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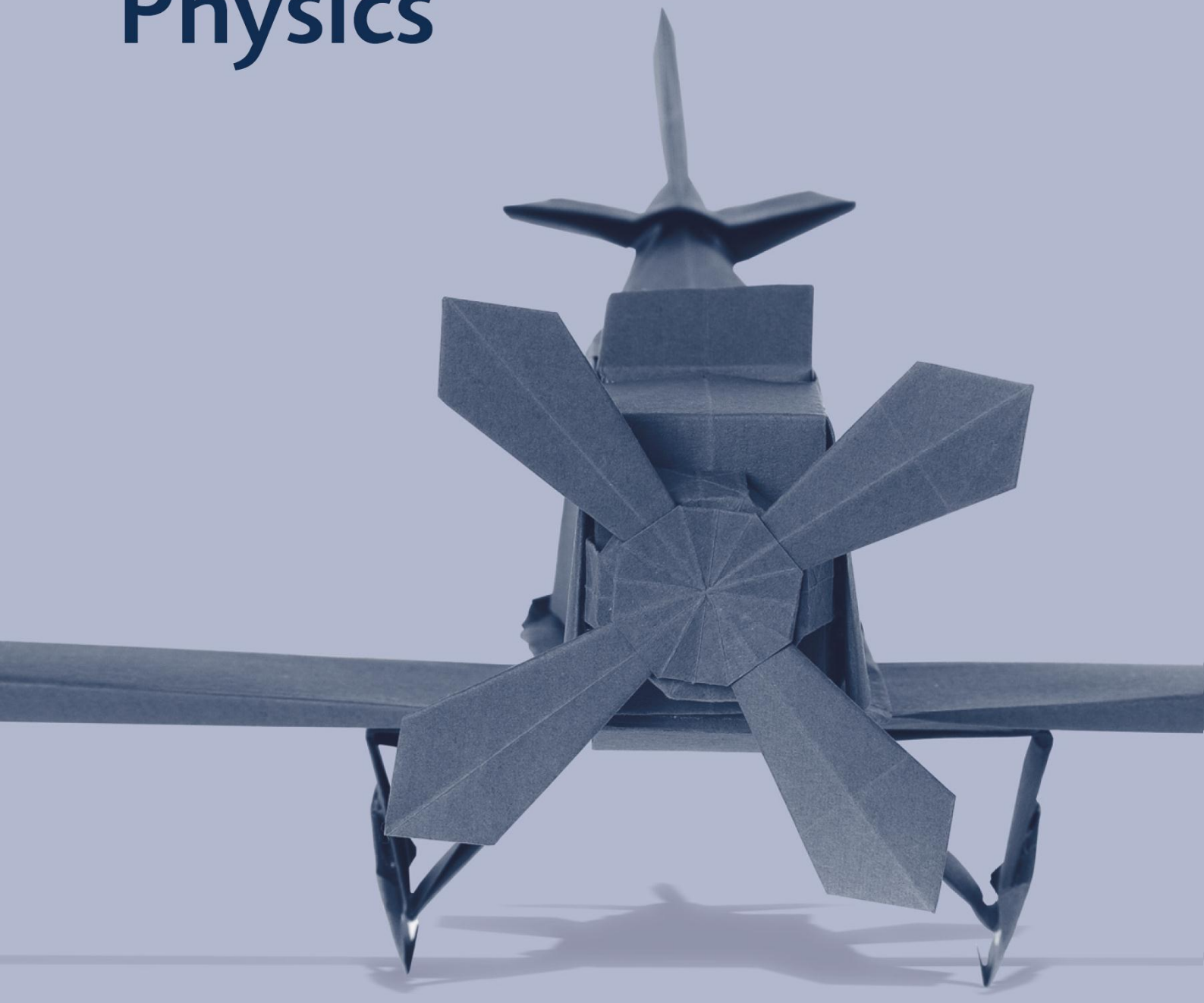
AS and A Level Physics



Getting Started Guide

Pearson Edexcel Level 3 Advanced GCE in Physics (9PH0)

Pearson Edexcel Level 3 Advanced Subsidiary GCE in Physics (8PH0)

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Getting Started: GCE Physics 2015

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1. Introduction

This revised specification, for first teaching from September 2015, has been developed in consultation with a variety of contributors. Teachers have been involved – through surveys, focus groups and one-to-one interviews – at each stage of the development from initial conversations about the current specification, as well as at each draft stage. We have also worked with a number of different universities to help ensure that the content of the specification provides a good foundation for further study at university, not just of Physics, but of related subjects. In addition, we have reviewed both the content and the assessment models of Physics specifications in a number of other countries. This research means that we can be confident that this new Edexcel specification offers students a Physics qualification that is the best it can be.

