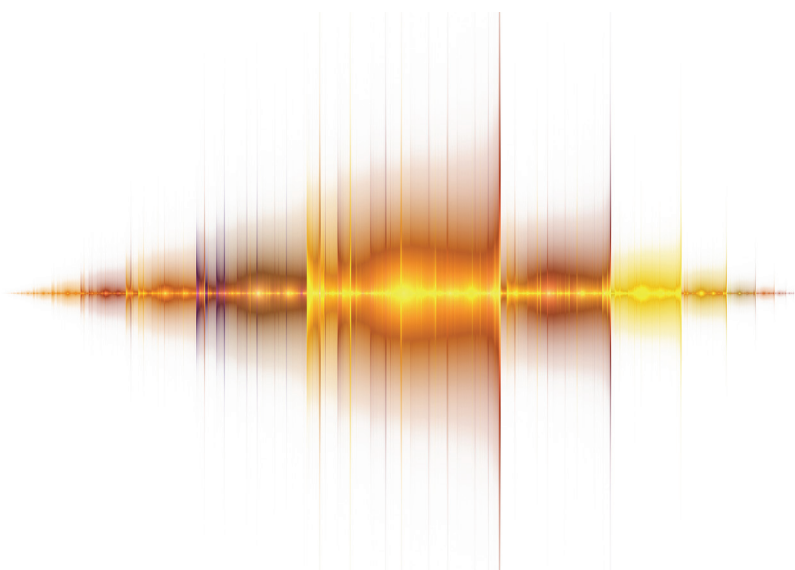


Teacher Guide

Incorporating language learning support

Cambridge IGCSE™

Physics 0625



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Contents

Introduction	4
1: Planning the course	5
2: Planning lessons.....	8
3: Classroom practice	11
4: Preparing learners for final assessment.....	14
5: Resources and support.....	22
Appendix: Sample lesson plan template	23

Introduction

The purpose of the teacher guide

This teacher guide is designed to help you to organise and plan your teaching for Cambridge IGCSE Physics. 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 multi-lingual 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 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 to understand and learn all of the facts and concepts required by the syllabus, and to develop the necessary skills. Cambridge 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 Cambridge 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.

- Starting with a course in practical techniques to generate enthusiasm.
- Starting with topics which are conceptually easier, saving the more difficult topics for the second year of the course.

- Using the suggested pattern in the ‘Schemes of Work’ provided on Teacher Support.
- Following your own and learners’ interests and enthusiasms to begin with.

Long-term planning will also consider what you would like the learners to be 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.

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.

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 physics 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, although timings for each section would have to be added. 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 in section 2.2 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 physics, 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 de-motivated. 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
<p>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.</p>	<p>It is good practice to check:</p> <ul style="list-style-type: none"> • what your learners knew/understood before the lesson (content) • how this has changed after the lesson, including language and communication improvements (language). 	<p>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.</p>
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?	<p>Use the space below to reflect on your lesson. Answer the most relevant questions from the box on the left about your lesson.</p> <p>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.</p> <p>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.</p> <p>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.</p>	
Summary evaluation		
<p>What two things went really well? (Consider both teaching and learning.)</p> <p>1.</p> <p>2.</p> <p>What two things would have improved the lesson? (Consider both teaching and learning.)</p> <p>1.</p> <p>2.</p> <p>What have I learned from this lesson about the class or individuals that will inform my next lesson?</p>		

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

Physics is, or at least should be, a practical subject. The syllabus does not suggest any particular experiments which should be undertaken.

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 appendices. Practical simulations may be required where experiments are not possible (for example in the radioactivity section).

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. 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
- 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. 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 and bangs 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 materials and what is to be done with them but also who is doing it and where.

