RECOGNISING ACHIEVEMENT

14-19 CHANGES
A LEVEL

Support Materials

GCE Physics B (Advancing Physics) H159/H559:

Coursework Handbook

Version 1

AS/A Level Physics B (Advancing Physics)

AS/A Level GCE

Coursework Handbook

GCE Physics B (Advancing Physics)

OCR Advanced Subsidiary GCE in Physics B (Advancing Physics) H159

OCR Advanced GCE in Physics B (Advancing Physics) H559

This Teacher Support: Coursework Handbook is designed to accompany the OCR Advanced Subsidiary GCE and Advanced GCE Physics B (Advancing Physics) specifications for teaching from September 2008.

OCR will update this document on a regular basis. Please check the OCR website (www.ocr.org.uk) at the start of the academic year to ensure that you are using the latest version.

Contents

1 General Introduction

This guide has been written to assist teachers in setting suitable coursework tasks and in assessing candidates' work. The guide should be read in conjunction with the OCR AS/A Level Physics (B) Advancing Physics specifications. However, all sections of the specifications relating to coursework assessment are included here.

While this guide is concerned with the assessment of coursework, it cannot be emphasised too strongly that before candidates are assessed on their communication, research, experimental and investigative skills, these skills must be taught and candidates must have opportunities to practise and to develop their abilities.

Throughout the Advancing Physics course candidates develop their ability to learn independently, and develop their experimental and investigational skills and their research and communication skills. There are many opportunities for formative assessment as a candidate follows the course and the assessment of coursework recognises the wide range of skills candidates will have acquired.

All the coursework is assessed by the candidate's physics teacher using criteria set by OCR and externally moderated by OCR.

In the AS GCE course candidates carry out two short tasks: a measurement task, Quality of Measurement, and a presentation on a material chosen by the candidate, Physics in Use. Together these two tasks form assessment Unit G493: Physics in Practice.

In the A2 half of Advancing Physics the coursework consists of two more substantial pieces of work, recognising the more developed skills and maturity of candidates by this stage. The candidates are required to tackle a Practical Investigation and produce a Research Briefing both on topics chosen by the candidate. Together these two pieces of coursework form the assessment Unit G496: Researching Physics.

In each coursework unit the marks awarded contribute towards aspects of Assessment Objectives AO1: Knowledge and understanding of science and of How science works; AO2: Application of knowledge and understanding of science and of How science works; and to Assessment Objective AO3: How science works.

Coursework provides a number of opportunities to develop key skills and to collect evidence that may contribute towards the assessment of key skills. Section 6.3 of the specification indicates where these opportunities may exist in each coursework unit. Teachers are advised to discuss such opportunities with colleagues and with the students concerned.

2 Introduction to the tasks

2.1 AS Unit G493: *Physics in Practice*

30 marks

In the AS GCE course candidates carry out two short tasks: a measurement task, **Quality of Measurement**, and a presentation on a material chosen by the candidate, **Physics in Use**. Together these form Unit G493: Physics in Practice.

The two tasks are:

Quality of Measurement (20 marks)

- A report of a measurement or study of a physical relationship, with attention paid to improving the quality of measurement and making valid inferences from the data gathered.

Physics in Use (10 marks)

- A presentation on the use, properties and structure of a material.

The work is carried out during the AS course, and assessed at that time. The two pieces of work together form a coursework portfolio for which a single mark out of 30 is submitted for Unit G493.

Quality of Measurement

Candidates undertake a task of the following kind:

- a careful measurement of a physical quantity;
- a careful quantitative study of the relationship between two or more variables, where there are some indications from theory of what to expect;
- a careful calibration of a sensor or instrument;
- a careful study of one or more of the properties of a sensor or instrument;
- a comparison of methods of measuring the same thing.

The word ‘careful’ implies both practical skill (‘hands on’) and thoughtful analysis of problems and data (‘minds on’).

Candidates should demonstrate their ability to:

- recognise the qualities and limitations of measuring instruments, particularly resolution, sensitivity, calibration, response time, stability and zero error;
- identify and estimate the most important source of uncertainty in a measurement and seek ways to reduce it;
- consider the possibility of systematic errors and seek to estimate and remove them, including considering calibration;
- make effective plots to display relationships between measured quantities, with appropriate indication of uncertainty;
- use simple plots of the distribution of measured values to estimate the median (or mean) value and the spread (which may be estimated from the range of values), and to identify and account for outlying values.

A written report of the work done is produced. This task builds on the measurement tasks that candidates will have performed in their experimental work throughout the AS course.

Managing the Quality of Measurement Task

This task is expected to take no more than five hours of contact time, used in the laboratory for setting up and taking measurements, and an equivalent amount of time for writing the report. It is expected that the teacher will provide a clear problem or goal from the kind listed above.

The time allocation for the Quality of Measurement Task sets a modest bound on what candidates are expected to achieve. The experience should build on practical exercises from the course and measurement skills developed at GCSE, and should be the practical climax to their AS course, having been prepared for by tasks carried out in teams throughout the year.

What are the aims?

Candidates should develop a sense of pride in measuring as well as possible given the tools they have, and to be clear about how well the job has been done. They should be able to experiment well, to recognise the limitations of instruments and to discuss the uncertainty of measurements, learning to look for important sources of uncertainty and attempt to reduce them. They should also consider possible systematic errors and try to remove them. Candidates should be able to analyse data carefully make intelligent use of graphs and tables, extract as much information as possible and present a report that explains clearly the procedures they have used. The written record should communicate the results obtained and have a clear outcome that is qualified with statements of uncertainty.

Assessing the Measurement Task

This task provides an opportunity for students to demonstrate their practical, experimental, measuring and investigational skills. This task gives the opportunity within the AS course to assess practical aspects of the assessment objective AO3 How Science Works.

