUR CALCULATOR

Most calculators are capable of performing functions far beyond the demands of the course. When simple numbers are involved try to solve problems without using your calculator (you will need to do this for real in Paper 1). Even when the numbers are more complex try to estimate approximately what the answer will be before using the calculator. This should help to ensure that you do not accept and use a wrong answer because you failed to realize that you pushed the wrong buttons. Don't just give the 'calculator answer' but record the answer to the correct number of significant figures.

For HL students make sure you know how to use your calculator to work out problems involving logarithms for pH and  $pK_a$  calculations. The examples given below are for a TI-84 plus.

To convert a hydrogen ion concentration of  $1.8 \times 10^{-5} \text{ mol dm}^{-3}$  into pH.

$$\text{pH} = -\log_{10} 1.8 \times 10^{-5}$$

To obtain the value press the following keys in sequence.

( $\pm$ ) ( ) LOG 1.8  $\times$  10  $\wedge$  ( $\pm$ ) 5 ) ENTER

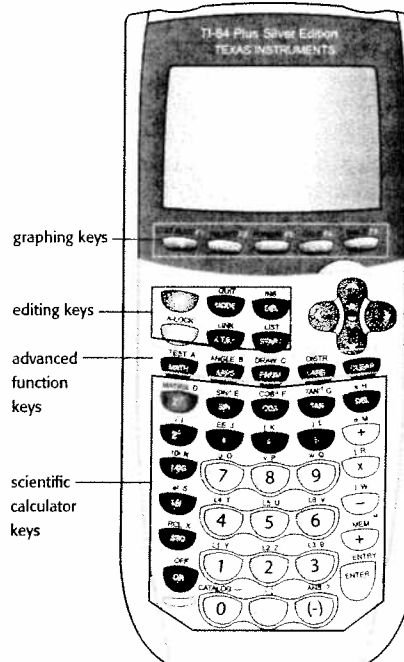
This will give a value of 4.74.

To convert a  $pK_a$  value of 3.75 into a  $K_a$  value

Press

2nd 10<sup>x</sup> ( $\pm$ ) 3.75 ENTER

to give a value of  $1.78 \times 10^{-4}$  (don't forget to include the units in your answer).



# The final examinations

## PREPARING FOR THE EXAMINATIONS

Hopefully for much of the course the emphasis has been on enjoying learning and understanding Chemistry rather than always worrying about grades. Towards the end of the course, however, it does make sense to prepare yourself for the final exam. Examiners are human and mark positively (i.e. they look to give credit rather than penalize mistakes). You have to help them by being clear in your answers and addressing the particular question(s) asked.

- **Know what it is you have to know** Ask your teacher for a copy of the current programme for the core and the two options you are taking. Higher Level students should also have a copy of the Additional Higher Level material. Go through the programme carefully and make sure you recognize and have covered all the points listed for each topic and sub-topic.
- **Understand what depth you have to cover** Each sub-topic on the programme has an objective next to it. Objective 1 is the lowest and implies you just have to define or state the information. Objective 2 means you have to apply your knowledge of the topic in a straightforward situation. Objective 3 is the highest level and means that you will have to recognize the problem and select the appropriate method to solve it.
- **Be familiar with key command terms** Each statement in the programme and each question in the exam will contain a key command term. A list of all these verbs and their precise meaning can be found in the programme. If a question asks you to *describe* a reaction then a very different answer is required than if the question had asked you to *explain* a reaction. Examiners can only award marks for the correct answers to the question asked for. Not paying careful attention to the correct command term verb may cost you marks unnecessarily.
- **Practice with past papers** Most schools will give their students a 'mock' or 'trial' exam. This is helpful as it enables you to judge the correct amount of time to spend on each question. Make your mistakes in the mock exam and learn from them. Of course the IB questions are different each year but they do tend to follow a similar pattern. It helps to have seen similar questions before and know what level to expect.
- **Organize your notes** As you review your work it is often helpful to rewrite your notes. Concentrate on just the key points – they should trigger your memory. This book already contains the important points in a fairly condensed form. Condense them even more to make your own set of review notes. Each time you review each topic try to condense the notes even more. By the time you are ready to take the exam all your personal review notes should ideally fit onto a single page!
- **Be familiar with using the IB data booklet** You should get into the habit of using this throughout the course so that you are completely familiar with its contents and how to use them by the time of the exams.
- **Know the format of the exam papers** Both HL and SL students take three exam papers. Papers 1 and 2 examine the core (and additional HL) material. Paper 3 will be taken on the next day (or examination session if a weekend intervenes) and covers the options. Paper 1 is multiple choice and you are not allowed a calculator or the IB data booklet. A Periodic Table is provided. Paper 2 contains short answer questions in Section A that you must attempt and longer questions in Section B. SL students must choose one of the longer questions from a choice of three and HL students must choose two longer questions from a choice of four. Paper 3 contains questions on all the options. You are required to answer all the questions on two of the options.
- **Know the dates of the exams** Plan your review timetable carefully in advance. Remember that you will have exams in other subjects and that you may not have much time for a 'last minute' review.