3.2 Active learning

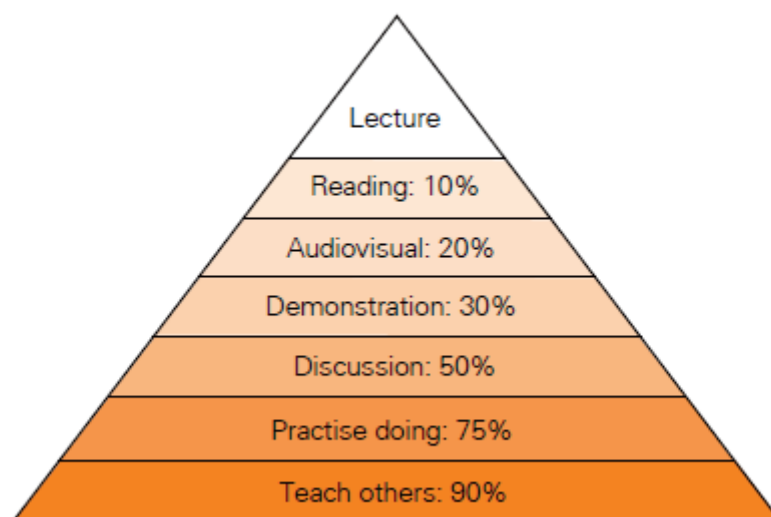
Not every topic in physics can be taught by means of an experiment. A description/explanation by the teacher is easily forgotten by the learner, even if it was understood in the first place.

Videos of industrial processes and computer animations 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.

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 high a ball bounces'. 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's secure website for teachers at <https://teachers.cie.org.uk>. You can obtain a log in for this from your exam officer. From this site you can download past papers and marking 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 the 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, 'Describe two precautions you took in order to obtain reliable results in this experiment'.
- 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 use it in interesting ways. The following suggestions are provided to help you think about what might support learners with the 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. a variety of bouncing balls of different materials and how high they bounce.
- (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. the use of the definite and indefinite article.
- (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.

Try and ensure pronunciation and word stress is correct. You can use delayed feedback, i.e. make notes of errors made during the group discussion time of difficult language areas 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 laboratory reports. Learners are likely to write several laboratory 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 measuring the volume of a liquid.

Rewrite this simple experiment into a report using the passive voice.

Procedure

Completely fill the boiling tube with water.

- (1) Pour the water from the boiling tube into the measuring cylinder.
- (2) Read and record the volume of the water

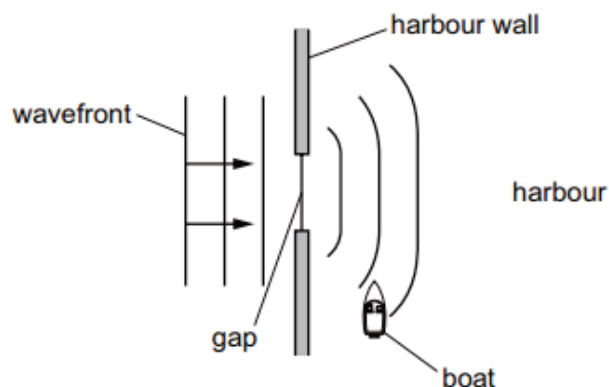
Exercise 2: Matching exercise

In this exercise the learners must match the definition with the words and then use the information to answer a visual question.

(1) Choose the correct word to fill in the gaps:

Diffraction Reflection Refraction

- (i) _____ occurs when a wave bounces from the surface of an obstacle.
- (ii) _____ occurs when a wave moves from one material to another.
- (iii) _____ occurs when a wave passes an edge, passes through a narrow gap or goes past an object.
- (2) The diagram shows a water wave passing through a gap in a harbour wall. The wavefronts curve around the wall and reach a small boat in the harbour.