Physics in Use

This task involves researching the nature and use of a material, and making a presentation about it. Each candidate may choose to give the presentation as an illustrated talk using a presentation program such as Microsoft PowerPoint, a web page, a video or a poster. It is envisaged that each candidate will choose the manner of presentation that appeals to them, and is best suited to the audience and topic. Overlong presentations should be discouraged; ten minutes should be considered a maximum.

New materials offer a wide variety of stimulating choice, but the choice of topic should not be restricted to novel materials. The presentation should show relationships between the properties and uses of the material. Some aspect of the wider context, for example, a social, historical, economic or personal context must be considered.

A paper record of the presentation must be available in a form which can be easily be sent to moderators.

This task comes directly out of the work done in relation to Designer materials in module PA 2 of Unit G491. The assessment rewards independent learning and presentation of physics in a non-written format.

Managing the Physics in Use task

This task is expected to take no more than three hours of contact time; this includes that required for students' oral presentations to the whole class. Candidates should use around two further hours for research and writing.

What are the aims?

By the time of the presentation, candidates' understanding and vocabulary should have developed significantly from the GCSE background with which they started the course. They should feel confident to access and make use of information from a variety of sources, and be extending their study in a direction which interests them.

It is hoped they will enjoy careful research, and consider their fellow-candidates, the audience, as they prepare this research for presentation.

Assessing the Physics in Use task

This task provides an opportunity to assess the candidates' independent learning and presentation of physics in a non-written format. The assessment addresses, in particular, aspects of AO1 Knowledge with understanding and AO2 Application of knowledge with understanding, synthesis and evaluation.

The tasks in the AS course arise directly out of the students' own learning and it is expected that these assessment tasks will be tackled at the appropriate place in the course. Each task would be expected to take not more than 10 hours and five hours respectively, including time in class.

2.2 A2 Unit G496: *Researching Physics*

In the A2 half of the Advancing Physics the coursework consists of two more substantial pieces of work, recognising the more developed skills and maturity of candidates by this stage. The candidates tackle a Practical Investigation and produce a Research Briefing both on topics chosen by the candidate. Together these two pieces of coursework form assessment Unit G496: Researching Physics.

Each of these tasks provides an opportunity for candidates to work independently, choosing their own topic for study. The tasks require more time from the candidate and it is expected there will be a significant difference in the outcome in comparison with those tasks tackled in the AS course.

Practical Investigation (20 marks)

- A report of an extended investigation of a practical problem related to physics or its applications. The practical investigation should be carried out on any aspect of physics of interest to the candidate.

Research Briefing (10 marks)

- A short written (max 2000 words) and verbal report based on the individual work of a candidate summarising a topic in physics of his or her own choosing that requires the need to use and synthesise ideas from different areas of the subject. The criteria for assessment include the ability to defend and explain the ideas involved during questioning.

The Practical Investigation is expected to take about 10 hours of contact time and the associated independent study time, and the Research Briefing about half of that. The two pieces of work together form a coursework portfolio for which a single mark out of 30 is submitted making up the assessment Unit G496.

Practical Investigation

Each candidate carries out an investigation of a practical problem related to physics or its applications. It is anticipated that candidates will use a wide variety of experiments and techniques in this extended investigation. The most suitable topic is a clearly defined problem, which offers scope for genuine investigation, rather than routine, mechanical and unimaginative work. The topic chosen should afford the candidate the opportunity to demonstrate understanding of physics at an Advanced GCE standard.

What are the aims?

One of the central features of the course is the emphasis placed on learning physics through the interplay of theory and experiment – so that candidates understand where ideas come from, how they make sense and how they may be used. This is made possible through the range and variety of illustrative experiments, practical demonstrations and investigations that candidates meet during the course. But the importance of the experimental work extends beyond the fulfilment of this objective. Many students will study more science when they leave school or college, and there are some whose careers will involve science. An ability to investigate an unfamiliar situation in a sensible and scientific way is an asset not only to these students, but to all in tackling practical problems in everyday life. To this end, it is hoped that the development of experimental and investigative skills is a significant feature of the Advancing Physics course.

Building on the AS Quality of Measurement task, it is expected that candidates should use skills developed there, namely:

- recognise the qualities and limitations of measuring instruments, particularly resolution, sensitivity, calibration, response time, stability and zero error;
- identify and estimate the most important source of uncertainty in a measurement;
- make effective plots to display relationships between measured quantities, including an appropriate indication of uncertainty;
- use simple plots of the distribution of measured values to estimate the median (or mean) value and the spread (which may be estimated from the range of values), and to identify and account for potential outlying values to quantify and enhance their investigation.

The outcome of the task is a written report that describes the process of the investigation and discusses the conclusions that may be drawn from the practical work done.

Managing the Practical Investigation

The time allocated to this task is ten hours of teaching time and an equivalent amount of time in research and writing up the report.

To begin, the candidate chooses an interesting topic for investigation and carries out some preliminary research – analysing the topic, getting 'a feel' for the relevant factors, considering the selection of appropriate apparatus and measuring techniques, carrying out a literature search, if appropriate – with a view to deciding upon an experimental design that will allow the first set(s) of readings to be taken.

The next stages are to carry out the Investigation in the laboratory, to write-up the findings of the experimental work, in the form of a daily diary, and then to submit the finished report to the teacher for assessment. The assessment should be based on observation of the work done, and on discussion with the candidate, as well as information revealed in the written report.

This task provides an opportunity for candidates to demonstrate their experimental and investigative skills. The assessment addresses all practical aspects of Assessment Objective AO3 How Science Works.

Research Briefing

What are the aims?

