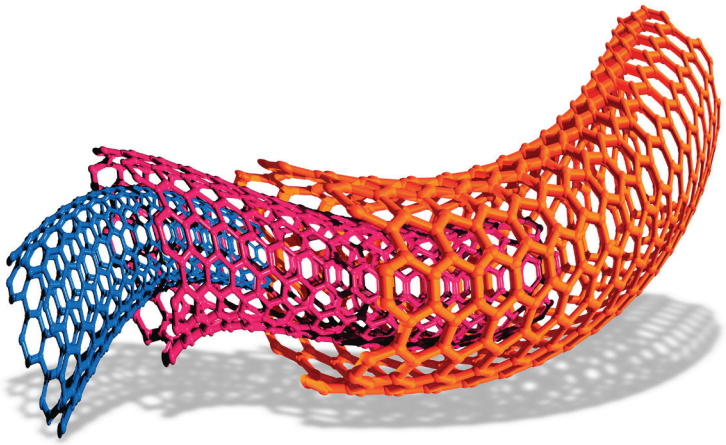
Cambridge Assessment International Education

Teacher Guide

Incorporating language learning support

Cambridge IGCSE™

Chemistry 0620



Version 2.0

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Introduction

The purpose of the teacher guide

This teacher guide is designed to help you to organise and plan your teaching for Cambridge IGCSE Chemistry. It also offers advice and guidance on teaching strategies and how to prepare your learners for the final assessment.

As an international awarding body, many of our candidates are either multilingual or possess English as a second language which presents them with great opportunities but also with potential barriers. Learners cannot develop academic knowledge and skills without access to the language in which they are discussed, constructed and evaluated.

In this guide we have also included some prompts and tips on how to incorporate the development of language skills within the general teaching of this subject. This information is indicated in the text with the icon shown here.

Where language levels are already highly developed amongst learners, this advice will not be so applicable. However, it is often the case that those learners with lower-ability skills in general and those with lower-ability language skills tend to share similar misunderstandings.

What do I need to get started?

You should make sure at an early stage that you have access to our secure online support for Cambridge teachers called the School Support Hub, www.cambridgeinternational.org/support. You can obtain a login from your Examinations Officer. This provides a wide range of resources to help you, including:

- syllabuses
- past examination papers and specimen papers
- mark schemes
- examiner reports
- example candidate response booklets
- schemes of work
- a resources list
- community resources and discussion forum.

All of these forms of teacher support are invaluable in helping you and your learners understand exactly what Cambridge International expects of candidates in examinations, and will help you to prepare your learners appropriately.

When planning your course, your starting point should be the syllabus. This contains information not only on the curriculum content but also the overall aims and assessment objectives. It gives details of the papers, the grade descriptions and additional information (such as the minimum marks needed for particular grades). It is most important that you become thoroughly familiar with all parts of the syllabus document.

You will then need to devise a scheme of work. To do this, you need to think how you will organise the time that you have available to help learners understand and learn all the facts and concepts required by the syllabus, and to develop the necessary skills. Cambridge International provides a scheme of work that you could use as a starting point but you will undoubtedly want to produce your own at some point.

Your scheme of work will help you to determine what resources you will require to deliver the course and this will help you to build up teaching, learning and reference resources such as textbooks and worksheets.

1: Planning the course

This section looks at how you can plan your course to ensure that you can cover the whole syllabus (whether this is to be just the Core, or the Core plus Supplement) within the time that you have available. It includes long-term planning (developing a scheme of work) and planning for individual lessons. It also includes ideas and support for incorporating language into the lesson to help learners become more fluent and accurate users of English.

Language is an important part of communication and the aim of considering this within a lesson is to expose learners to situations where they need to use English to complete the tasks given. The language focus is not an additional element to be added to the course but should be seen only as the medium through which the topic (content) is taught.

The promotion of critical thinking skills and collaborative work is considered to be very important in acquiring language and improving fluency whatever the topic. Personalisation of the topic is also known to increase motivation and self-confidence as well as interest in the topic.

Section 4 provides some ideas and activities for incorporating language into the lesson without increasing the teacher's work load.

1.1 Key factors to consider when planning your course

These factors will need to be considered before starting the planning of your course.

- the amount of teaching time available each week for the duration of the course
- the availability of resources such as laboratories and chemical equipment
- the previous learning of your learners
- the level of English language of the learners
- whether your group is monolingual or multilingual
- whether your teaching groups will be mixed ability or will be streamed by ability
- the number of lessons you will need to cover the syllabus (the recommended time for an IGCSE course is 130 hours of teaching time)
- the school calendar; holidays, examinations, etc.

1.2 Long-term planning

A long-term plan will provide the overall structure of your course. It will include the order in which topics will be taught, the approximate length of time to be spent on each and the factors listed in section 1.1 above.

It will need to take into account the number and nature of the groups following the course and whether they should all follow the same path through the course. There may, for example, be issues with the use of laboratory space if two groups are studying a topic requiring a large amount of practical work at the same time. In this case it would be better if the plan was organised so that groups could study such a topic at different times.

Topics should also, ideally, be arranged so that they fit into the school's sessions, so that a topic is not split because of a school holiday or an examination session.

In a two-year course the second year will probably have fewer weeks because of the timing of the examinations.

It is important to note that you do not need to teach the syllabus content in the order in which it is printed in the syllabus. It is likely that you will want to order your teaching to suit your particular needs and preferences. This may be done in a number of ways.

- Start with the structure of atoms followed by the Periodic Table and then the Chemistry of different elements.