## TAKING THE EXAMINATIONS

- Try to ensure that the night before you are able to take some time to relax and get a good night's sleep.
- Take all you need with you to the examination room, i.e. pens, pencils, ruler, and a simple translating dictionary if English is not your first language. You will need your calculator for Paper 2 and Paper 3 – remember to include a spare battery.
- There is no reading time allowed for Paper 1. Work through the questions methodically. HL have 40 questions in 1 hour, SL have 30 questions in 45 minutes. If you get stuck on a question move on and then come back to it if you have time at the end. Make a note of those questions you are unsure about. You can then come back to these at the end rather than going through all of them again. Make sure you give one answer for each question. You are not penalized for wrong answers so if you run out of time make an educated guess rather than leave any questions unanswered.
- Use the five minutes reading time for Paper 2 wisely. You have to answer the questions on Section A so use this time to read through the questions on Section B thoroughly and decide which you will choose to answer.
- Read each question very carefully. Make a mental note of the key command term so that you give the required answer.
- Try to write your answers within the required space. Write as legibly as you can. For questions involving calculations do not round up too early but make sure your final answer is given to the correct number of significant figures. Always include the correct units. If you do need extra space continue in a separate answer booklet.
- Attempt all the required number of questions. If you do not attempt a question you can receive no marks. For sequential numerical questions even if you get the first part wrong continue as you will not be marked wrong twice for the same mistake. For this reason it is essential that you show your working. Do not answer more questions than required. The examiner will simply mark the required number in the order they are written, not necessarily the best ones.
- Leave yourself time to read through what you have written to correct any mistakes.
- Ensure that you have filled in the front of the paper correctly, including stating the number of the optional questions answered, before leaving the examination room.

# Internal assessment (1)

## INTRODUCTION

You are expected to spend 40 hours (SL) or 60 hours (HL) during the two years engaged in work that can be assessed internally. This is essentially time spent in the laboratory and comprises 24% of the final marks. Chemistry is an experimental science and practical work is an important component of the course. Your teacher should devise a suitable practical programme for you to follow. Practical work can have many different aims; for example, to improve your skills at different techniques, to reinforce the theoretical part of the course and to give you experience of planning your own investigations. Hopefully it will make studying Chemistry much more challenging and rewarding. Through the practical course you are expected to understand and implement safe practice and also to respect the environment.

## INTERNAL ASSESSMENT – THE FACTS

Your practical work will be assessed continually throughout the two years of the course. The assessment is exactly the same for both SL and HL. It is assessed according to five different criteria. The first three criteria, Design (D), Data collection and processing (DCP) and Conclusion and evaluation (CE) carry a maximum of six marks each. The best two marks obtained for each of these three criteria over the two years will be used to give a maximum of 36 marks. The fourth criteria, Manipulative skills (MS) is assessed summatively throughout the course for a maximum of six marks and the fifth criteria Personal skills (PS) is assessed once only (during the group 4 project) for a maximum of six marks. This gives an overall total maximum mark of 48. This mark will then be halved to make up the 24% Internal Assessment component of the overall assessment mark. Some of your practical work may not be formally assessed at all and some may only be assessed for one or two of the criteria. However your teacher must assess the first three criteria at least twice during the two years. Most teachers will assess more than this and then submit the two best marks. Each criterion is broken down into three different aspects. Your teacher assesses whether you have covered each aspect **completely**, **partially** or **not at all** to arrive at the mark given for each criterion. Completely scores two marks, partially one mark and not at all zero marks. Each school will send the work of a few students for moderation so that everyone is graded uniformly.