Informed by this range of feedback, the revised 2015 Physics specification that we have developed:

- allows the co-delivery of AS Physics alongside A level
- gives a coherent approach for linear teaching of Physics
- provides an context-based teaching approach using the Salters Horners Applied Physics teaching approach to give an inspiring alternative for your students
- encourages the understanding of physics principles
- puts practical Physics at the heart of the specification and assessments
- provides one set of clear examination papers, using a variety of question styles for both approaches.

This *Getting Started Guide* provides an overview of the new AS and A level specifications, to help you get to grips with the changes to content and assessment, and to help you understand what this new specification entails for you and your students.Support for the new specification

We will be providing a package of support to help you plan and implement the new specification.

- Planning: In addition to the section in this Guide, we will be providing a course planner and schemes of work that you can adapt to suit your department.
- Mapping: Mapping documents will show you clearly what has changed between the existing GCE 2008 specifications and the new ones, from September 2015.
- Understanding the standard: For some questions in the specimen papers, we will be providing marked student exemplars, with an examiner commentary.
- Practical work and mathematics: Guidance will be provided for both these areas, in terms of delivering the skills, as well as how they will be assessed.
- Personal, local support: To help you get started, and to answer further questions, we can support you in hosting local network groups. This is in addition to the on-going support from your local Pearson curriculum support team and from Stephen Nugus, our Science Subject Advisor.

Support documents will be available on the AS and A level 2015 Physics pages on our website.

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2. What's changed?

2.1 How have AS and A level changed?

Changes to AS and A level qualifications

From September 2015, A level Physics will be a linear qualification. This means that all examinations must be sat (and non-examination assessment submitted) at the end of the course. The move to linear assessment has implications for the teaching of the subject, which will be addressed in Section 3 of this Guide, while the implications for the assessment of the subject are addressed in Section 5.

From September 2015, AS level Physics will be a linear, stand-alone qualification. This means that it cannot be used to contribute towards an A level Physics grade. More information about the relationship between AS and A level is covered in Section 3 of this Guide.

Changes to subject criteria

The subject criteria for AS and A level Physics have been revised. All awarding organisations' specifications for AS and A level Physics must meet these criteria.

The final subject criteria, published by the Department for Education[1], show the core content which must be present in all A level Physics specifications. This core content makes up 60% of the course and is largely unchanged from the subject criteria for the GCE 2008 specifications.

In addition, the subject criteria also contain revised appendices for the delivery and assessment of practical and mathematical skills within Physics.

The following **practical** requirements apply to GCE Physics specifications:

A level Physics specifications must:

- contain a minimum of 12 core practical activities
- provide opportunities for learners to use and develop the techniques listed in *Appendix 5c*
- assess practical skills within externally-assessed written examinations
- provide opportunities for learners to develop competency in practical work, which can be assessed by teachers.

The following **mathematical** requirements apply to GCE Physics specifications:

A level Physics specifications must:

- provide opportunities for learners to use and develop the mathematical techniques listed in *Appendix 6*
- assess mathematical skills within externally-assessed examinations, with at least 40% of marks assessing mathematical competency at Level 2 or above
- ensure that a range of mathematical skills are tested over time.

[1] https://www.gov.uk/government/publications/gce-as-and-a-level-for-science

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Changes to Assessment Objectives

The AS and A level Assessment Objectives for all science subjects have been revised. The Assessment Objectives are the same for both AS and A level, although the weighting differs slightly between the two levels.

Notice that, compared to the GCE 2008 Assessment Objectives, these contain no explicit references to *How Science Works* (although these statements still form part of the subject criteria).