- Start with raw materials such as petroleum, air, water, carbonates etc. and cover their uses before the Chemistry theory.
- Start with a course in practical techniques to generate enthusiasm.
- Start with topics which are conceptually easier, saving the more difficult topics for the second year of the course.
- Use the suggested pattern in the 'Schemes of Work' provided on Teacher Support.
- Follow your own and learners' interests and enthusiasms to begin with.

Long-term planning will also consider what you would like the learners to able to communicate either in spoken or written form at the end of the course. This will help with identifying what language could be included in medium- and short-term plans.

Two possible re-orderings of the syllabus topics are included in the appendices but these take no account of your particular situation. The most important thing is to choose a teaching order that suits you, your learners and the availability of resources at your school.

A long-term plan should also consider how practical skills will be developed and which topics will contribute largely to the development of these skills. This is particularly important if you intend to follow the Paper 4 route to practical assessment.

A long-term plan is not 'set in stone'; it is a working document. As the course progresses you can adapt it as required. When you have worked through it once or twice you will have a much better idea of the best way for you to work through the syllabus.

1.3 Medium-term planning

Medium-term planning is the most important of the three types. It defines, in some detail, what will be taught and when. It also details how language skills, practical work and other activities are to be incorporated into the course.

Medium-term plans are often called 'schemes of work' and these schemes inform you and other chemistry teachers in your school what will happen and when.

Some examples of schemes of work can be found on the School Support Hub (www.cambridgeinternational.org/support). A password is needed to access the site and your Examination Officer will be able to provide you with one.

These schemes of work are useful resources but are not really suitable as an alternative to your own medium-term planning because:

- they take no account of the situation in your Centre
- they are arranged in a way which may not be what you had designed in your long-term plan
- they have no statement of the amount of time required
- they have many suggestions for suitable activities and web sites which you would not necessarily have the time or the resources to follow.

However, they can still be useful.

- They could be used as they stand as one way of moving through the course. They can also include a note about the sort of output you would like your learners to produce in terms of language e.g. oral, written, group/pair work, discussions etc.
- They are certainly a good source of possible practical exercises and web addresses.

However:

- Always check URLs before using them. Web addresses do change from time to time and you need to know what you would be accessing in advance.
- It is really better to develop your own scheme of work as this is more likely to be suitable for your Centre and your learners.

A medium-term plan is best developed with contributions from all of the teachers who will be using it. If they have had an input they will feel an 'ownership' of the plan and will be more likely to adhere to it.

A medium-term plan, like a long-term plan, should not be ‘set in stone’. It should, if necessary, be amended if it is found not to be working as planned. It should certainly be reviewed at the end of each year to assess how well it has worked and to decide if any improvements could be incorporated.

1.4 Short-term planning

Short-term planning involves planning for a single lesson or perhaps a small group of lessons. It involves not only the content and the language of the lesson but also the activities which will take place and the progress that is expected of the learners during the lesson.

Short-term planning is something which is done by an individual teacher, taking into account their own strengths and the needs of the learners they will be teaching. Teachers new to the subject may need guidance but the plan should still be their own.

This process is covered in more detail in the next section.

2: Planning lessons

2.1 Lesson plans and templates

A lesson plan is written by the teacher and should include details of how the lesson is intended to proceed. It should take account of:

- what is to be taught (learning objectives)
- what is to be achieved by the learners (lesson objectives, content and language)
- what the learners already know (previous learning and relevant knowledge)
- how learners' understanding will be monitored (assessment of learning)
- how learners at different levels of ability are going to access the lesson (differentiation).

It should detail the learning activities which will take place and have approximate timings showing how long each part of the lesson will last. It should also note the language focus for the lesson in brief.

A lesson should ideally have three main parts:

- a beginning which engages and motivates the learners. This activity will also stimulate the background knowledge the learners can bring to the topic
- a middle which covers the main learning and language activities of the lesson
- an end, in which learners can assess and feedback their understanding of what has gone before.

It is most convenient to have a printed template to use in lesson planning. You could design your own but there are many available on the internet or in books. We have included an example lesson plan below and populated each section with helpful notes to guide you. A clean version of the template is also available for you to copy and use.

2.2 Constructing a lesson plan

Lesson:	**School:**	
Date:	**Teacher name:**	
Class:	**Number present:**	**Number absent:**
Learning objectives to which this lesson is contributing	This will be based on something written in your medium-term plan. It will state which part of the syllabus the lesson is going to address.	
Lesson objectives	These may be the same as the learning objectives but more often will be only a part of them. This is what you intend the learners to fully grasp by the end of the lesson. It should be a realistic target and many learning objectives will take more than one lesson to be fully understood. It should also include a reference to the language the learner is likely to need to be able to reach the targets you set.	
Vocabulary, terminology and phrases		
Previous learning		

Plan		
Planned timings	**Planned activities**	**Resources**
Beginning	This should be a relatively brief part of the lesson and should 'switch the learners on' to chemistry, rather than what they were doing previously. It may be a short question and answer session, or a simple written task to assess what they know about the topic to be covered. It could even be a rapid practical demonstration to introduce them to the topic to be covered in the lesson. This starter session should also stimulate the interest of the learner by providing materials such as visuals for the particular vocabulary needed or some activity which is personalised to encourage the learners to bring their own background knowledge and interest to the topic. This should be learner focused with as little teacher talk time as possible. Give an estimated time, usually about five minutes.	Your plan should also include a list of the resources (books, internet, practical equipment, chemicals, etc.) which will be needed in each session of the lesson.
Middle	This may build on and extend previous understanding, explore and solve practical problems, develop knowledge and skills, practise previously learned techniques or any of many other alternatives. It is important not to include too many activities, but equally important not to spend so much time on one activity that learners become demotivated. Good lessons will involve the learners in the activities as much as possible. Activities should encourage the learners to have confidence in communication through speaking or writing and there should be some feedback from the teacher regarding possible language errors. Delayed feedback is recommended to avoid demotivating the learners and hindering communication. Timings should be included for each separate activity.	
End	This part of the lesson brings it to an organised conclusion. Learners (in groups or pairs) can assess how well they understand the material covered during the lesson. This may involve a short written exercise or a question and answer session. This may also include feedback from the teacher on some language errors noticed during the lesson, for example, pronunciation of certain words, use of tenses. It may also be used to link to whatever is going to happen in the next session. This should again take around five minutes at most.	