This task is designed to assess the ability of a candidate to find information from a variety of sources; to compare, analyse and evaluate the information obtained, and to synthesise and summarise the essential points. The Research Briefing gives candidates an opportunity to be rewarded for:

- working independently;
- drawing together ideas from different aspects of physics;
- selecting and extracting information from a variety of sources;
- applying knowledge and understanding of basic ideas to a new topic;
- translating and interpreting information that may be available in a variety of forms;
- placing physics ideas in a wider human or social context;
- communicating scientific ideas in continuous prose using good English;
- using published material as part of research.

The nature of the task

This task involves researching a topic of the student’s choice to produce a short paper of about 1500-2000 words, a Research Briefing. The student will need to be able to explain the content of this work and to respond to questions that test understanding and mastery of the material included. The task is modelled on the professional activity in which members of a research group brief one another on recent work in the field, but adapted to the assessment of A-Level students.

The student should collect, analyse, evaluate and summarise information about a topic that involves a significant range of physics ideas at a suitable level. The information is to be obtained from the candidate’s own research using a representative range and variety of sources. These sources might include books, journals, pamphlets, surveys, interviews, libraries, databases and web sites on the internet. The topic may be experimental, theoretical or applied. The topic must be approved in advance by the class teacher. The teacher should ensure that the student chooses a topic that will enable them to fulfil the assessment criteria.

Managing the Research Briefing task

This task is expected to take no more than three hours of contact time; this includes that required for students’ discussions with the teacher and/or the whole class. Candidates should use around five further hours for research and writing.

The outcome of the task is a written Research Briefing (2–3 pages A4, about 1500 words), in the candidate’s own words, that summarises the key results and ideas in the topic studied. This must be based on the candidate’s own independent study of sources.

Candidates must include a list of the sources that they have used, which the teacher can sample as necessary to confirm authenticity.

The Research Briefing will be sent to Moderators, together with the teacher's supporting notes about the student's response to questioning and understanding of the material, and the overall assessment.

Assessing the Research Briefing

This task provides an opportunity to assess some aspects of AO1 Knowledge and understanding and AO2 Application of knowledge and understanding of science and AO3 How Science Works, and has a strong synoptic component. The task and its assessment are designed to make mindless copying of source material unrewarding.

In assessing the work, the teacher must use three sources of evidence:

1. the written Research Briefing including the list of sources used;
2. the candidate's ability to explain the Briefing verbally or by some other appropriate method, and to respond to questions that test understanding of the topic, including questions about sources;
3. observation of and interaction with the candidate during the preparatory work.

The Research Briefing must:

- be in the candidate's own words;
- explain the main results and ideas in the topic studied, and what they are based on, where relevant how they have developed or changed, or are novel or disputed;
- give arguments for the importance and/or interest of the topic, which may include its relevance to specific issues (e.g. scientific, technological, ethical, social, economic or environmental).

3 Criteria for the Assessment of Coursework

For the two practical tasks, AS Quality of Measurement and A2 Practical Investigation, there are four strands of assessment, giving a raw score total of 20 marks for each.

For the two presentation tasks, AS Physics in Use and A2 Research Briefing, there are two strands of assessment, giving a raw score total of 10 marks for each.

Each strand consists of a general statement of the intent of the criterion, followed by a matrix of statements describing levels of performance on a scale of 1 to 5, with descriptors of the achievement required for ratings 1, 3 and 5. Levels 2 and 4 are to be obtained by interpolation.

A mark of zero should be awarded where there has been an attempt to address the skill but the work does not meet the requirements of the lowest defined mark level.

Having obtained marks for each such set of statements, the average of the set gives the mark for that strand.

3.1 AS Coursework

3.1.1 Strands of assessment in the *Quality of Measurement* task

1. Quality of practical work in the laboratory

   Was the practical work done systematically and carefully, showing skill in handling and using apparatus? Were sufficient observations and measurements made to deal with the problem? Were results tabulated carefully in a well-thought-out structure, recorded as they were taken? Were measurements made so as to minimise systematic error, and to reduce uncertainty to the limits allowed by the apparatus?

Level 1	Methods and approach have limitations, with shortcomings in the measurements and observations and limited attention to practical detail.
Level 3	Methods and approach are adequate, with relevant measurements and observations and competent attention to practical detail.
Level 5	Methods and approach are well chosen, with sufficient measurements and observations made to deal with the problem and considerable skill used to obtain them, avoiding unnecessary systematic error.

2. Quality of thought about uncertainty and systematic error, and attempts to improve the measurements

   Were the relevant properties of sensors or measuring instruments studied and assessed systematically and carefully? Was the calibration of instruments considered, and attempted where possible? Was the largest source of uncertainty identified and estimated? Were possible systematic errors considered, and their sign identified? Did the student suggest and try out possible improvements to the experimental method and apparatus used?

Level 1	Measuring instruments are used directly without consideration of their properties; little understanding of the nature of error or uncertainty is shown, and data is limited to a simple set of measurements.
Level 3	Some efforts are made to use measuring instruments to their best advantage; error and uncertainty are considered, possibly with some flaws in approach, and some improvements to experimental method are considered.
Level 5	The relevant properties of measuring instruments are assessed systematically; errors and uncertainty are identified and, where possible, reduced and improvements to the experiment to reduce error and uncertainty are tried out.

3. Quality of communication of physics in the report

Is the report clear, well-ordered and concise, with enough detail to allow someone else to repeat the experiment and obtain similar measurements? Does the report explain clearly the physics of the experiment? Was available ICT used well? Are graphs and utables well-chosen, and presented so as to communicate the findings as well as possible? Is the use of English effective for the purpose?