Within AO1, there is a limit on the proportion of questions that can test simple factual recall. The rest of the marks for AO1 should require a demonstration of understanding of material in the specification content.

AO2 still retains a higher weighting than the other Assessment Objectives, and retains its emphasis on applying skills and knowledge, either through performing calculations and other procedures, or by applying physics knowledge to new contexts or scenarios.

The last Assessment Objective, AO3, is new to science subjects. In part, questions that meet AO3 will be drawn from some aspects of practical work in the area of planning and critique of methods. However, other questions, that allow students to draw conclusions from data or information, will also count towards AO3.

		A level	AS level
AO1	Demonstrate knowledge and understanding of scientific ideas, processes, techniques and procedures ☐	30–35%	35–40%
AO2	Apply knowledge and understanding of scientific ideas, processes, techniques and procedures: • in a theoretical context • in a practical context • when handling qualitative data • when handling quantitative data	40–45%	40–45%
AO3	Analyse, interpret and evaluate scientific information, ideas and evidence, including in relation to issues, to: • make judgements and reach conclusions • develop and refine practical design and procedures. ☐	25–30%	20–25%

As mentioned earlier, at least 40% of marks on a series of question papers must assess mathematical applications within Physics. In addition, at least 15% of marks at A level must assess practical scenarios. In some cases, questions may count towards both targets, for example where experimental data is processed and interpreted.

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2.2 Changes to the specification

Specification points 1-8 are called 'Working as a Physicist', but note that this part of the specification is not intended to be taught as a discrete topic. These specification points refer to the use of units, the development of practical skills and the ability to communicate information in a variety of ways. They also require an understanding of the impact that science can have on society and how that science is used by society. This knowledge and these skills will gradually be acquired during the course and should be taught using examples and applications that draw on all topics of both the AS and the A level courses.

A key feature of the GCE Physics specification is that it can be approached in one of two ways:

- the concept approach
- the context approach (SHAP)

Both the concept and context routes cover the same Physics content and have a common assessment model but teachers can select the teaching approach that best meets their students' needs and learning styles.

In the Salters Horners Advanced Physics context-led course, conceptual demand increases over time while providing a **full coverage of content** required for AS and A level. The context-led approach gives the course a **spiral structure** so that students revisit and build on key ideas on several occasions and in different contexts.

The SHAP approach is supported by the University of York and further information and support can be found on their website.
https://www.york.ac.uk/org/seg/salters/physics/

To show the choice of route, the specifications are written out twice, once following the topics for the concept model, with the A level specification points being numbered from 1 to 191 in the order of topics listed below. It is then written again using the topics for the context (SHAP) approach, with the same numbering as for the concept approach.

The specification points are numbered based on the concept approach, working through the topics in the order they appear in the left- hand column of the table below. For the Salter Horners (SHAP) approach, those same specification points have been grouped together using the topics listed in the right hand column of the table below.

A level - Year 1/AS content	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Mechanics	Higher, Faster, Stronger
Electric Circuits	The Sound of Music
Materials	Good Enough to Eat
Waves and Particle Nature of Light	Technology in Space

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	Digging up the Past
	Spare-Part Surgery

A level - Year 2 content	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Further Mechanics	Transport on Track
Electric and Magnetic Fields	The Medium is the Message
Nuclear and Particle Physics	Probing the Heart of Matter
Thermodynamics	Build or Bust
Space	Reach for the Stars
Nuclear Radiation	
Gravitational Fields	
Oscillations	

Please note that the ordering of topics within this table does not imply a particular teaching order. This order is the order in which the topics appear in both the concept and the context section of the specification. The topics may be organised in a variety of different orders. For example, Gravitational Fields could be taught with Electric and Magnetic fields for the concept approach; and Year 2 for the context approach could start with Build or Bust. For teachers who are planning a two-year linear course, there could be a complete mix of the topics, although in general most of the work in Year 2 does build on the work from Year 1.

It is also possible to adopt a mix-and-match approach, with some of the specification being taught by the concept approach, and some by the context approach.

Changes to specification content

The subject criteria for Physics, as with all specifications, are defined by the DfE and must be met by all accredited A level Physics specifications after 2015. These subject criteria – making up 60% of the specification content and are very similar to those used for the previous GCE 2008 specification.