Additional information		
Differentiation: How do you plan to give more support? How do you plan to challenge the more able learners?	**Assessment: How are you planning to check learners' learning?**	**Health and safety check: ICT links**
How will you try to ensure that the lesson is accessible to all of the learners so that all will benefit from the experience? This is especially important with mixed ability groups. There is more on differentiation in the next section.	It is good practice to check: • what your learners knew/understood before the lesson (content) • how this has changed after the lesson, including language and communication improvements (language).	If your lesson includes any practical activity, whether a demonstration or a class practical, an assessment of the risks involved should be included with the lesson plan.

Reflection and evaluation	
Reflection Were the lesson objectives realistic? What did the learners learn today? What was the learning atmosphere like? Did my planned differentiation work well? Did I stick to timings? What changes did I make from my plan and why?	**Use the space below to reflect on your lesson. Answer the most relevant questions from the box on the left about your lesson.** As soon as possible after the lesson you need to think about how well (or badly) it went. There are two reasons for this; if you share your plan with other teachers in your Centre it will enable them to learn from your experiences. It is a good idea to discuss with colleagues how well lessons went. This applies whether they went well or whether there were problems. It will also help next time you teach the same topic. If the timing was wrong or the activities did not fully occupy the learners you may want to change some aspects of the lesson next time. There is no need to re-plan a successful lesson every year, but it is always good to learn from experience and to incorporate improvements next time.

Summary evaluation
What two things went really well? (Consider both teaching and learning.) 1. 2. **What two things would have improved the lesson? (Consider both teaching and learning.)** 1. 2. **What have I learned from this lesson about the class or individuals that will inform my next lesson?**

3: Classroom practice

The aim of any teacher is to get their learners to gain knowledge and understanding, to develop the skills to be able to apply this knowledge, and to learn to communicate what they know as effectively and accurately as possible in the time available to them on the course.

Whether you are teaching a class including learners who have English as their second language, are multilingual or who only speak English, the same difficulties of written expression occur within the subject to both lower-level ability and second language learners. The teacher's role should therefore also be to support the language element of the lesson which underpins the content. This element should enhance learners' communicative skills and their accurate use of the language. A key part of this should be for teachers and learners to notice the language used in different stages of the lesson.

Here are some strategies that you can try in your next lesson:

- record language prompts on the whiteboard
- encourage learners to underline key terms
- use images
- provide writing frames
- enable learners to write collaboratively
- introduce learners to new language before setting a task
- provide sentence stems and model language
- activate prior knowledge of the subject
- create a bank of useful expressions
- repeat explanations and progressively increase the difficulty of explanations
- provide feedback on language and content
- highlight examples of good language use from learners.

The teaching should also take account of the different needs and abilities across the full range of learners represented in the group. Lessons should be interesting and involve the learners as much as possible.

3.1 Practical lessons

Chemistry is, or at least should be, a practical subject. The syllabus does not suggest any particular experiments which should be undertaken, although sections 2, 7.2, 8.3, 8.4, 9.2 and 10.2 do imply certain practical activities.

All sections can, however, be enhanced by the use of practical work, and a list of possible practicals linked to syllabus sections is provided in the appendix to this guide.

Practical work is usually motivating to learners, whether it is a class practical or a teacher demonstration, but it should always have a purpose other than entertainment. It may:

- develop the skills that the learners need, including communication skills (spoken and written)
- illustrate facts or concepts which are being studied
- provide a stimulus for further study.

It may, of course, accomplish more than one of these.

3.1.1 Class practicals

Ideally such practicals should be carried out in small groups (two or three learners). In this way learners learn to work co-operatively and can also, by discussion, develop their understanding of what is taking place. Working in groups also means that less equipment is needed.

It is always a good idea to try out a practical activity before asking a class to do it. In this way you can anticipate the problems that they might discover. It also gives you a good idea of how long the activity might last; learners will probably take longer than you.

It is important that the instructions you give are clear. Oral instructions are fine for a simple task but if there are a number of steps involved, a written worksheet is a good idea. Such a sheet can be reused each time the practical is attempted. Worksheets are also useful to teachers who are new to teaching your scheme.

It is important that you check for understanding of the instructions by asking one or two of the group to explain the instructions to the rest of the class (checking questions).

It is important that learners know why they are carrying out the practical activity. This could be achieved by giving it a simple title such as 'How do different metals react with hydrochloric acid?' or 'Producing pure water from sea water'.

If time permits, learners should be encouraged to set up their own apparatus and to clear things away afterwards. This is especially true if your Centre has no help from a science technician to deal with the preparation of practical lessons.

3.1.2 Demonstration practicals

There are a number of occasions when a practical demonstrated by the teacher in front of the class is necessary or more appropriate, but this type of practical should never replace class practical work. A practical may be demonstrated:

- where complex or expensive apparatus is needed
- where the procedure is too dangerous for a class practical
- where the teacher wishes to demonstrate a technique to be used by the class, e.g. using a pipette and burette
- where the teacher wishes to explain what is going on
- where the teacher wishes to demonstrate a phenomenon which is to be explained subsequently.

