Key Skills – GCE AS/A Level Physics A

This Appendix offers detailed guidance on the Key Skills evidence that a candidate might produce during their programme of study. It focuses on the evidence required to meet the criteria for the internally assessed Key Skills portfolio. The evidence requirements are reproduced from Part B of the QCA Key Skills specifications. For example, in producing work for assessment as evidence of C3.2 (Read and synthesise information from two extended documents about a complex subject. One of these documents should include at least one image.) a candidate is required to:

- select and read material that contains the information you need;
- identify accurately, and compare, the lines of reasoning and main points from text and images; and
- synthesise the key information in a form that is relevant to your purpose.

The Key Skills and Evidence Requirements below are quoted from the Part B of the QCA Key Skills specifications and, as such, are addressed to the candidate. The text below the Evidence Requirements is guidance for teachers about how the specification might be used to provide teaching and learning opportunities and/or assessment opportunities for the Key Skill.

For further information, teachers should refer to QCA's Key Skills specifications for use in programmes starting from September 2000.

The examples given under the heading *possible opportunities* are meant to be illustrative rather than exhaustive.

For further information about the assessment and certification of Key Skills, teachers should contact OCR.

C3 Communication Level 3

C3.1a *Contribute to a group discussion about a complex subject.*

Evidence requirements

(i) Make clear and relevant contributions in a way that suits your purpose and situation.

(ii) Listen and respond sensitively to others, and develop points and ideas.

Create opportunities for others to contribute when appropriate.

Possible opportunities

Many opportunities exist throughout the course for group discussion about complex subjects. Sources for the generation of such complex subjects may be television programmes, newspaper articles, papers in scientific journals on current topical research or simply in the development of concepts in a practical lesson.

Module 2821, Forces and Motion

A possible opportunity for the development of C3.1a in Module 2821 might be through a discussion of *safety features in cars* as an introduction to Module 2821 Car Safety (section 5.1.7). Candidates study the factors affecting *vehicle stopping-distances* together with relevant equations. The focus of the discussion might be on how the properties required of seat belts, air bags and crumple zones affect the design of such safety features.

C3.1b *Make a presentation about a complex subject, using at least one image to illustrate complex points.*

Evidence requirements

(i) Speak clearly and adapt your style of presentation to suit your purpose, subject audience and situation.

(ii) Structure what you say so that the sequence of information and ideas may be easily followed.

(iii) Use a range of techniques to engage the audience, including effective use of images.

Possible opportunities

There are a number of opportunities to allow candidates to prepare and deliver a presentation that covers one or more of the evidence requirements. This might involve candidates in performing and explaining a demonstration experiment that would normally have been carried out by the teacher. For a theoretical topic, material may be gained from secondary sources such as a reference library or the Internet. Candidates may vary the presentation technique by considering the use of models to simulate the teaching point, using IT to produce video or static images and the involvement of the audience through questioning or by other means.

Module 2824, Forces, Fields and Energy

Section 5.4.11 The Nuclear Atom, provides a number of learning outcomes that could provide opportunities to develop and generate evidence for C3.1b. For example, a candidate could research the $\alpha-$particle scattering experiment and the evidence it provides for the existence, charge and small size of the nucleus and then deliver a presentation of the findings. Alternatively a candidate could demonstrate electron diffraction to a class and explain the significance of the effect with respect to the spacing of atoms.

C3.2 *Read and synthesise information from two extended documents that deal with a complex subject. One of these documents should include at least one image.*

Evidence requirements

(i) Select and read material that contains the information you need.

(ii) Identify accurately, and compare, the lines of reasoning and main points from texts and images.

(iii) Synthesise the key information in a form that is relevant to your purpose.

Possible opportunities

There are numerous opportunities for candidates to read and synthesise information throughout the course. Opportunities to develop and generate evidence for C3.2 could be derived from the presentation made by a candidate. Candidates should be reading from sources that go beyond their course texts, (for example New Scientist, Physics Review, current newspaper articles etc.) extracting relevant information and acknowledging lines of reasoning. It might be appropriate as part of preparatory work for a topic, to direct the background reading, for example to the history of the discovery of radioactivity.