The remaining 40% of the AS and A level specifications is at the discretion of each Awarding organisation. Using feedback from teachers, as well as taking into account the needs of students going on to study Physics or related subjects, we had taken the opportunity to alter, re-word and reorganise some of the discretionary content in the new Edexcel A level. Some of the changes were necessary in order to meet the 40% mathematics requirement in all of the examination papers. Some of the changes that you will notice include:

- the removal of fluid flow diagrams and the definitions of mechanical properties such as brittle, ductile, hard malleable and tough.

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- the placing of momentum and conservation of momentum in one dimension in AS
- the inclusion of moments and the speed of a transverse wave on a spring
- the inclusion of lenses, ray diagrams, the lens formula and magnification
- the removal of identify and describe applications of the electromagnetic spectrum
- the need for students to derive some formulae, such as resistors in parallel and series, and the kinetic theory of gases equation
- the addition of electric and gravitational potential and some AC theory.

Changes to assessment

We have already seen two important changes to the assessment of Physics at AS and A level ie the mandatory assessment of:

- a minimum proportion of mathematical skills
- practical skills within written question papers.

Further regulatory requirements for new AS and A level subjects have been provided by Ofqual, following consultation with teachers and other stakeholders. These requirements provide a common assessment framework, to ensure comparability between different awarding organisations. These requirements include:

- a minimum of 3 hours of assessment for AS Physics
- a maximum of two assessment components, i.e. question papers for AS Physics
- a minimum of 6 hours of assessment for A level Physics
- a maximum of three assessment components, i.e. question papers for A level Physics.

It is also a regulatory requirement that AS and A level are 100% externally assessed, i.e. there can be no coursework or other internal assessment units.

Further information on the new assessment model can be found in Section 5 of this Guide.

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3. Planning and delivering AS and A level

The new courses, both for AS and for A level, are linear courses. This means that all assessment takes place only in the May/June examination series. When you are planning how to deliver the course, there are several factors which you should consider.

3.1 The function of AS level

For the revised Physics 2015 specification, the AS level is now a stand-alone qualification, rather than forming one half of the A Level, as with the 2008 specifications. This means that there is no obligation for students taking A level Physics to take AS level examinations. If students do complete the AS level examinations they will, of course, receive an AS level certificate; but the results of these examinations do not form a part of the final A level grade.

The A level grade depends solely on the performance of candidates on the final A level examination papers at the end of the two-year course. These final A level papers will test candidates on material that they have learned over the whole A level course – in other words, these papers will include topics that you may consider as 'AS topics'.

You may decide that there are still good reasons for A level students to sit the AS level examination, in terms of motivation, performance monitoring, or to provide a possible 'fall back' grade.

However, A level candidates who do not sit AS level are in no way disadvantaged. Indeed, time that might be otherwise spent on revising for, and sitting, AS level examination papers can instead be used by A level candidates for further coverage of theory or practical work.

3.2 Co-teaching AS and A level

The new specification has been designed in such a way that the AS and A level courses are co-teachable. In other words, the AS level Physics specification represents a sensible first year of the A level course.

At the start of the course, not all students will know whether they are likely to take a full A level, or just an AS level. Therefore, many centres will not separate students into different teaching sets based on their likely pathway. This is not a problem, because of the flexibility to co-teach AS alongside A level.

However, some centres may decide that there is merit in having different teaching sets for A level students and AS level students, as teachers may wish to deliver the content in a different order, or to a different level, for their A level students.

3.3 Ordering the topics into a teaching route

There are two important questions to consider when building a possible teaching route for this specification:

1. Are students taking AS and A level going to be taught together, i.e. will the class be a mixture of AS and A level students?
2. Will the specification content be delivered by one member of staff, or will the teaching be split between different teachers?

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Co-teaching AS and A level together

For classes with a mixture of AS and A level students, the content to be covered in the first year of the course is fairly fixed, and is very likely to be the AS topics of the course only. Once you have completed delivery of the AS topics, those students taking AS examinations will need revision time, study leave, and time off to sit examinations. Those students aiming for A level may also be taking the AS examinations although, as we have seen earlier in this Guide, there is no necessity for them to do so.