It can be a good idea to explain to a class what is happening during an experiment and to get them to summarise in pairs or groups what they have understood afterwards. This may be something relatively simple like fractional distillation. Explaining each step of the process as it is carried out will produce more learning than simply letting the candidates carry it out for themselves.

A spectacular demonstration followed by the question 'Now why did that happen?' can sometimes be a good way to introduce a topic. However, the temptation to use flashes, bangs and nasty smells purely for the sake of it should be resisted.

3.1.3 Risk assessment

It is essential that the risks involved in any practical carried out by a teacher or a learner are assessed. Some processes, such as burning fuels, are hazardous, as are some chemicals such as acids. These factors should be taken into account when deciding on a practical activity, as should the situation of the activity. What is safe in a laboratory may not be safe in a classroom. What is safe for a teacher to do may not be safe in a class practical. What is safe for one group of learners may not be safe for another.

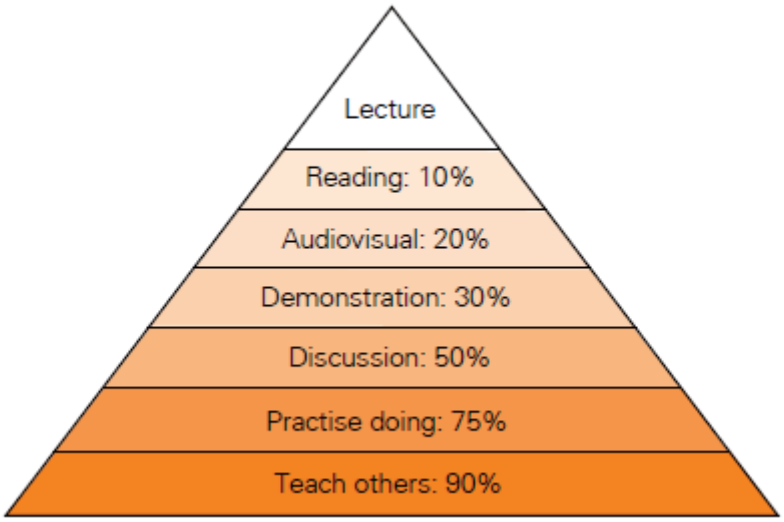
A risk assessment involves not only the chemicals and what is to be done with them but also who is doing it and where.

3.2 Active learning

Not every topic in chemistry can be taught by means of an experiment. Atomic structure and chemical bonding are two such topics; the various industrial processes which need to be explained form another. A description/explanation by the teacher is easily forgotten by the learner, even if it was understood in the first place.

Videos of the industrial processes and computer animations of the atoms and their bonds can help, but they are still 'passive'. The learner is not involved in 'discovering' the information.

Research has shown that the more a learner is involved in the process of learning, the more they retain. This also extends to language acquisition.
The learning pyramid below shows the percentage of information retained as a result of different forms of delivery stimulating different learning processes.



From this it will be seen that although audiovisual (videos and computer animations) may be better than a lecture (being told by a teacher), there are methods which are better still. Clearly not everything can be absorbed by discussion and practice, but activities where the learners actually participate work better.

At least some such activities (active learning) should be used alongside practical work in order to maximise learning. There will not be time for everything to be covered in this way but some topics certainly should be.

The Royal Society of Chemistry has developed a series of activities called 'Alchemy' (www.rsc.org/education/teachers/resources/alchemy/index2.htm). The industrial processes in the syllabus are included and each topic can be downloaded. There is information to read, a video to watch and questions to answer. Learners interact with the information delivered. Different groups could even investigate different processes and then 'teach' others by explaining the process to a different group. This is a good language exercise in terms of communicating knowledge learned through language.

To ensure that learners are getting a language focus as well as learning content use the guiding questions for each topic set out in the 'Alchemy' site. This is an example of what is called 'scaffolding'. If you give learners questions to answer while listening this will activate knowledge and language and will allow the learners to feed back the answers or contribute to the group discussion more effectively.

There are, of course, many other methods of getting learners involved and plenty of ideas in books and on the web.

3.3 Differentiation

Differentiation is a way of trying to ensure that members of your group with differing abilities can all access the material you are delivering. There are a number of ways of approaching this problem and, again, they can be found in books and on the web. They fall into three main categories.

- **Differentiation by outcome.** In this method an open-ended task is set which can be accessed by all, e.g. 'Find out how these metals react with acid'. Learners will produce different results according to their ability, but all of their 'outputs' will be valid.
- **Differentiation by task.** Learners are set slightly different tasks based on the same objective. This may involve worksheets which pose questions on the same topic where differing amounts of understanding are required.
- **Differentiation by support.** All learners undertake the same task but those who are weaker are given additional support. Writing frames, where a template is provided for them to record their work, are one way of doing this.

4: Preparing learners for final assessment

4.1 Key considerations for integrating content and language in the course

In previous sections we have stressed that the objective of the language element of the lesson is to help the learners gain greater confidence in communicating knowledge of the subject. Subject teachers are not expected to teach the language; however having the confidence to communicate in accurate and precise language will also be of benefit to learners taking an external examination at the end of the course. It will also benefit them in the long term should they continue their studies in the subject at a higher level with a view to a career in the field.

As mentioned you will find many useful resources on Cambridge International's secure website for teachers at www.cambridgeinternational.org/support. You can obtain a log-in for this from your exams officer. From this site you can download past papers and mark schemes which can be used to practise model answers. You will also find examiner reports for each paper which indicate the strengths and weaknesses of candidate performance across the whole cohort sitting the examination.