Module 2824, Forces, Fields and Energy

Students might be directed to reading about the handling, storage and disposal of radioactive materials, (in section 5.4.12). Alternatively, candidates could be asked to research circumstances in which resonance is useful and other circumstances in which resonance should be avoided, (5.4.4 Oscillations).

C3.3 *Write two different types of documents about complex subjects. One piece of writing should be an extended document and include at least one image.*

Evidence requirements

(i) Select and use a form and style of writing that is appropriate to your purpose and complex subject matter.

(ii) Organise relevant information clearly and coherently, using specialist vocabulary when appropriate.

(iii) Ensure your text is legible and your spelling, grammar and punctuation are accurate so your meaning is clear.

Possible opportunities

Throughout the course opportunities for the assessment of C3.3 is available through the writing-up of either a piece of practical work or of a piece of research set around the topic that is currently being studied. It is advisable to select at least one task that includes numerical data, allowing candidates the opportunity to organise the information clearly in the form of tables and graphs.

Module 2821, Forces and Motion; Module 2822, Electrons and Photons

In 5.1.5, candidates can determine the Young modulus of a metal. They could be asked to write up a report of the experiment, tabulating the data, producing an appropriate graph and subsequently making conclusions. Similarly in 5.2.1 candidates could be asked to take appropriate measurements to enable them to sketch the current-voltage characteristics of a filament lamp and then to write up a report using their knowledge of physics to explain the shape of the graph obtained.

N3 Application of Number Level 3

You must:

Plan and carry through at least one substantial and complex activity that includes tasks for N3.1, N3.2 and N3.3

N3.1 *Plan, and interpret information from two different types of sources, including a large data set.*

Evidence requirements

(i) Plan how to obtain and use the information required to meet the purpose of your activity.

(ii) Obtain the relevant information.

(iii) Choose appropriate methods for obtaining the results you need and justify your choice.

Possible opportunities

Many opportunities arise naturally throughout the course in both routine practical work and theory. It should certainly be possible to plan and executive a practical assignment, of a substantial and complex nature, that covers all three of: N3.1, N3.2 and N3.3. Since virtually every practical task in physics involves measurement and analysis of quantitative data, each experiment undertaken by a candidate is likely to cover at least some of the evidence requirements in N3.

Module 2823, Component 02: Coursework 1 and Module 2826, Component 02: Coursework 2

Planning exercises related to quantitative work will naturally feature in some of the practical work undertaken by candidates. Large data sources can be incorporated into appropriate practical work either being generated by the candidates themselves (perhaps through the use of data-capture computer interfaces) or from published material available from texts or the Internet. When assessing candidates' level of performance in Planning (skill P) and Analysing Evidence and Drawing Conclusions (skill A) it is possible that evidence will be generated in relation to N3.1.

N3.2 *Carry out multi-stage calculations to do with:*

(a) amounts and sizes;

(b) scales and proportion;

(c) handling statistics;

(a) rearranging and using formulae.

You should work with a large data set on at least **one** occasion.

Evidence requirements

(i) Carry out calculations to appropriate levels of accuracy, clearly showing your methods.

(ii) Check methods and results to help ensure errors are found and corrected.

Possible opportunities

Multi-stage calculations routinely occur throughout the course. Many topics inherently involve dealing with quantities covering a vast range of magnitudes: e.g. from work on subatomic particles to dealing with astronomical data. There are many opportunities for using and, rearranging formulae, for handling statistics and for dealing with scales and proportion.

Module 2821, Forces and Motion

Many opportunities exist in module 2821 for the algebraic manipulation of formulae, including the constant acceleration equations in section 5.1.2. The work on the deformation of solids in section 5.1.5 deals with a wide range of magnitudes involving both positive and negative indices and requires graphs to be plotted necessitating appropriate choice of scales.

Module 2824, Forces, Fields and Energy

Section 5.4.4: Oscillations requires the use and rearrangement of the simple harmonic motion formulae and in 5.4.7: Capacitors more complex graphical work is involved together with the use of the exponential decay formula for capacitor discharge. Section 5.4.12 Radioactivity involves the analysis of wide ranging statistics concerning the relative proportions of radioactive isotopes such as Carbon-14 for dating purposes.

Module 2825, Component 02: Health Physics

Section 5.6.2 offers opportunities to rearrange and use formulae.