Level 1	Recording and presentation of data lacks clarity; graphical plots may be inappropriate or incorrect and the report is poorly structured and presented.
Level 3	Data are presented clearly, with some possible inconsistencies in headings, units or significant figures; graphical plots are clear and the report covers most details needed to repeat the experiment.
Level 5	Data are presented clearly and effectively with correct headings, units, tolerances and significant figures; graphical plots are well chosen to display the data to good effect and the report is clear, concise, well-structured and gives all details needed for someone else to repeat the work.

4. Quality of handling and analysis of data

Was data analysed with care and attention, looking for anomalies or unexpected features, and extracting as much information as possible? Does the analysis demonstrate a clear and correct understanding of the physics involved? Were results cross-checked through alternative ways of looking at the data or going back to the apparatus? Was there a clear claim about the outcome, qualified with statements of uncertainty and possible systematic error?

Level 1	Analysis is limited to direct calculations or plots of measured data with possible major flaws in physics, or no attempt to explain the outcomes in terms of physical ideas, and limited attempt to discuss shortcomings in procedures.

Level 3	Some correct calculations of relevant quantities are made with an attempt to discuss the outcomes in terms of physical explanations (including discussion of errors and uncertainties) with minor errors of physics in the analysis. Obvious anomalies are noted.
Level 5	Data are analysed carefully, extracting as much information as possible, leading to a clear claim about the outcome, well-founded in the data and analysis, demonstrating understanding of the physics and relating uncertainties in the conclusions to limitations of the procedures and the measurements made.

3.1.2 Strands of assessment in the *Physics in Use* task

1. Quality of the research and presentation

   Does the presentation have a clear context? Has the student worked independently, taking advice where appropriate? Is there a good range of sources, correctly attributed and listed? Is it presented clearly, with good use of illustrations, images and data where appropriate?

Level 1	Some data and facts about the chosen material are included as a consequence of substantial guidance having been given, with at least one identified source used, and the content of the presentation is related to the title but lacks coherence.
Level 3	The report has a definite focus, with work produced independently with some advice, with some sources identified, and the presentation shows care in ordering and choice of data and illustrations.
Level 5	The presentation has a clear focus, with substantial independent work, taking advice where appropriate, a good range of sources have been used, they are clearly attributed, illustrations are well chosen, there is a clear structure to the presentation that aids clarity.

2. Use and understanding of physics

   Does the presentation include a substantial amount of physics at AS standard? Has the student used a range of material properties at microscopic and macroscopic scales to explain the use of the material in its context? Has the student shown understanding of physics in interpreting and explaining the behaviour of the material in its context?

Level 1	The presentation is simple, with aspects of the work not linked to the topic and in which the physics used is mainly descriptive.
Level 3	Relevant physics at AS Level is included in development of the work, with at least one aspect of the topic linked in terms of physical explanation to the context chosen and explained demonstrating some understanding of the physics included.
Level 5	A substantial amount of physics at AS Level is included, with a range of aspects of the topic linked in terms of physical explanation to the context chosen and explained with a sound understanding of the physics included.

3.2 A2 Coursework

3.2.1 Strands of assessment in the Practical investigation

1. Approach and experimental skill

Was the practical work done systematically and carefully, showing skill in handling and using apparatus? Was the work well-planned and done in a careful, methodical way? Was flair or inventiveness shown in doing the job as well as possible? Were sufficient observations and measurements made to deal with the problem?

Level 1	The problem is defined in simple terms, with help needed to get started. The approach has shortcomings or limitations, with little attempt to deal with interfering effects.
Level 3	The definition of the problem is sound but lacking in detail. Methods and approach are adequate and practical work is competent.
Level 5	The problem is clearly analysed in terms of the underlying physics. The methods and approach are well chosen and considerable skill and care is used to obtain results.

2. Progress, independence and use of physics

Is a sound knowledge of physics used to make decisions about the progress of the investigation? Does the student show initiative and make use of advice where appropriate? Are there a good range of experiments, showing progression and development?

Level 1	The work is largely empirical, with the student needing considerable guidance. Experimental work is limited or lacking in demand. Only the most obvious measurements are taken.
Level 3	Some knowledge of the relevant physics is demonstrated, but not utilised fully in making decisions about the development of the investigation. Some guidance is needed, or progress is limited by not seeking it when necessary. A relevant set of experiments is designed, most of the important variables in the experiment, are investigated.
Level 5	Sound knowledge of physics is used to make decisions about the development of the investigation. Initiative is shown and advice is actively sought and acted upon. A good range of experiments is designed and executed effectively showing progression and development. Work is limited only by the time available.

3. Quality and presentation of observations

Does the report explain clearly the physics underlying the experiment? Were graphs well-chosen and carefully and accurately plotted, with appropriate scales, units, best-fit lines and uncertainty bars, so as to communicate the findings as well as possible? Is the use of English effective for the purpose?

Level 1	Data is limited in quantity or range, and may have shortcomings in presentation; graphical plots may be inappropriate of unclear. The physics of the experiment is in simple terms.
Level 3	A satisfactory range of data is collected and displayed clearly, with some inconsistencies in headings, units or significant figures; graphical plots are clear and without distracting elements. The report is legible but may have shortcomings in structure, length or quality of English.
Level 5	A good range of data is collected and displayed clearly and correctly; graphical plots are well-chosen to display the data to best effect. The report is concise and well-written and adds value to the investigation with good structuring and clear illustrations and referencing. The quality of the English used is good.

4. Conclusions and evaluation

Was physical understanding used to decide on how to analyse data? Was data analysed with care and attention, looking for anomalies or unexpected features, and extracting as much information as possible? Was there a clear claim about the outcome, qualified with statements of uncertainty and possible systematic error? Does the analysis demonstrate a clear and correct understanding of the physics involved?