For A level students not taking AS examinations, this period of study leave and examinations for AS students may be a good time to explore further practical opportunities. Or they could consolidate learning of AS topics, prepare for some of the mathematical aspects of the second year of the A level course, or consider other aspects of their curriculum, such as Extended Projects, or other research activities.

Students returning from AS study leave can then rejoin the class for the final weeks of the summer term.

The advantages to separating AS and A level students

In many schools, having separate classes for AS and A level students will not be possible, for reasons of student numbers, teacher availability, or simply because students have not made a final decision on this issue.

However, where it is possible to separate students out, there are some advantages, in terms of the flexibility that becomes possible in delivering topics. It also means that no breaks in teaching occur, driven by students needing to revise for AS examinations.

Groups with more than one teacher

It is a fairly common practice to have more than one teacher involved in the delivery of the course to the same group of students. Just as with the current specification, the revised specification lends itself easily to this splitting of material. For example, one teacher might start by teaching the Mechanics topic, followed by the Materials topic. Meanwhile, the other teacher might teach the Electric Circuits topic, followed by the Waves and Particle Nature of Light topic.

Similarly, in the second year one teacher can start with Further Mechanics, while the second teacher starts with Thermodynamics and Oscillations.

Other factors to consider

When planning the delivery of the specification, you will also need to bear in mind that:

- There are no January examinations, so that all exams fall in the May/June window. At this stage, we have to wait for JCQ guidance on the timings of these examinations for the first 'live' examination series.
- Most learners, on a linear course, benefit from a route through the specification which builds in revision of key principles. You will also want to build in opportunities for end-of-course revision, as well as for sufficient checkpoint assessments, to allow tracking of progress to take place.
- Although there are some changes to the specification content, these have involved both deletions and additions, so that the specification should be the same, in terms of teaching time, as the current course.

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3.4 Delivery models

With changes to the specification being relatively small, there should be few barriers, in terms of content. More challenging is the change in the structure of the qualification to one that is linear. As it is many years since A level specifications were linear, many teachers will have limited, or in many cases, no experience of teaching a linear A level.

Planning the delivery of a modular A level is relatively easy, as it is strongly dictated by the nature of the modules. Although some preparation is needed where the teaching is split between more than one teacher, it is usually fairly simple to deliver the topics that make up a module, have students sit that module, and then move on to the next.

Planning a linear course needs a little more consideration. Physics is a very hierarchical subject and so it is not possible to study, for example, Gravitational Fields, until students have studied Mechanics. The work in Year 1 provides the building blocks for the work in Year 2, and so probably most of the Year 1 work needs to be done first. However the Waves topic, especially the work on refraction and lenses, does stand alone. A teacher might consider leaving this until later in the course so that the more difficult concepts can be taught earlier, thus allowing the students time to develop a better understanding of the more difficult concepts.

Teachers following the context approach are likely to use materials developed by the Salters Horners team. It is worthwhile looking at the assessment model since, although there will be some synoptic questions at both AS and AL, the AS papers and the AL papers 1 and 2 are mainly topic-based, and this might influence the order in which the course is taught.

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4. Content guidance

4.1 General

As mentioned earlier, at the start of the specification there is a topic called 'Working as a physicist'. This topic needs to run alongside all of the other topics for AS and A level and teachers need to refer to it and ensure that their teaching addresses the points. Specification point 1, which is to do with SI units, applies to the whole specification. Units, and how they are related, and the homogeneity of equations, should be considered throughout the course. Similarly, the other areas, such as estimating physical values, limitations of measurements, decision-making, should be considered, as suitable experiments and applications of physics are met. It is important that the practical work is not just limited to the core practicals. Physics is a practical subject and students should have as much experience of experimental work as possible.

Appendix 7 in the specification is a table of command words, and this is something that the students should be familiar with. These command words give an indication of the type of answer that is required.

4.2 AS content (Year 1 of A level)

The revised subject criteria place momentum back into the AS content/Year1, and so we can return to defining Newton's 2nd law in terms of rate of change of momentum. As it is part of the 40% optional content, we have moved the de Broglie equation into the AS content as well.