A number of questions require longer answers and learners can gain good marks if language is used accurately. For example, comments by some examiners on previous papers have noted the incorrect use of vocabulary, the lack of ability in writing a logical discussion and a lack of precision in answers.

To help learners with their use of language it may be helpful to consider the following questions when writing a lesson plan for a subject area:

- What is the topic and what does it cover? (content)
- Is there something in the topic you can make personal to the learners? For example, is there something you can relate to their particular culture to stimulate interest and prior knowledge? (context, personalisation)
- Make a note of what language the learners will need to produce during the lesson and later in the exam. For example, they may be asked questions related to explaining the differences in reaction between metals, to write about the experiments they would carry out to compare reactivity in different metals or to explain what the differences are between elements, compounds and mixtures.
- Consider what the language is focused on, e.g. to compare and contrast, to make a point in a discussion or to write a logical explanation for the results they have gathered. You can also think about the relevant vocabulary and terms they could practise to help with precision.

4.2 Some ways to integrate content and language

Language is the medium through which the content is delivered and the main aim is not to teach the language but provide language support and to use it in interesting ways. The following suggestions are provided to help you think about what might support learners with language during the lesson:

- Use of visuals and charts for building vocabulary and understanding meaning – this has been shown to stimulate interest and the learners' prior knowledge.
- Use gap fill and word definition to discover meaning – this helps with retaining the language to a greater extent than when learners are simply given the answers.
- Use checking questions to ensure understanding – asking learners if they could tell the group or their partner what they have to do is an important part of communication and retention.
- Pair and group work is important – learners learn from each other and it has been shown that teenagers prefer to work in groups rather than on their own. Learners need a safe place to practise the language before expressing it individually.
- Personalise the topic – this increases motivation and assimilation of the language.
- Oral interaction between learners in English about the content is beneficial as is cooperative work. The more the learners speak the greater the development of accuracy and confidence in using the language.
- Repeat vocabulary, grammar and useful phrases commonly used in the topic. For example, practise using words to compare and contrast, words to make a point or develop an argument.
- If learners are encouraged to notice the language they are more likely to use it at a later date.

- The use of context is important for learners to understand meaning.
- Language needs to be used in conversation before it can be assimilated as part of the output.

4.3 Possible activities

(1) Starter – activate prior knowledge, use simple visual clues to vocabulary, match pictures to words.
(2) Bring in everyday recognisable items which are related to the topic (realia).
(3) Personalisation – start the lesson by making the topic relate to the learners' lives, e.g. metals used in everyday situations such as car manufacture and parts of mobile phones.
(4) Vary the font and sizes for reading exercises and use pictures or cartoons to explain concepts. Underlining key words or phrases helps the learner to notice the language.
(5) Learners acquire and retain language through discovering the meaning themselves from within the text or through ordering a set of sentences to describe a process.
(6) Repeat the key language during the lesson in different exercises (e.g. use of the passive tense and the definite and indefinite article (Exercise 1 and Exercise 2)).
(7) To help with developing thinking skills and using the language, start by asking simple questions using *what*, *when*, *where* and *which* followed by more challenging ones using *how* and *why*. This works well in group and pair work.
(8) Have a glossary and word bank available. Give the learners specific words and phrases to build the precise and more complex sentences they will need to use in their reports.
(9) Provide scaffolding – i.e. using activities where learners need to add correct answers from a choice to make the sentences correct. Follow this by freer practice of the same language used in the sentences (Exercise 3 and Exercise 4).
(10) Try to ensure pronunciation and word stress is correct. You can use delayed feedback, i.e. make notes of difficult language areas during the group discussion time and highlight this to the whole group at the end of the lesson.

4.3.1 Some examples of exercises to integrate language learning within lessons

Exercise 1: The use of the passive voice

One of the most common uses of the passive voice is in the writing up of lab reports. Learners are likely to write several lab reports during the two years of the course.

Often teachers write the aim of an experiment on the board and provide an equipment list, which helps with spelling. The procedure is often left for the learners to write themselves. This can be a little daunting for second-language learners and often the incorrect tense and/or voice is used.

If the learner is following a recipe from a text, this can make the task somewhat simpler.

Here is a simple procedure for investigating exothermic and endothermic reactions:

Procedure

1. Place 30 cm^3 of water into a polystyrene cup. Measure and record its initial temperature.
2. Add two spatulas full of anhydrous copper (II) sulfate to the water. Stir the solution and check the temperature frequently.
3. Record the highest temperature reached in the data table.
4. Take a new polystyrene cup and add 30 cm^3 of water to it.
5. Add two spatulas full of sodium hydrogen carbonate to it. Measure and record its initial temperature.
6. Record the lowest temperature reached.

Once the above procedure has been followed and data recorded, the experiment is finished. So when the learner comes to write up the experiment s/he should do it using the past passive voice as follows:

1. 30 cm^3 of water was placed in a polystyrene cup and the initial temperature was measured.

2. Two spatulas full of anhydrous copper (II) sulfate were added to the water. The solution was stirred and the temperature checked frequently … etc.

With guidance, most learners should be able to complete such an exercise resulting in a good quality method and in time apply the passive voice to other tasks correctly.

Exercise 2: Replacements/additions

The following exercises all come from past paper questions.