Level 1	Analysis is limited to direct comparisons or plots of measured data. There is little attempt to explain the outcomes in terms of physical ideas. Discussion of the limitations of the procedures is missing or incorrect.
Level 3	Some valid calculations of derived quantities are attempted, and there is an attempt to explain the outcomes in physical terms with few major errors in physics. The main limitations of the procedures are discussed.
Level 5	The data are analysed in depth to allow the student to propose valid relationships between variables and discuss the outcomes in terms of relevant physics. Uncertainties in conclusions are discussed in terms of the limitations of the procedures used.

3.2.2 Strands of assessment in the *Research Briefing*

1. Quality of the Research Briefing

Would this briefing usefully and effectively inform another A-Level student about the essentials of a suitably demanding new topic? Is understanding of the topic demonstrated? Is it clearly explained and concise, including the key elements of the topic? Is it presented coherently so as to make it easy to follow and comprehend?

Level 1	Considerable guidance was needed with the chosen topic. At least one source was identified, and may be used extensively. The briefing is too long, or too short, lacking in relevance in parts and with poor structure and attribution of quotations
Level 3	Some of the potential of the topic was developed and several sources of information were used, perhaps without cross-checking. The briefing is neatly produced and of the required length, but may have flaws in logical structure or in written English.

Level 5	There is a clear focus on a challenging topic, chosen independently, with an appropriate range and variety of sources with cross-checking of information. The briefing is clear, succinct and well-written in good English.

2. Use and understanding of physics

Is this the student's own work, developing a personal understanding of a new topic that involves substantial use of physics, through seeking out sources, assessing them critically, working on understanding them and expressing the ideas so as to make them understandable to others?

Level 1	The ideas used require little physics at A Level. The briefing does not identify the key elements and is not reworked into a summary. Questioning reveals that much of the physics is not well understood.
Level 3	The chosen topic requires some knowledge of physics at A Level. There has been some selection of essential ideas, but the focus on the key elements is unclear or incomplete. Questions asked are mainly dealt with competently, showing that the physics is mostly understood, although there may be some misunderstandings.
Level 5	The chosen topic requires substantial knowledge of A-Level physics, involving ideas or applications new to the student. Essential ideas have been thoughtfully selected and reworked into a coherent summary. Questioning reveals a good understanding of the physics included.

4 Suggested Tasks

4.1 Quality of Measurement

There are a number of possible approaches to this task. Suggested topics for each kind are listed below:

4.1.1 A careful measurement of a physical quality

- Breaking stress of steel
- Conductivity of copper
- Emf and/or internal resistance of a cell
- Gravitational field strength near the Earth's surface
- Planck constant
- Power and/or magnification of a lens of a lens
- Speed of light
- Speed of sound in air
- Wavelength of red light
- Young modulus of copper

4.1.2 A careful quantitative study of the relationship between two or more variables, where there are some indications from theory of what to expect

- Absorption of light with thickness of materials, or concentration of a solution
- Frequency of a standing wave on a string and length
- Resistance of a metal wire and temperature
- Response of a solar cell to varying light intensity
- Speed of a trolley down a slope and angle
- Speed of falling paper cones and area
- Speed of wave on a string and tension

4.1.3 A careful calibration of a sensor or instrument

- LDR used as a simple light meter
- Linear sprung potentiometer used as simple balance
- Rotary potentiometer as an angle sensor
- Thermistor or thermocouple used as a simple thermometer

4.1.4 A careful study of one or more of the properties of a sensor or instrument

- Resolution of a thermocouple
- Response time of a photodiode and/or phototransistor
- Response time of a thermistor and/or thermocouple
- Sensitivity of a thermistor

4.1.5 A comparison of methods of measuring the same thing

- Airflow from a fan using a hinged flap and rotary potentiometer compared with a hot wire anemometer
- Liquid level based on flotation and a rotary potentiometer compared with an LDR and light source
- Mass using a sprung potentiometer or a strain gauge
- Measuring g in more than one way
- Proximity using an ultrasonic sensor or a photodiode
- Temperature using a thermocouple, thermistor or using change of resistance of a metal

4.2 Physics in Use

- Aluminium: a shining example to society?
- Bullet proof glass
- Carbon fibre in Racing Cars
- Composite materials in skis
- Concrete through the ages
- Contact lens materials
- Glass fibre boats, planes etc
- Glass in architecture
- Gold in jewellery
- Gore-tex used in making quality waterproof products
- Neoprene - not just a wet suit material
- Nitinol in dentistry
- Rubber used for car tyres
- Space shuttle tiles

- Spiders' silk in webs
- Teflon used on pans
- Tempur (memory foam) for use in mattresses.
- Titanium in bike frames, golf club heads, hip replacements, skis etc
- Tungsten filaments in lamps

4.3 Practical Investigation

- Absorption of radioactive emissions
- Acoustic properties of double-glazing
- Adhesive properties of blutak
- Aerofoil lift
- Bicycle brakes
- Bifilar pendulums
- Bounce height of (squash) balls
- Compound pendulum
- Conduction in flames
- Craters
- Damping effects on SHM
- Efficiency of the d.c.motor
- Efficiency of transformers
- Flight of shuttlecocks
- Fluid flow
- Frictional effects of bowling shoes
- Investigating sails
- Keels on boats
- Light absorption by liquids
- Loudspeakers
- Magnetic braking / suspension
- Parachutes
- Parallel plate capacitors
- Projectiles