The requirement for a minimum of 40% of the assessment to be mathematical has influenced the nature of the 40% optional content that we have added to the required subject criteria. This has meant that we have removed, for example, the wordy descriptions from the Materials section.

We have retained the extra Materials work on upthrust, viscosity and Stokes law.

The 2008 specification has work on refraction and refractive indices which lends itself to questions using Level 2 mathematics. We have added to this work on optics by adding in lenses, image formation, the lens formula and magnification. Again, the lens formula meets the Level 2 mathematics requirement, and this work also provides an opportunity to develop practical skills.

The rest of the 40% optional content that we have added to the required subject criteria adds depth, and so may not be evident at a first look at the specification. However, this should not be a concern for teachers, because the specification clearly lays out what physics is required for all topics.

One significant addition to depth is in relation to diffraction, where we have added use of Huygen's construction to explain diffraction, and use of $n\lambda = d \sin\theta$ for diffraction gratings. This means that there will now be a more mathematical approach to diffraction, which was not possible on the previous specification.

The other significant change is the reintroduction of an understanding how some of the equations in physics are derived. At AS, this is limited to the resistors in series and parallel formulae.

4.3 Year 2 of A level

We have retained the topics 'Space' and 'Particle Physics' as the two significant areas of content that we have chosen to add to the required core material. We were aware that the wording relating to the standard model on the previous

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specification did not give much detail, so we have taken the opportunity to define what aspects of the standard model we expect students to know. For those centres following the concept approach, the Space topic makes a good choice for the final topic to study, because it provides revision opportunities for other topics, such as Gravitational Fields, Oscillations, Thermodynamics and Nuclear Radiation.

The equations which students should know how to derive are: centripetal acceleration by vector diagrams, $pV = 1/3\ Nm\langle c\rangle^2$, $\frac{1}{2}\ m\langle c\rangle^2 = 3/2\ kT$ and $g = Gm/r^2$.

As well as understanding how these equation are derived, students should know that often there are assumptions made which put limitations on the use of the equations. Students should also learn how to set out equations, rearrange them and equate them to show a relationship.

In addition, a small amount of AC theory has been selected to supplement the required core material, as well as specific latent heat of fusion. The addition of this will broaden the understanding of internal energy.

Since this is now a linear course, it is possible for teachers to teach all three aspects of fields: electric, gravitational and magnetic, in one topic.

Paper 3 at A level will contain some questions that link various sections of the specification together and this is something that teachers need to consider as they teach the course. For example, a question could be asked that assesses the exponential relationship for capacitors and radioactive decay.

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5. Assessment guidance

5.1 Implications of linear assessment

As has been mentioned elsewhere in this Guide, the assessment of both AS and A level is linear in style. This means:

- Examinations are available in the May/June session only.
- Candidates must sit all assessment components in the same session. Note that candidates entering for A level Physics would not need to take any AS Physics examinations (except if, under exceptional circumstances, they are taking AS and A level in the same examination series).
- Centres will enter for the qualification, rather than for a series of units.
- If a candidate is absent for an examination, centres would need to apply for Special Consideration, under the usual conditions, to allow a grade to be awarded to that candidate. If the request for Special Consideration is not successful, then the candidate would need to sit all examination papers again in a future examination series.

5.2 Assessment models

When developing our assessment model, we wanted to respond to feedback from teachers, showing that students preferred to have question papers assessing only some of the topics in the specification. In addition, we wanted to make sure that some question papers allowed students to show their depth of knowledge of particular topics; and others encouraged students to show their breadth of knowledge across all topics in the specification.

AS assessment model

At AS, there are two examination papers. The papers will both contain around 8 to 10 multiple-choice questions, along with a variety of short and long response questions. Some of the questions may require more extended responses, worth up to 6 marks, and requiring students to follow a line of reasoning to complete an answer.

Across the two papers, the total proportion of questions assessing mathematical skills will reach the required 40%, although this may not be evenly balanced across both papers. The two papers will also meet the minimum requirement of 15% of marks testing practical skills.

Each paper has a focus within a particular set of topics from within the AS specification, with the last two questions of both papers (approximately 24 marks) being of a synoptic nature, assessing physics from all of the topics at AS.