Complete the following sentences about fractional distillation using words from the list below.

boiling **condenses** **cooled** **heated** **higher**

lower **melting** **mixture** **pressure** **vaporises**

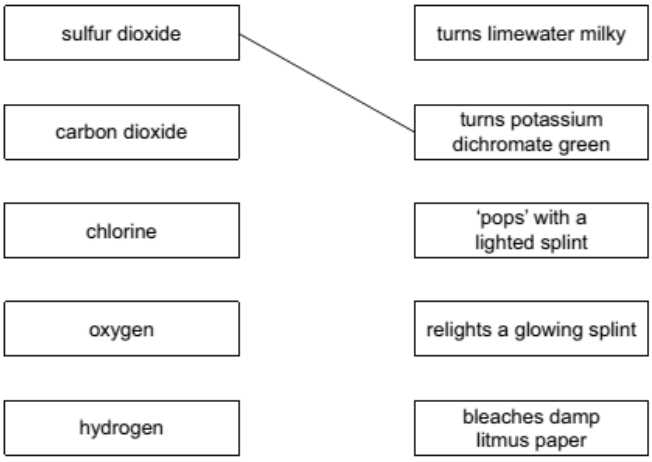
Petroleum is a ..... of hydrocarbons. This mixture is ..... and the hydrocarbons vaporise. The temperature in the fractionating column is ..... at the top than at the bottom. As the vapours move up the column, each hydrocarbon fraction ..... when the temperature in the column falls below the ..... point of the hydrocarbon fraction. [5]

Exercise 3: Matching exercises

These can also be constructed fairly quickly from past paper questions.

1 (a) Gases can be identified by carrying out particular tests.
Some gases and tests to identify them are shown below.

Match the gases on the left with the tests on the right.
The first one has been done for you.



[4]

Exercise 4: Structured support

2 Three ways of making salts are

- titration using a soluble base or carbonate
- neutralisation using an insoluble base or carbonate
- precipitation.

(a) Complete the following table of salt preparations.

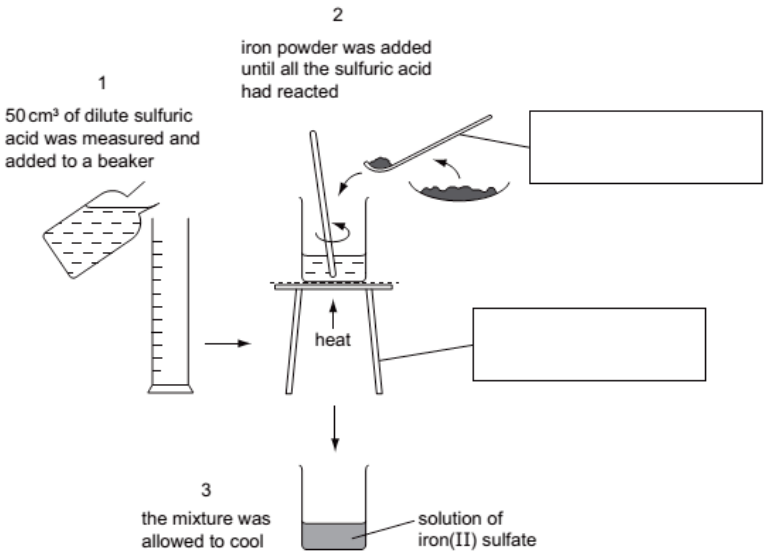
method	reagent 1	reagent 2	salt
titration	....	....	sodium nitrate
neutralisation	nitric acid	....	copper(II) nitrate
precipitation	....	....	silver(I) chloride
neutralisation	sulfuric acid	zinc(II) carbonate	....

[6]

Exercise 5: Using diagrams

Diagrams are a powerful way to help learners recall information. In this example the learner has to label the apparatus. Hopefully the learner has seen the real objects in the laboratory and, better still, used them.

1 A student reacted excess iron powder with sulfuric acid to prepare a solution of iron(II) sulfate.
The diagram shows the procedure followed in three stages.



(a) Complete the boxes to identify the pieces of apparatus labelled. [2]

4.4 Study habits

By the start of the IGCSE course, the learner will probably have explored preferred methods for studying and revising. However, not all of these methods are necessarily effective.

Much research has been published on this subject, suggesting that some of the following methods are not effective:

- generous use of highlighters
- reading and re-reading notes
- working exhaustively and alone
- re-writing existing notes to create a more attractive set of notes.

Dedicated learners will often revise intensely for long periods and convince themselves that they have prepared thoroughly. Sadly, they may well have been largely wasting their time, especially if they are aiming to develop a deep and lasting understanding of the topic in addition to just passing the examination.

Here are some methods that are proven to work for most learners:

- Distributive practice: that is, spreading out study over time. This method is believed to aid true understanding of the topics.
- Studying in short bursts, followed by testing themselves regularly over several weeks.
- At the end of a revision session, writing down what they can remember.
- Creating a revision timetable for the mock and final exams. This will ensure that they study different subjects little but often.
- Answering many practice questions/past papers.
- Connecting ideas together by the use of mind maps.
- Using revision guides rather than the subject textbook.

4.5 Deep subject understanding

If learners start to make connections between topics, not only will the study of the subject be more enjoyable for them, but a deeper understanding will be nurtured.

Concept maps (mind maps) can be drawn and connections made between sub-topics in a unit, between units in a syllabus, and indeed between related subjects.

4.6 Technology in and out of the classroom

There is now a great range of technological tools that can be used in and out of the classroom. It is important for learners to experience their learning in a variety of different ways, not least to maintain interest and motivation. Here are just some of the possibilities:

4.6.1 Virtual laboratories/simulations

These are especially useful for illustrating difficult or abstract concepts or models in science to learners, for example particle theory or equilibria but can equally be used for experiments that learners are unable to do in lab time. Learners can manipulate variables and predict outcomes and they can repeat the process as often as they like. Since these tools are interactive, they are much better than just reading and memorising the topic. The University of Colorado PhET simulations are a good place to start exploring. The language used is simple and uncluttered which makes this way of learning chemical concepts and ideas appealing.