- Protection for postage parcels
- Resolution of the human eye
- Resonance in wine glasses
- Resonant frequency of tower blocks
- Rising bubbles in fluids
- Ski jumps
- Sliding friction
- Solar cells
- Sparks between electrodes
- Stability of high-sided vehicles in cross-winds
- Strength of chocolate
- Structural properties of a daffodil stem
- Tea diffusion
- Thickness of soap bubbles
- Torsional pendulum
- Trebuchet
- Vibrating strings
- Viscosity of sugar solutions
- Vortices in fluids
- Water rockets
- Windmills

4.4 Research Briefing

- Autofocus systems in cameras
- Bend it like Beckham (the physics of football)
- Could an asteroid destroy the Earth?
- What are the technological difficulties in getting a man to Mars?
- How fast can we go?
- Hybrid cars - is there a future?
- Optical tweezers

- Power from waste
- Roller Coasters
- Satellite communications
- Speech synthesis and recognition
- Superconductors
- The Sun, the largest fusion reactor in the Solar System - but for how long?
- What is the evidence for the existence of black holes?
- What is the evidence for the Higg's field?
- Why did the Millenium Bridge wobble?
- What is ‘Blu-ray’ technology?

5 Notes for Guidance on Coursework Submission and Assessment

5.1 Assessment of coursework

The purpose of coursework assessment is to ascertain the value of the work carried out by the candidate using the criteria for assessment. The criteria provide the framework within which fair-minded and informed decisions can be made that result in ratings that fairly reflect the level of performance, are internally consistent and comparable with those produced in other centres. The person responsible for teaching the students must carry out the assessment. Where several teachers in a centre are involved, it is expected that arrangements will be made to ensure that they are all interpreting the criteria in the same way and that their marking is internally standardised.

The specific criteria and mark descriptors for each task are outlined in Appendix D of the Specification and also in Section 3 of this Coursework Handbook. One significant difference from the scheme used in the preceding specification, in line with the simplification of the coursework demands on candidates and teachers alike, and with the reduced weighting given to coursework, is that the number of strands to be assessed on the five-point scale is reduced to four for the practical tasks, Quality of Measurement and the Practical Investigation, and to two for the research tasks Physics in Use and the Research Briefing.

An Assessment Form, consisting of a matrix of mark descriptors, has been produced for each coursework task. The current versions of these forms are provided as an appendix to this Handbook, and are also available on the OCR website (www.ocr.org.uk). The teacher is asked to mark on the assessment form the ‘best fit’ descriptor for each of the criteria shown. These judgements are then used to determine the mark out of five awarded for that criterion. If necessary teachers are invited to write a few words about the evidence they are taking into account, both from personal observation and from the written outcome.

It is important to realise that the coursework can be fairly and effectively assessed at this general level, without becoming immersed in detail. By using the guidance in this handbook, the exemplar material provided by OCR, with experience of assessment and feedback from moderation teachers will become increasingly confident and consistent in their application of the criteria.

Some of the important administrative procedures relating to coursework are outlined below. However for details of the regulations governing coursework centres should consult the Administrative Guide to General Qualifications, available on the OCR website (www.ocr.org.uk).

The JCQ document Instructions for completing coursework/portfolios is a source of much useful advice for teachers. This is available on the JCQ website (www.jcq.org.uk).

5.1.1 Supervision and Authentication

An important feature of Advancing Physics coursework is that teacher and candidate will work closely together throughout. However this must be done in such a way that it is possible for the candidate to perform at all levels.

As with all coursework, teachers must be able to verify that the work submitted for assessment is the candidate's own work. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence. The supervisor responsible for the marking should complete a Centre Authentication Form, signed by all teachers to confirm that steps have been taken to ensure that the work submitted is solely that of the candidates concerned. A copy of this form must accompany the work of candidates sent to the Moderator. Each candidate must also sign a declaration that authenticates the coursework they produce as their own.

5.1.2 Marking Candidates' Work

The marks awarded should be based on both the final written work and on the teacher's knowledge of the work carried out by the candidate. The marking should take place as soon as possible after receipt of the work in order to complete the task efficiently and fairly. Annotations by the teacher help to inform decision making, facilitate the standardisation of marking within the centre and enable the moderator to check easily the application of the assessment criteria. They should Indicate how marks have been awarded, highlighting both examples of positive achievement and significant errors of physics.

5.2 Moderation of coursework

The purpose of moderation is to ensure that the standard for the award of marks in coursework is the same for each Centre, and that each teacher has applied the standards appropriately across the range of candidates within the Centre. For all coursework components there are two stages in the moderation procedure: Internal Standardisation and External Moderation.

5.2.1 Internal Standardisation

The purpose of internal standardisation is to check that the work of all candidates from the Centre has been assessed to a common standard, in keeping with the criteria. Teachers are encouraged to use reference and archive materials to help fix the standard of marking within the centre.

In all cases where more than one teacher in the centre has marked the work, the centre must standardise the marking in order to ensure that candidates who have demonstrated the same level of attainment receive the same mark, and that the rank order of coursework/portfolio marks for the centre, as a whole, is appropriate. Prior to marking, centres may undertake a trial marking exercise of common pieces of coursework. In this teachers are asked to mark the same relatively small sample of work to allow for the comparison of marking standards. This may identify at an early stage any teachers whose standards are out of line with that of their colleagues; and it alleviates a heavy marking load at the end of the course.

A sample of work which has been marked by each teacher must be re-marked by one designated teacher, who is not necessarily the Head of Department. Where the re-marking of a sample reveals discrepant standards, appropriate adjustments must be made to the marks of all candidates whose work was initially marked by any teacher whose marking was out of line with the centre's standards.

It is the responsibility of the Centre to ensure that internal standardisation is carried out effectively, and to provide evidence of this process.