N3.3 *Interpret results of your calculations, present your findings and justify your methods. You must use at least one graph, one chart and one diagram.*

Evidence requirements

(i) Select appropriate methods of presentation and justify your choice.

(ii) Present your findings effectively.

(iii) Explain how the results of your calculations relate to the purpose of your activity.

Possible opportunities

Almost all practical work in physics requires the interpretation of quantitative, empirical data involving calculations. Results are most commonly presented in charts and tables and findings are often derived from an analysis of appropriate graphs. When assessing candidates' Experimental and Investigative skills in Analysing Evidence and Drawing Conclusions (skill A) and Evaluating Evidence and Procedures (skill E), it is likely that evidence related to N3.3 can be generated.

Module 2821, Forces and Motion

The results of the experiment in section 5.1.5 (d), planned in N3.1 and analysed for N3.2, can be plotted on a graph to determine the Young Modulus for different wires and the force-extension line graph can be used to determine the strain-energy for a stretched wire.

Module 2824, Forces, Fields and Energy

Section 5.4.4: Oscillations requires a graphical representation of the changes in displacement, velocity and acceleration during simple harmonic motion. In section 5.4.7: Capacitors calculations of the time-constant (τ) for capacitor-resistor circuits are used in conjunction with an interpretation of graphs, showing the variation with time of the potential difference and current during the discharge process, to highlight the physical significance of time constant (τ).

IT3 IT Level 3

You must:

Plan and carry through at least one substantial activity that includes tasks for IT3.1, IT3.2 and IT3.3.

IT3.1 *Plan, and use different sources to search for, and select, information required for two different purposes.*

Evidence requirements

(i) Plan how to obtain and use the information required to meet the purpose of your activity.

(ii) Choose appropriate sources and techniques for finding information and carry out effective searches.

(iii) Make selections based on judgements of relevance and quality.

Possible opportunities

Opportunities may arise during the planning of a report on a practical task or when assessing some aspects of C3 as a stand-alone exercise. A variety of resources are now commercially available on CD-ROMs. These include subject specific tutorial packages that are essentially 'substitute textbooks' and virtual laboratory software that elucidate topics through simulated routines. Many of the popular journals are now available on CD-ROMs, for example New Scientist. Also available are non-specialist, but all encompassing CD-ROMs like Encarta, which contain valuable scientific text and images. Most CD-ROMs make searching specific information very easy. The Internet is also rapidly becoming a popular vehicle for the search and selection of information.

Module 2821, Forces and Motion

An independent learning exercise could be developed on Car Safety for Sections 5.1.6 and 5.1.7. The Internet and some well-chosen CD-ROMs could provide valuable information on different braking mechanisms and the physical principles behind seat belts, air bags and crumble zones. Sometimes, car manufactures and car magazines do supply CD-ROMs that address such topics in some detail. The Internet or the CD-ROMs could be used to search and select relevant material. Candidates have to make judgements on the suitability and quality of the information. Such an exercise could also embrace some of requirements of C3.

A range of other independent learning exercises could be devised. For example, in Module 2822, research could be undertaken on wave-particle duality in 5.2.4.

Module 2822, Electrons and photons

A number of experimental tasks could be modified so that search and selection of information become an integral part of the learning experience. For Section 5.2.1 (m), a class experiment on The factors affecting resistance of an electrical conductor, could be extended so that candidates also have to identify the material used in the experimental task. Instead of using a databook or a textbook to identify the electrical conductor from its resistivity value, a CD-ROM or a database on Materials may be used. By determining some other physical property like density or Young Modulus, the search activity could be optimised. Such an exercise might also provide opportunities to cover some aspects of N3.

IT3.2 *Explore, develop, and exchange information and derive new information to meet two different purposes.*

Evidence requirements

(i) Enter and bring together information in a consistent form, using automated routines where appropriate.

(ii) Create and use appropriate structures and procedures to explore and develop information and derive new information.

(iii) Use effective methods of exchanging information to support your purpose.