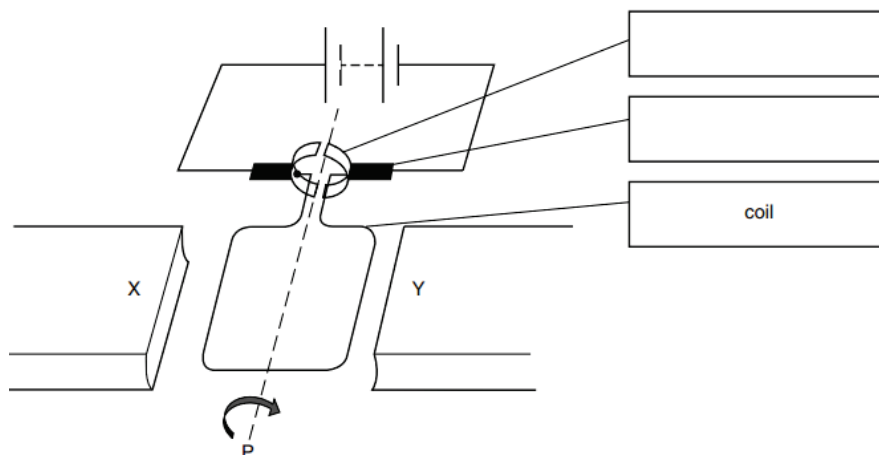
What is the name of this curving effect, and how can the gap be changed so that the wavefronts do not reach the boat? Choose from the options below.

	Name of effect	Change to the gap
A	Diffraction	Make the gap slightly bigger
B	Diffraction	Make the gap slightly smaller
C	Refraction	Make the gap slightly bigger
D	Refraction	Make the gap slightly smaller

Exercise 3: Using diagrams

An example of structured support using a diagram.

The figure shows a simple electric motor with a singular rectangular coil between magnetic poles X and Y.



(a) Add labels to the empty boxes to the right of the figure to identify the parts indicated.

(b) The coil rotates in a clockwise direction when viewed from point P.

Which of the magnetic poles X or Y is the N-Pole? _____

(c) Suggest two changes which would cause the motor to spin faster.

Exercise 4: Structured support

This question supports a learner through the process of planning and writing an experiment. Learners should understand the key words in the questions and what they mean i.e. *plan, how, instructions, measurements, precautions* and *sketch*.

A student suggests that the area of the water surface will affect the rate of cooling of hot water in a container.

(a) Plan an experiment to investigate the relationship between surface area and rate of cooling.

(b) Write a plan for the experiment, including:

- the apparatus needed
- how you will obtain a range of surface areas
- instructions for carrying out the experiment
- the measurements you will take
- the precautions you will take to ensure that the results are as reliable as possible
- the graph you will plot from your results – you should sketch the axes, with appropriate labels.

A diagram is not required but you may draw one if it helps to explain your plan.

Exercise 5: Cloze exercise

The use of missing words where the learner needs to work out the missing words activates the learner's knowledge of a process.

Put the correct words in the process column and in the blank spaces in the definitions.

Select from the following words

convection condensation condenses
radiation conduction conductors

Process	Definition
	Liquids and gases are fluids. The particles in these fluids can move from place to place. _____ occurs when particles with a lot of heat energy in a liquid or gas move and take the place of particles with less heat energy. Heat energy is transferred from hot places to cooler places by _____.
	The particles in a gas have different energies. Some may not have enough energy to remain as separate particles, particularly if the gas is cooled down. They come close together and bonds form between them. Energy is released when this happens. This is why steam touching your skin can cause scalds: not only is the steam hot, but energy is released into your skin as the steam _____.
	Heat can be transferred by infrared _____. Unlike conduction and convection, which need particles, infrared _____ is a type of electromagnetic radiation that involves waves. _____ can even work through the vacuum of space. This is why we can still feel the heat of the Sun even though it is 150 million km away from the Earth.
	Heat energy can move through a substance by _____. Metals are good _____ of heat but non-metals and gases are usually poor _____ of heat. Poor _____ of heat are called insulators. Heat energy is _____ from the hot end of an object to the cold end.

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 concepts and ideas in physics 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 given 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.

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

Teachers can also now easily record 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. Also 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 practice 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 on which the question is based from the syllabus.

Learners should be aware of any data provided in the syllabus and more importantly, any changes to this data that might affect how they understand any practice question 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 re-iterated 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 if their final answer is incorrect.
- Some questions, for example in Paper 6, 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.
- Questions involving comparing two or more pieces of data: so often it is 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 physics. 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 Cambridge online, 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 very reliable and good source for practical work is to be found at www.nuffieldfoundation.org/practical-physics

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:

- on-line 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 Physics 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 Physics teachers, and also to interact directly with a trainer from Cambridge

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

In addition, Cambridge 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?

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org www.cambridgeinternational.org

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