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Paper 1 – Core Physics I (50% of AS level)	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Mechanics	Higher, Faster, Stronger (HFS)
Electric Circuits	Technology in Space (SPC) (except items 92–96)
	Digging up the Past (DIG) (except items 84–86)
The last two questions will draw on any of the topics in this qualification	

Paper 2 – Core Physics II (50% of AS level)	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Materials	The Sound of Music (MUS)
Waves and Particle Nature of Light	Good Enough to Eat (EAT)
	Technology in Space (SPC) (only items 76–79)
	Digging up the Past (DIG) (except items 70–72)
	Spare-Part Surgery (SUR)
The last two questions will draw on any of the topics in this qualification	

A level assessment model

At A level, there are three question papers. The papers will both contain a variety of short and long response questions. Some of the questions may require more extended responses, worth up to 6 marks, and requiring students to follow a line of reasoning to complete an answer. Paper 1 and Paper 2 will also contain 10 to 15 multiple-choice questions.

Across the three papers, the total proportion of questions assessing mathematical skills will reach the required 40%, although this may not be evenly balanced across the three papers.

Approximately half the marks of Paper 3 will focus on the assessment of practical skills, meeting the minimum requirement of 15% of marks testing indirect practical skills.

Paper 1 and Paper 2 each have a focus within a particular set of topics from the A level specification. They will assess material from both years of the course.

Paper 3 meets the requirement within A level for students to make links between different topics. The paper contains a variety of short and longer response questions, some of which will be longer responses where students can

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demonstrate their understanding of the physics. Approximately half of the paper will test indirect practical skills within physics.

Paper 1 – Advanced Physics I (30% of A level)	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Mechanics	Higher, Faster, Stronger (HFS)
Electric Circuits	Technology in Space (SPC) (except items 76–79)
Further Mechanics	Digging up the Past (DIG) (except items 70–72)
Electric and Magnetic Fields	Transport on Track (TRA)
Nuclear and Particle Physics	The Medium is the Message (MDM)
	Probing the Heart of the Matter (PRO)

Paper 2 – Advanced Physics II (30% of A level)	
Concept approach	**Salters Horners approach**
Working as a Physicist	Working as a Physicist
Materials	The Sound of Music (MUS)
Waves and Particle Nature of Light	Good Enough to Eat (EAT)
Thermodynamics	Technology in Space (SPC) (only items 76–79)
Space	Digging up the Past (DIG) (only items 70-72)
Nuclear Radiation	Spare Part Surgery (SUR)
Gravitational Fields	Build or Bust? (BLD)
Oscillations	Reach for the Stars (STA)

Paper 3 – General and Practical Principles in Physics (40% of A level)

- Questions in this paper may draw on any of the topics in this specification.
- The paper will include some questions that may draw on two or more different topics.
- The paper will include questions that assess conceptual and theoretical understanding of experimental method (indirect practical skills) that will draw on students' experience of the core practicals.

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5.3 Resitting

Students are permitted to resit both AS and A level qualifications. Any resit must abide by the same linear rules, so that a resitting candidate must resit all papers that make up the qualification. A new grade will be issued, based on the results of the new linear sitting of the qualification.

It is not permitted for students to combine results from examination components sat in different examination series e.g. Paper 1 from June 2017 and Paper 2 from June 2018.

Where a candidate resits, the higher grade will be credited to the candidate.

5.4 Assessing mathematical and practical skills

As has been seen elsewhere in this Guide, it is a regulatory requirement for all AS and A level examinations to test mathematical and practical skills, in line with the weighting required by the subject criteria.

Mathematical skills

Appendix 6, at the back of the specification, lists the mathematical skills that should be developed in students during the teaching of GCE Physics. For each skill, there is some exemplification to illustrate some areas of the specification where this skill may be encountered. Note that this exemplification is not comprehensive: the skills may be tested in the context of any area of the specification.

In addition, each topic in the specification content has an introductory paragraph, giving further examples of where mathematics can be addressed within that topic.

The Scheme of Work, found on the Edexcel GCE physics pages, also gives guidance as to the mathematical skills that are required.