Possible opportunities

Analyses and presentation of experimental data are important features of physics at all levels and this is where the use of automated routines such as spreadsheets, virtual laboratory software, etc. can play a key role. Analytical and numerical information can be entered and brought together to create new information through the use of equations and physical principles. The exchange of information can present logistical problems, but the evidence requirements could be met in two ways. On a sophisticated level, the exchange of information could take the place via the Internet or email. Alternatively, if a Centre has Network facilities, then exchange of information can take place between machines within the Centre. The exchange of information electronically could be seen a natural extension of normal sharing of data amongst candidates.

Module 2821, Forces and Motion

There are many experiments within Section 5.1.2 for which data could be entered and modified using spreadsheets. Additional data could be pooled within a group of candidates using the exchange mechanisms mentioned above. One possible experiment is the dynamics of a trolley down an incline plane. Data in the form of distance travelled and the time taken could be entered. The data could come from a ticker tape arrangement or from a data-logging package. The velocity of the trolley at different times could be calculated. This in turn could be used to calculate the acceleration of the trolley. Parts of IT3.3 could be addressed if graphs were to be produced from this data and the manipulation of data ensures some coverage of N3.

Module 2824, Forces, Fields and Energy

In Section 5.4.7, for the experiment on a discharging capacitor, the variation of p.d across the capacitor with time could be entered onto a spreadsheet. The data could then be manipulated to calculate the average time constant of the capacitor-resistor circuit. This information could then in turn be used to calculate the capacitance of an unmarked capacitor. If candidates are given identical unmarked capacitors, then exchange of data amongst candidates could be used to asses the validity and accuracy of the experimental task. Some aspects of N3 could be covered by such an exercise.

IT3.3 *Present information from different sources for two different purposes and audiences. Your work must include at least one example of text, one example of images and one example of numbers.*

Evidence requirement

(i) Develop the structure and content of your presentation using the views of others, where appropriate, to guide refinements.

(ii) Present information effectively, using a format and style that suits your purpose and audience.

(ii) Ensure your work is accurate and makes sense.

Possible opportunities

Processing of experimental data and producing a textual report is not new to science. There are numerous packages that may be used to produced text and images. Graphs may be drawn using spreadsheet routines and images may be produced or imported within Microsoft Word. Some of the requirements in C3 could be fulfilled if there is a presentation to a group. Presentations can now have an air of sophistication with information presented on overhead projectors or monitors using commercial packages like Microsoft PowerPoint.

Module 2821, Forces and Motion

All the Module 2821 and Module 2822 examples given in IT3.1 and IT3.2 may be used to prepare an IT based presentation to a range of audiences.

Module 2822, Electrons and Photons

For the electromagnetic spectrum work in section 5.2.5, as part of an independent learning exercise, candidates could import relevant images and related text from CD-ROMs to prepare a presentation. There is also a possibility of sending scanned images from textbooks via the Internet or email.

WO3 Working with Others Level 3

You must:

Provide at least **one** substantial example of meeting the standard for WO3.1, WO3.2 and WO 3.3. You must show you can work in both one-to-one and group.

Sound understanding of physics concepts is best achieved by the theory work being supported by appropriate hands-on practical activity. This experimental work often has greatest impact when investigations are carried out with candidates working in groups. Such collaborative work can readily be used as the basis for activities in relation to the Working with Others. Throughout AS and A2 there are very many opportunities for collaborative practical work. In addition, candidates could choose to work together while studying one of the options in module 2825. Delivery of the options will vary from one centre to another; for those opting for a supported self-study approach the collaboration of candidates can be very beneficial. An activity could be set for example where candidates are required to give a presentation, concerning their chosen option, to the rest of the cohort.

WO3.1 *Plan complex work with others, agreeing objectives, responsibilities and working arrangements.*

Evidence requirements

(i) Agree realistic objectives for working together and what needs to be done to achieve them.

(ii) Exchange information, based on appropriate evidence, to help agree responsibilities.

(iii) Agree suitable working arrangements with those involved.

Possible opportunities

There are many opportunities for co-operative activities in both practical work and whilst studying the theoretical content of the modules (particularly the options in module 2825). Virtually any practical task can be use as a planning activity with the appropriate delegation of responsibilities and working arrangements .

Module 2821, Forces and Motion

This module contains many opportunities for co-operative practical work such as the experiment to determine the Young Modulus of a metal in section 5.1.5: Deformation of solids. Section 5.1.7: Car Safety lends itself well to the preparation of a presentation of the most essential issues connected with safe driving and the avoidance of car accidents.