5.2.2 Submitting marks to OCR

OCR will send Centres internal assessment mark sheets (MS1) for the submission of coursework marks, along with instructions for completing and returning the mark sheets. The top copy of the MS1 should be despatched to OCR and the second copy should be sent to the moderator, who will then select the sample for moderation. Centres retain the third copy of the MS1 for their records. Coursework marks may also be submitted electronically by EDI. Centres using EDI to submit their coursework marks should print a copy of their EDI file and sign it before sending to their allocated moderator. In either case a copy of the Coursework Summary Form for each coursework unit must also be set to the Moderator.

The deadline for the receipt of coursework marks is 15 May for the June series.

5.2.3 Incomplete Coursework/ Portfolio

Candidates who fail to submit any coursework/portfolios must be recorded on the mark sheets as ‘absent’. If a candidate completes any work at all for that unit then the work should be assessed according to the criteria and marking instructions and the appropriate mark awarded, which may be zero.

5.2.4 External Moderation

All internally-assessed components are externally moderated. The purpose of moderation is to bring the marking of internally-assessed components in all participating centres to an agreed standard.

Moderator address labels will be sent to Centres shortly before the coursework mark submission date. Where the Centre has 10 or fewer candidates entered for a coursework component/unit all the candidates’ work should be sent to the Moderator with a copy of the internal assessment mark sheet(s). Where there are more than 10 candidates, the Centre should send all marks to the Moderator by the mark submission deadline and keep the work secure. The Moderator, once he/she has received the marks from the Centre, will contact the Centre to request a sample of work. Centres should respond promptly to any requests for work from the Moderator.

Moderation is a sampling process. The sample includes work from across the range of attainment of the centre’s work. The moderator checks that the centre has applied the marking criteria, that the marking is accurate, consistent and, if more than one teacher has marked the work, that the marking has been standardised**. If the centre’s order of merit cannot be accepted, the work will have to be re-marked to enable the moderation to proceed**. The moderator will, if necessary, recommend an adjustment to a centre’s marks in order to bring them into line with the overall agreed standard.

A report on the outcome of the moderation will be sent to Centres at the time results are issued. A centre may request the re-moderation of its internally-assessed coursework, in accordance with OCR procedures.

5.2.5 Consortium Arrangements

Some schools and colleges work in partnerships in which candidates from more than one Centre are taught and assessed together, but are entered through separate Centres. In such cases OCR must be informed by the centres that they wish to be treated as a consortium. The centres must carry out internal standardisation of coursework marking across the consortium.

OCR will allocate the same moderator to each centre in the consortium and the candidates will be treated as a single group for the purpose of moderation.

5.3 Special Consideration

Special arrangements may be made for candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own.

In the case of inadvertent loss of all or part of a candidate's coursework/portfolios, OCR may, in certain circumstances, make special arrangements to enable an assessment of the candidate's attainment in coursework/portfolios to be made.

Teachers should consult the Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations, available from the JCQ website (www.jcq.org.uk).

Applications for Special Consideration relating to coursework and portfolio units/components must be made by submitting the relevant JCQ form to OCR by the deadline dates for receipt of marks.

6 Health and Safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for GCE AS and Advanced GCE this is likely to be the Local Education Authority or the Governing Body. Teachers have a duty to co-operate with their employer on health and safety matters.

Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment.

A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of *Safety in Science Education*. For members, the CLEAPSS guide, *Managing Risk Assessment in Science* offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

- *Safety in Science Education*, DfEE, 1996, HMSO, ISBN 0 11 270915 X
- *Topics in Safety*, 3rd edition, 2001, ASE ISBN 0 86357 316 9
- *Safeguards in the School Laboratory*, 10th edition, 1996, ASE ISBN 0 86357 250 2
- *Hazcards*, 1995, CLEAPSS School Science Service*;
- CLEAPSS *Laboratory Handbook*, 1997 with 2004 update, CLEAPSS School Science Service*;
- CLEAPSS *Shorter Handbook (CLEAPPS 2000)*, CLEAPSS School Science Service*;
- Hazardous chemicals: A manual for science education, (SSERC 1997) ISBN 0 9531776 0 2

* Note that CLEAPSS publications are only available to members or associates.

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual centre then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

When candidates plan and carry out their own investigative work the teacher has a duty to check the plans before practical work starts and to monitor the activity as it proceeds.

7 FAQs

Does all coursework have to be carried out under the direct supervision of the teacher?

No; in order to meet the requirements of the Physics in Use and the Research Briefing tasks in particular candidates will need to carry out research which may require the use of library facilities, the Internet etc... Also, it may not be possible to devote sufficient time in the laboratory/classroom to allow candidates to write up their work. However, sufficient work must be completed under direct supervision to allow the teacher to authenticate the marks awarded, and this is left to the discretion of the Centre.

So, candidates can use the Internet for their Physics in Use and Research Briefing?

Yes; there is some excellent material available and the highest mark descriptors require candidates to draw together material from several sources. For material taken from the internet, the reference must show the precise web page, not the search engine used to locate it. Candidates should include as much detail as possible about the website, as with more traditional sources such as books and journals i.e. authors, publication dates. These details are not always apparent from the URL alone. It is particularly important that information gained from sources such as Wikipedia is verified elsewhere.

Is there any size or word limit on coursework submissions?

There is absolutely nothing to be gained by submitting particularly large volumes of work for assessment. Students should be warned that excessively long reports may reflect a lack of clarity. Moderators will be looking at the quality of the work rather than the quantity and for clear evidence that candidates have achieved the criteria listed under each skill. The guideline for the Research Briefing task is between 1500 and 2000 words.

Will candidates improve their chances of achieving high marks by making extensive use of Information and Communication Technology in their reports?