## GRADING OF INTERNAL ASSESSMENT

You will only gain good marks if you try to address each aspect of each criterion completely. It is important that you understand fully what is required for each of the different aspects. The description of each aspect to gain **complete** is given.

| CRITERION                            | ASPECTS  |   |  |
|--------------------------------------|--|---|--|
| Design (D)                           | Formulates a focused problem/ research question and identifies the relevant variables                                  | Designs a method for the effective control of the variables                           | Develops a method that allows for the collection of sufficient relevant data   |
| Data collection and processing (DCP) | Records appropriate quantitative and associated qualitative raw data, including units and uncertainties where relevant | Processes the quantitative raw data correctly   | Presents processed data appropriately and, where relevant, includes errors and uncertainties                                     |
| Conclusion and evaluation (CE)       | States a conclusion, with justification, based on a reasonable interpretation of the data                              | Evaluates weaknesses and limitations  | Suggests realistic improvements in respect of identified weaknesses and limitations  |
| Manipulative skills (MS)             | Follows instructions accurately, adapting to new circumstances (seeking assistance when required)                      | Competent and methodical in the use of a range of techniques and equipment            | Pays attention to safety issues  |
| Personal skills (PS)                 | Approaches the group 4 project with self-motivation and follows it through to completion                               | Collaborates and communicates in a group situation and integrates the views of others | Shows a thorough awareness of their own strengths and weaknesses and gives thoughtful consideration to their learning experience |

## THE GROUP 4 PROJECT

The group 4 project is a collaborative activity whereby all the IB students in the school from the different group 4 subjects work together on a scientific or technological topic. You are required to spend about ten hours in total on the group 4 project. In the planning stage, which should last for about two hours, you should decide on an overall topic with your fellow students and then, in small groups, decide how you will investigate a particular aspect of the chosen topic. During the action stage, which lasts for about six hours, you should investigate your topic. The investigation may be practically or theoretically based and may be just in chemistry or across all the scientific disciplines. You should collaborate with other students and in any practical work pay attention to safety, ethical and environmental considerations. Finally there is the evaluation stage. This should last for about two hours and involves sharing your results, including your successes and failures, with all the other students. Unlike the remainder of your internally assessed work, the emphasis for the group 4 project is on the collaborative experience of working with other students. It is the **process** not the **product** that is important. To gain high marks for the personal skills criterion you need to show considerable self-motivation and perseverance. You need to be able to listen to others as well as put forward your own views and you need to be able to reflect on the learning experience. There are different ways in which this assessment may take place and each school will determine its own way. For example, you may be required to write a report or you may be asked to review your peers or you may be asked to complete a self-evaluation form.