4.6.2 Mobile apps

One has to be careful in the selection of mobile apps for education, but if chosen well, these can provide another mode of learning or revision for the learner. The options are numerous from games and quizzes to videos and animations.

‘Socrative’ is an excellent app for formative assessment and learners love it. You can create online multiple-choice style quizzes which provide immediate feedback to teachers, who can instantly identify problem areas. Correction and explanation can then be dealt with immediately.

4.6.3 Podcasts

These audio teaching aids are a handy alternative tool, which are especially useful while learners are travelling to and from school or do not want to disturb others. Listening to the same podcasts over and over again can be especially useful for the second language learner.

4.6.4 Video

Nowadays, video is not just something that learners sit down and watch in order to add variation to a lesson. Videos can be stopped periodically and questions asked in the traditional way or more recently they can easily be edited and teacher questions inserted/embedded within the video itself. This makes the process much more active which increases learning potential.

4.7 Providing feedback on learner work

Whichever type of assignment you have asked your learners to complete it is necessary to provide meaningful feedback, in order for them to improve the quality of their written answers and understanding of a subject. The learner may find the subject itself challenging and/or may not have the skills in English to deal fully with the question. Either way, meaningful feedback and reflection time are the answer.

For example, a learner was asked to answer the following question as part of a homework exercise. The other questions were only worth one or two marks each, but this one was worth three marks:

Question: Describe and explain the effect of sulfuric acid on buildings made from limestone (calcium carbonate). [3 marks]

A possible answer supplied by the learner might be: ‘The acid rain eats the building away and damages it.’

When the teacher collects in the assignment, two common scenarios are that s/he might:

(1) Give just one out of the three possible marks and review the answer in class orally, whereby the learner will hopefully write down the extra information needed which would have resulted in full credit for the question.
(2) Give one out of the three possible marks and briefly write down themselves the other pieces of information needed to gain full credit for the question.

Method 2 shows dedication on the teacher’s part and is also quite time-consuming.

It would be much better if the learners were to take a more active part in the correction process. For example, the teacher could write a comment in the learner’s notebook such as:

‘Good, you have recognised that sulfuric acid will react with the limestone.

Can you think of a word that would be better than ‘eats’?

Also, notice that this is a ‘describe AND explain’ question and is worth 3 marks. Can you describe and explain what happens what happens when an acid reacts with a carbonate?’

The learner should then be given some time to reflect and improve their answer, which would then be checked by the teacher.

Hopefully the learner will then arrive at two of the following possible marks:

- the sulfuric acid reacts with the limestone
- a neutralisation (reaction occurs)
- a gas is released (carbon dioxide)
- soluble substances are formed
- the building is eroded [this is the correct word the learner hopefully arrived at instead of ‘eaten away’].

The reflection process needs time which could be at home, in class on their own or during dedicated peer correction time.

Teachers can also now easily film units of their own teaching in short, manageable portions. These can be made available to learners who can watch them as a homework assignment. This saves time and allows the teacher to concentrate on other aspects of learning and allows more time for formal assessment. The fact that these videos can be watched again and again is especially useful to the second language learner.

4.8 The mock examination

The mock examination in Year 11 is an important benchmark for teachers and learners, and it serves several purposes:

- It is an opportunity to be tested on the complete course material* under proper exam conditions.
- Many of the learners will have had to force themselves to start revising for these exams. Without the mock exams, they may have put off revision until only a month or less before for the final exam.
- Learners who are apprehensive or nervous about taking exams will have a chance to gain familiarity with the process so that 'on the day' they may feel less stressed and more confident.
- It provides an opportunity to spread the revision load of the subject over several months.

After reviewing the results of the mock exam, the learners may gain an insight into the following:

- how successful their revision techniques had been
- which topics and sub-topics need more revision
- if they had enough time to complete the exam and check through their answers
- if they were able to perform properly under pressure
- whether there are questions in which they would have gained the mark(s) had their English been clearer. Similarly, whether they lost marks because of not being clear and/or using the correct terminology.

If learners treat the mock exams as if they were the finals, evidence indicates that they may well perform even better in their final assessment. Some learners may take considerable persuasion to take the mock exams seriously enough to revise properly. They need to be encouraged to appreciate that the process is a positive and supportive one, and one in which very useful feedback will be provided.

* even if learners have not completed the course by the time of the mock exams, an exam should be created which allows the learner to get the mock exam experience on the majority of the syllabus content.

4.9 Use of past papers

It is commonly known by learners everywhere that working through large quantities of past papers is a major factor in their success in the final assessment. It can be argued that they are a very useful tool in that they allow learners to practise the type of question that may come up in their final exams.

It should be borne in mind that mark schemes contain several alternative acceptable answers. However, when teachers review past paper questions used in unit tests and the mock examination, they should encourage learners to suggest which is the best possible answer and, in discussion, talk broadly around the topic area from the syllabus on which the question is based.

Learners should be aware of any data provided in the syllabus and, importantly, any changes to this data that might affect how they understand any practice questions you may have drawn from past papers.

The Principal Examiners Reports for Teachers are very helpful to use in conjunction with the mark schemes. They give very useful advice on areas in which the learners need to improve, as well as informing teachers which questions the learners performed well in. Some of the same advice is reiterated year after year.