Written material may be handwritten or word-processed. Computer-generated material is not in itself worth any more marks than hand-written work. However, if the use of I.C.T. enables the mark descriptors for any of the skills to be more effectively addressed, then candidates could gain extra credit. It should be noted that many graph-plotting packages, if not used expertly, may not produce the most appropriate graphs.

Some of my students have produced a poster for the Physics in Use task. Should this be sent to the moderator?

The Moderator does need to see the poster in order to judge its content, but it is best to send a photocopy. It is preferable that any materials sent to the moderator should be of A4 size so the poster may need to be copied in sections.

What evidence needs to be provided for the oral aspects of the Physics in Use and the Research Briefing tasks?

It depends on the nature of the presentation. For example if a PowerPoint is produced for the Physics in Use task then talk notes should be included along with printouts of the slides themselves. For the Research Briefing it is helpful to list the questions that the candidate is asked, together with an indication of the candidate's response so that the moderator can judge their level of understanding.

Do I need to show evidence of marking on candidates' work?

Yes; the more comments that are clearly written on submitted work, the easier it is for Moderators to judge whether candidates have been fairly assessed. Additional comments on the Assessment Sheets may also be helpful in justifying the marks awarded.

How do I grade candidates' work which does not fit exactly into one level within a strand?

You should use the marking matrix to obtain a 'best fit' mark out of 5 for each strand, interpolating as necessary. For example a mark of 4 should be awarded if all the descriptors at level 3 have been satisfied, but not all those at level 5.

How much help can I give students with their coursework?

It is important that candidates are taught the skills and given opportunities to practise, before being assessed. Candidates should be made aware of the descriptors used to assess their work, so that they can ensure that all aspects of the criteria are addressed. Teachers may find it helpful to go through a worked exemplar, provided that candidates are not allowed to produce work on the same topic for submission.

Since students choose their own coursework topics In Advancing Physics, guidance should be given by the teacher to ensure that the tasks are of appropriate demand. It is suggested that plans are submitted to the teacher for an initial assessment to be made of their suitability. For example, in a Practical Investigation, is the choice of topic likely to generate results capable of analysis? Such assistance is acceptable without penalty provided that candidates are not given direct guidance about what to do. In some circumstances it may be necessary to give direct help to students, for example to ensure that they are working safely or to get them through a difficulty. Such help should be taken into account in the award of marks and details must be provided to the Moderator.

Can I take in the work of my students, mark it, and then give it back to them for any errors to be corrected before taking it in again for a final mark to be awarded?

No. However teachers may review coursework before it is handed in for final assessment. Provided that advice remains at the general level, enabling the candidate to take the initiative in making amendments, there is no need to record this advice as assistance or to deduct marks. Assistance should be limited to the identification of aspects of the assessment descriptors that have not been addressed. Generally one review would be expected to be sufficient to enable candidates to understand the demands of the assessment criteria.

Examples of unacceptable assistance listed in the JCQ document 'Instructions for completing coursework/portfolios' include:

• detailed indication of errors or omissions;

• advice on specific improvements needed to meet the criteria;

• the provision of outlines, paragraph or section headings, or writing frames specific to the coursework task(s).

A clear distinction must be drawn between any interim review of coursework and final assessment for the intended examination series. Once work is submitted for final assessment it may not be revised.

Can I inform my students of their coursework marks?

If desired, the centre may inform candidates of the marks they have submitted to OCR, but in doing so must make it clear that those marks are subject to change through the moderation process.

Can work completed in the AS year be submitted for assessment for A2?

This is not recommended, as the work submitted for A2 must be of an appropriate demand. For example, tackling the Practical Investigation too early may result in a rather restricted choice of topics for study, whilst the Research Briefing requires a 'substantial knowledge of A-Level physics' for the award of the highest marks.

I suspect that one of my students has submitted coursework work that is not their own work.

There are a number of clues that point to the possibility of plagiarism, and teachers should remain alert to these. Further guidance on the detection of plagiarism may be found in the JCQ document 'Plagiarism in Examinations: Guidance for Teachers/Assessors'. This can be found on the JCQ website (www.jcq.org.uk).

Can coursework tasks be repeated?

Yes, but completely new topics must be chosen for each repeated task. It is possible to re-use one of the tasks from an earlier submission provided that it is re-submitted unchanged. For example a candidate may be happy with the marks achieved for the Physics in Use task at AS, but wishes to improve his or her marks for the Quality of Measurement task. They can then just repeat this latter task. However both pieces must be assessed with the work of other candidates in the current cohort, and should be available if requested by the Moderator.

I am having trouble deciding whether the tasks we set our students are appropriate. What advice is available?

The submission of proposed coursework tasks for approval by OCR is not a requirement of the scheme. However, Centres wishing to obtain guidance on whether a coursework task is suitable should use the 'Coursework Enquiry Forms' available on the OCR website (www.ocr.org.uk).

Can I get advice on the standard of my marking prior to moderation?

Yes. 'Coursework Enquiry Forms' can also be used to request feedback and advice on the marking of students' work before marks are submitted to OCR and the Moderator. Teachers should send details of the task set, any background information and marked examples of candidates' work. 'Coursework Enquiry Forms' are available on the OCR website (www.ocr.org.uk).

I am new to Advancing Physics. What further help can I get with coursework assessment?

A programme of INSET meetings is arranged to provide detailed guidance on coursework assessment. These generally take place in October each year. Details are circulated to Centres and are also available on the OCR website. In addition to the Individual Moderators report, sent to centres with the publication of results, OCR publishes the Principal Moderators reports for each examination session.

More informal advice is available via the Advancing Physics website (http://advancingphysics.iop.org) maintained by the Institute of Physics. Here you can find useful resources from other teachers, and details about how to access the CAPT email discussion group.