Module 2825, Components 01 – 05

Within each option there are numerous opportunities for collaborative practical work and presentation type activities.

WO3.2 *Seek to establish and maintain co-operative working relationships, over an extended period of time, agreeing changes to achieve agreed objectives.*

(i) Organise and carry out tasks so that you can be effective and efficient in meeting your responsibilities and produce the quality of work required.

(ii) Seek to establish and maintain co-operative working relationships, agreeing ways to overcome any difficulties.

(iii) Exchange accurate information on progress of work, agreeing changes where necessary to achieve objectives.

Possible opportunities

Throughout A2 and particularly within the options in module 2825 there are many opportunities for more complex collaborative activities that require careful deliberation by the members of the group in order to achieve an effective and efficient method of working.

Module 2824, Forces, Fields and Energy

Opportunities for collaborative practical work are to be found, for example, in section 5.4.4: Oscillations by investigating the factors that determine the frequency response and sharpness of resonance. The sections on Electromagnetism (5.4.8) and Electromagnetic Induction (5.4.9) may be used as the focus for collaborative work on a presentation describing the range of applications of electromagnetism to enhance life in a modern, technological society. Equally applicable for this type of activity would be a presentation based on the material contained in section 5.4.12 identifying the advantages and potential hazards of using radioactivity isotopes.

Module 2825, Components 01 – 05

Within each option there are numerous opportunities for collaborative practical work and presentation type activities.

WO3.3 *Review work with others and agree ways of improving collaborative work in the future.*

Evidence requirements

(i) Agree the extent to which work with others has been successful and the objectives have been met.

(ii) Identify factors that have influenced the outcome.

(iii) Agree ways of improving work with others in the future.

Possible opportunities

For each of the activities, both practical and presentational, described for WO3.1 and WO3.2 candidates would be expected to evaluate the extent to which that had met their objectives and to identify the main factors which had contributed to the outcome. It may also be beneficial when reviewing the presentations to encourage comments and suggestions for improvement from the whole audience. Within each group candidates would be expected to reflect on how they felt they had worked as a team so that strategies for enhancing future tasks could be identified.

LP3 Improving Own Learning and Performance Level 3

You must:

Provide at least one substantial example of meeting the standard for LP3.1, LP3.2 and LP3.3.

LP3.1 *Agree targets and plan how these will be met over an extended period of time, using support from appropriate people.*

Evidence requirements

(i) Seek information on ways to achieve what you want to do, and identify factors that might affect your plans.

(ii) Use this information to agree realistic targets with appropriate people.

(iii) Plan how you will effectively manage your time and use of support to meet targets, including alternative action for overcoming possible problems.

Possible opportunities

Candidates could identify the learning and performance that need to be improved. Within this course, this is likely to be some form of study-based learning; for example: subject content that is proving difficult, disappointing exam performance, or activity-based learning, poor practical technique. Candidates may require advice how to improve their performance in terms of resources, activities or exam technique.

A candidate could set their own targets within an action plan outlining how they will improve a particular aspect of their work. Opportunities could arise within any module, as different candidates will identify different development needs. These targets may well be co-ordinated within a Centre's review procedures, possibly linked to a value-added approach. It is important that the targets and action plan span an extended period of time, typically 8-12 weeks, after which overall progress could be reviewed (LP3.3)

These opportunities arise in all modules.

LP3.2 *Take responsibility for your learning by using your plan, and seeking feedback and support from relevant sources, to help meet targets.*

Improve your performance by:

- studying a complex subject;
- learning through a complex practical activity;
- further study or practical activity that involves independent learning.

Evidence requirements

(i) Manage your time effectively to complete tasks, revising your plan as necessary.

(ii) Seek and actively use feedback and support from relevant sources to help you meet your targets.

(iii) Select and use different approaches to learning to improve your performance, adapting methods to meet new demands.

Possible opportunities

Candidates could use their initial action plan to actively improve their identified weaknesses. The plan may need to be modified as learning develops.

LP3.3 *Review progress on two occasions and establish evidence of achievements, including how you have used learning from other tasks to meet new demands.*

Evidence requirements

(i) Provide information on the quality of your learning and performance, identifying factors that have affected the outcome.