# Internal assessment (2)

## HOW TO MAXIMIZE YOUR INTERNAL ASSESSMENT MARKS

### General points

- Ascertain before you undertake the investigation which criteria (if any) are being assessed.
- Check that you are clear about all the aspects to be assessed.
- Record all your work as you proceed in your log book or laboratory notebook.
- Record the title of the experiment (or piece of work), the date and the name(s) of any partner(s) you worked with.
- Record precise details of all equipment used, e.g. a balance weighing to + or - 0.001 g, a thermometer measuring from - 10 to + 110 °C to an accuracy of + or - 0.1 °C, a 25.00 cm<sup>3</sup> pipette measuring to + or - 0.04 cm<sup>3</sup> etc.
- Record precise details of any chemicals used, e.g. copper(II) sulfate pentahydrate CuSO<sub>4</sub>·5H<sub>2</sub>O(s) and if it is a solution include the concentration, e.g. 0.100 mol dm<sup>-3</sup> NaOH(aq).
- Record all measurements accurately to the correct number of significant figures and include all units.
- Record all observations. Include colour changes, solubility changes, whether heat was evolved or taken in etc.
- Draw up a checklist to cover each criterion being assessed. As you write the laboratory account check that each aspect is addressed fully. (Some students give each aspect a sub-heading. Although this is not strictly necessary it does help to draw the aspect to the attention of the teacher).
- Your work may be hand-written (in ink) or word-processed. Ensure that it is neat, correct and legible.
- Write clearly and succinctly.
- Hand your work in on time. Teachers are within their rights to refuse to mark work handed in late as you may benefit from using other students' marked assignments.
- Learn from your mistakes. In the early part of the course do not expect to get everything correct the first time you do it. Find out why you lost marks and improve your next presentation.
- Keep all your laboratory reports. At the end of the course some of them may need to be sent off for moderation.

### Specific points for each criterion.

#### Design (D)

You will be given an instruction such as "Investigate an aspect of..." by your teacher but very little else in the way of instructions.

- Identify your own research question/problem and state it clearly.
- Identify all the variables. State clearly which variable are controlled, which one you will manipulate (the independent variable) and which one is the dependent variable that you will measure.
- Give accurate and concise details about the apparatus and materials used.
- Explain how the method chosen enables the controlled variables to be controlled and describe the method in sufficient detail so that it could be repeated by an independent researcher.
- Ensure that your method enables sufficient relevant data to be collected.

#### Data collection and processing (DCP)

- Ensure all raw data is recorded. Pay particular attention to significant figures and make sure all units are stated.
- Record the level of uncertainty for each quantitative reading.

- Include all qualitative data to describe what is observed during the experiment.
- Present your results clearly. Often it is better to use a table or a graph. If using a graph, ensure that the graph has a title and both axes are labelled clearly and that the correct scale is chosen to utilise most of the graph space.
- Draw the line or curve of best fit for graphical data
- When carrying out an acid-base titration ensure that the indicator is clearly stated and the change in colour recorded to signify the end-point.
- Ensure that you have used your data correctly to produce the required result.
- In quantitative experiments ensure that the limits of accuracy of each piece of apparatus have been stated and then summed to give the limits of accuracy with which you can state your result. Calculate it first in percentage terms then transform it into the + and - amount pertaining to your actual result.
- Include any other errors or uncertainties which may affect the validity of your result.

#### Conclusion and evaluation (CE)

- Include a valid conclusion. This should relate to the initial problem or hypothesis.
- Compare your result to the expected (Literature or IB data booklet) result.
- Calculate the percentage error from the expected value.
- Evaluate your method. Comment on random and systematic errors. State any assumptions that were made which may affect the result.
- Comment on the limitations of the method chosen by identifying any weaknesses and show an awareness of how significant the weaknesses are.
- Suggest how the method chosen could be realistically and specifically improved to obtain more accurate and precise results.

#### Manipulative skills (MS)

This criterion cannot be moderated from the written work you submit. It is assessed by your teacher on your performance throughout the two years when you are actually working in the laboratory. To gain high marks ensure:

- you follow instructions carefully and show initiative when necessary
- you ask when you are uncertain
- you show proficiency and competence in a wide range of different chemical techniques
- you are enthusiastic in your approach
- you show a high regard for safety in the laboratory
- you show respect for the environment in the way you conduct your experiments and dispose of any residues.

#### Personal skills (PS)

This is only assessed during the group 4 project. As you will only do the group 4 project once you will not be able to learn from your mistakes. To achieve good marks make sure:

- you show that you are highly motivated and involved
- you persevere throughout the whole of the group 4 project
- you collaborate well with others by listening to their views and incorporating them into your work as well as making your own suggestions
- you show an awareness of your own strengths and weaknesses
- you show that you have reflected well on the whole project and learned from the experience.