Learners need to be reminded that:

- In multiple-mark questions, they would be well advised to:
  - underline key words and what exactly the question requires them to do
  - take note of the number of marks available as this will indicate the extent of the answer required.

- Sometimes, in questions involving calculations, credit is given for showing working. At all times it is good practice to show every step of a calculation, even if doing so appears unnecessary to able learners in particular who arrive at the final answer easily. Learners often don't realise that 'method marks' may be awarded even though their final answer is incorrect.
- Some questions may span several pages. A good idea would be for the learner to collect and jot down essential information near the questions themselves, which can then be neatly crossed out at the end of the exam. Doing this can prevent loss of marks through errors that are easily avoidable.
- When questions involve comparing two or more pieces of data it is often unclear which piece of data the learner is discussing and the comparative language is not used properly.
- In multiple choice papers, some questions may take much longer than others. Learners should be advised to leave these questions until towards the end of the exam and take a second look at them if they have time. Learners should also not leave questions blank.

4.10 Command words

It is important that learners understand the vocabulary of the assessment objectives and the 'command words' of exam questions which indicate the approach they should take to an answer, for example comparing, evaluating or describing.

Many of these 'command words' are listed in the 'Glossary of terms used in science papers' which you will find in the syllabus. While these definitions are very helpful, remember that the context of the whole question will affect the explicit meaning of the command words.

Think about the skills level required to carry out each of the commands listed in the Glossary. For example, listing and defining are less complex tasks than discussing and explaining; and suggesting, deducing and predicting require learners to make logical connections rather than relying on recall.

You can use the Example Candidate Response booklet which contains candidate responses at different grades to help explain the meaning of the command words to learners. Showing learners good sample responses to questions using different command words can help them see how increasing levels of skill relate to the marks available. Asking questions in ascending order of skill whilst teaching a topic will encourage learners to ask themselves similar questions when they are learning alone. If they become practiced at this, they will begin to see patterns emerging where the same processes and concepts can be applied to similar scenarios even if they have not been covered in class.

5: Resources and support

5.1 Finding and evaluating resources

There is no shortage of resources to aid the teaching of Chemistry. They can be found in textbooks and on the internet. There are even books that consist entirely of a range of different resources. The problem is finding one that is effective and that suits your situation. The quality of resources varies widely from 'home made' ones which are uploaded to the internet, to professionally produced ones. The latter are not always the best.

The problem is not so much finding resources, but evaluating whether they will suit your situation and are effective.

Perhaps the easiest way to find reliable resources is to get them from a colleague who has already used them and can tell you how good they are. Certainly do ask other colleagues that you know, or ask for support from the Teacher Support Forum where other teachers may give you hints and tips.

There are also resources to be found on the Cambridge Assessment International Education website, more details of which are given later in this section.

Resources from the internet and from books need to be scrutinised to see if they are of use. A couple of websites which each give a wide variety of resources free of charge are given below.

www.nuffieldfoundation.org/practical-chemistry: this site gives detailed descriptions of a large number of practicals together with details of hazards. Experiments are at many levels, some at a more advanced level than IGCSE, but you will find details of most of the experiments you might wish to try.

www.rsc.org/learn-chemistry: this site has a huge range of resources of different types. You can search by age group, topic, type of resource or any combination of these. Remember though that not all resources may be suitable for your course or your school.

5.2 Teacher Support

This is an excellent source of information. You need a username and password to access it and these can be obtained from your Examinations Officer if you are in a Cambridge Centre.

On Teacher Support you will be able to access the syllabus and copies of past papers together with their mark schemes, examiner reports and grade thresholds, and a sample 'scheme of work' which can be downloaded and used to gain further information on the delivery of this syllabus. There is also a list of resources and a link to the discussion forum where teachers can post comments and questions. It is worth looking at this from time to time and following interesting threads even if you do not post any comments of your own.

5.3 Training

Teacher Support also has a list of upcoming training events. These include:

- online courses, including tutor-led courses. The tutor-led courses are highly recommended to help you improve your teaching skills. They are intended for teachers who have already been teaching IGCSE Chemistry for one year
- face-to-face courses, held at various venues at different times throughout the year. These enable you to meet up with other IGCSE Chemistry teachers, and also to interact directly with a trainer from Cambridge International

You can also find information about face-to-face training events at www.cambridgeinternational.org/events

In addition, Cambridge International runs professional development courses for teachers who want to develop their thinking and practice. These include the Cambridge International Certificate for Teachers and

Trainers, and the Cambridge International Diploma for Teachers and Trainers. You can find information about these at www.cambridgeinternational.org/qualifications/teacher

Appendix: Sample lesson plan template

Lesson:	**School:**	
Date:	**Teacher name:**	
Class:	**Number present:**	**Number absent:**
Learning objectives to which this lesson is contributing		
Lesson objectives		
Vocabulary, terminology and phrases		
Previous learning		

Plan		
Planned timings	**Planned activities**	**Resources**
Beginning		
Middle		
End		

Additional information		
Differentiation: How do you plan to give more support? How do you plan to challenge the more able learners?	**Assessment: How are you planning to check learners' learning?**	**Health and safety check: ICT links**

Reflection and evaluation	
Reflection Were the lesson objectives realistic? What did the learners learn today? What was the learning atmosphere like? Did my planned differentiation work well? Did I stick to timings? What changes did I make from my plan and why?	**Use the space below to reflect on your lesson. Answer the most relevant questions from the box on the left about your lesson.**

Summary evaluation
What two things went really well? (Consider both teaching and learning.) 1. 2. **What two things would have improved the lesson? (Consider both teaching and learning.)** 1. 2. **What have I learned from this lesson about the class or individuals that will inform my next lesson?**

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