(i) Identify targets you have met, seeking information from relevant sources to establish evidence of your achievements.

(iii) Exchange views with appropriate people to agree ways to further improve your performance.

Possible opportunities

After an extended period of time, enabling overall progress to be reviewed. This could follow an examination result (where improving exam performance has been a priority) or after an assessment of experimental skills (where practical technique has been an issue). The action plan from LP3.1 (and any modifications from LP3.2) should be evaluated against evidence, such as an exam result or marks for assessments, to see if learning and performance have improved. The outcome may need a need for a further action plan with revised targets.

PS3 Problem Solving Level 3

You must:

Provide at least one substantial activity for meeting the standard PS3.1, PS3.2, PS3.3.

PS3.1 *Explore a complex problem, come up with three options for solving it and justify the option selected for taking forward.*

Evidence requirements

(I) Explore the problem, accurately analysing its features, and agree with others on how to show success in solving it.

(ii) Select and use a variety of methods to come up with different ways of tackling the problem.

(iii) Compare the main features of each possible option, including risk factors, and justify your selection.

Possible opportunities

Module 2822, Electrons and Photons

Candidates could investigate and find the relationship between two variables. A number of opportunities arise in situations that involve variables whose relationship is non-linear. For example, a candidate might be asked to plan an experiment to verify that the fusing current I, of a wire is related to its length L and cross-sectional area A by an equation of the form $I=kL^xA^y$. In defining the hypothesis, appropriate methods could be considered for the solution of this problem together with the criteria which have to be met in order to show that the problem has been solved successfully.

Alternatively, a candidate could be given the problem of measuring the thickness of a pencil line. Various electrical methods might be considered providing opportunity for a candidate to give appropriate justification for the method chosen.

Module 2823, Component 02: Coursework 1 and Module 2826, Component 02: Coursework 2

Within the experimental work completed during the course, the following four skill areas are developed: Planning; Implementing; Analysing Evidence and Drawing Conclusions; and Evaluating Evidence and Procedures. (For more details, see Appendix C). Evidence for the assessment of PS3.1 may be found in the work produced by a candidate for skill P (planning) as part of the assessed coursework.

Module 2824, Forces, Fields and Energy

A candidate could try to find the relationship between the length of a cantilever and the frequency of forced oscillations on the cantilever. (5.4.4 Oscillations)

PS3.2 *Plan and implement at least one option for solving the problem, and review progress towards its solution, and revise your approach as necessary.*

Evidence requirements

(i) Plan how to carry out your chosen option and obtain agreement to go ahead from an appropriate person.

(ii) Implement your plan, effectively using support and feedback from others.

(iii) Review progress towards solving the problem and revise your approach as necessary.

Possible opportunities

All of the evidence requirements for PS3.2 could be found in skills P (planning), I (implementing) and E (evaluating). The evidence for the achievement of this PS3.2 could, therefore, be found in the submitted coursework.

The teacher / supervisor might comment on the submitted plan and then allow the candidate to carry out the experiment and make adjustments to the initial plan in the light of experience.

PS3.3 *Apply agreed methods to check if the problem has been solved, describe the results and review your approach to problem solving:*

Evidence requirements

(i) Agree, with an appropriate person, methods to check whether the problem has been solved.

(ii) Apply these methods accurately, draw conclusions and fully describe the results.

(iii) Review your approach to problem solving, including whether alternative methods and options might have proved more effective.

Possible opportunities

During the supervision of the practical work carried out by a candidate, the opportunity will exist for the teacher to discuss with the candidate and verify that the problem has been solved. Written evidence of achievement for PS3.3 could be in the body of the submitted coursework for skill A (Analysing Evidence and Drawing Conclusions) and skill E (Evaluating Evidence and Procedures). Critical evaluation of the reliability of the results could lead to a review of procedures.

Module 2822, Electrons and Photons

Candidates could approach the problem of measuring the thickness of a pencil line through electrical methods (see section 5.2.1). This involves a variety of measurements with different apparatus. The opportunity exists for candidates to consider the reliability of the measurements taken with each piece of apparatus, to identify the main source of error contributing to the result and to suggest improvements