Practical skills

Appendix 5, at the back of the specification, lists the practical skills that should be developed in students during the teaching of AS & A level Physics. This appendix has four separate sections:

Appendix 5a – details the practical skills which will be tested within written examination papers

Appendix 5b – details the practical skills which will be tested through the teacher assessment of practical competency at A level through practical work

Appendix 5c – details the apparatus and techniques that must be covered, through the core practicals, for all students studying A level Physics.

Note that *Appendices 5a, 5b* and *5c* are common to all A level specifications across the science subjects.

Appendix 5d – shows the core practicals that have been selected for the Edexcel Physics specification. It also maps these practical activities to the apparatus and techniques in *Appendix 5c*, allowing you to see how those skills are to be developed in your students.

The core practical activities that you should carry out with your students are also clearly marked in the specification. These practical activities make up, effectively, a minimum syllabus for practical work for AS and A level Physics. Knowledge of

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these techniques, including processing of data or results for these practical activities, will form the basis for the written assessment of indirect practical skills within examination papers.

Additional practical activities are to be encouraged, so that students develop a genuine competence in practical work, both in terms of techniques and manipulative skills, as well as in data analysis. With this in mind, each topic in the specification content has an introductory paragraph, giving further examples of practical activities that can be carried out within that topic.

5.5 Core practicals

Introduction

The subject criteria for Physics contain, as well as the Physics content that must be present in all specifications, a list of apparatus and techniques that must be taught to students studying A level Physics. These 12 techniques can be found in *Appendix 5c* of the specification.

To ensure that A level specifications give clear opportunities for you to cover the content of *Appendix 5c*, all specifications need to indicate a series of core practical activities. These core practical activities make up, essentially, a minimum syllabus of practical activities that accompany the theoretical teaching of A level. The subject criteria specify that the number of core practical activities must be a minimum of 12, across the whole A level course.

In developing the Edexcel specification, we considered a number of practical activities that led, in the opinion of the teachers writing the specification, to be key to the teaching and learning in Physics. This led to the total number of core practical activities in our final specification being 16.

The core practicals have been split over the two years of the A level course. For AS Physics, students should complete the core practicals linked to AS content, as questions on written examinations at AS will assess practical skills.

Completing the core practicals

It should be remembered that examination papers will have questions based on these core practicals. Students could be asked to describe aspects of these experiments, as well as being assessed on the skills that they have acquired, such as data analysis, commenting on a given method or a set of data, graph plotting, choice of apparatus etc. In addition, students could be asked to write a plan for an unfamiliar experiment. Students should, therefore, carry out all 16 core practical activities.

Ideally the practical work should be carried out close to the time when the relevant theory has been taught and the students themselves need to carry out these experiments. This might not be possible where centres do not have whole class sets of equipment, such as oscilloscopes or lasers. Practical work should not be limited to the core practicals: there are many more experiments that the students can do or have demonstrated that will enhance the learning of the theory, as well as develop the students' practical skills.

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5.6 Science Practical Endorsement ('Practical Competency')

Overview

A level qualifications in each science must give students opportunities to use relevant apparatus and techniques to develop and demonstrate specific practical skills.

These skills will be assessed through identified practical activities within each specification. Students who demonstrate competency in this range of practical activities will have a "pass" for this aspect of the A level reported separately on their exam certificates.

To achieve a pass, students must demonstrate that they have familiarity with all the techniques and apparatus listed in *Appendix 5c* of the specification. Performance in practical work will be assessed by teachers against common assessment criteria that will be consistent across exam boards.

Supporting students

Especially at the start of the course, students will need support and feedback in order to master the techniques of practical work. During the course of their studies, as they grow in confidence and experience, students will require less support. By the end of the course, in order to obtain a 'pass' grade, students should be independently competent.

Marking guidance

The specification gives the 'Common Practical Assessment Criteria' which will be used by all awarding bodies. Note that these criteria do not require work to be marked (in the sense of following a mark scheme and assigning numerical marks); rather the criteria list a series of competencies against which each student can be assessed.

Moderation process

Details of the process for authenticating centre judgements on the practical competency of their students will be confirmed in the spring of 2015, following a Ofqual trial of the process.

However, centres will need to collect evidence to show that enough practical work has been carried out to meet the minimum requirement, and that students have reached the level of competency described in the assessment criteria.

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