OCR
RECOGNISING ACHIEVEMENT

GCE

Physics B (Advancing Physics)

Advanced GCE **A2 H559**

Advanced Subsidiary GCE **AS H159**

Report on the Units

June 2009

HX59/MS/R/09J

Oxford Cambridge and RSA Examinations

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CONTENTS

Advanced GCE Physics B (Advancing Physics) (H559)

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

REPORT ON THE UNITS

Chief Examiner's Report

The summer session saw the first cohort assessed on the revised specifications. The candidates also had to contend with new-style examinations. This combination clearly caused some anxieties to teachers and candidates alike. The reports from the Principal Examiners are particularly detailed for this session in order to give as much information to Centres as possible at this time. On-screen marking allows consideration of papers at a question-by-question level that was impossible before. The reports on G491 and G492 reflect this detailed analysis.

Many of the examining team are currently teaching Advancing Physics and so fully understand the concerns of their teaching colleagues and the candidates. Papers for both January and June 2010 are being reviewed in the light of the concerns expressed over this summer's assessment.

G491 Physics in Action

General Comments

The paper achieved satisfactory differentiation with a range covering marks from 0 to 58 /60. However, the mean mark (25.4 / 60) was considerably lower than targeted or expected and it is to be regretted if this contributed towards any candidates having a negative feeling about this assessment experience. It was hoped that the mean mark would have risen from the first trial of this new style paper in January 2009, but sadly this was not the case. To the examiners, timing seemed to be far less of an issue than it did in January, with only a slight tailing off in question completion towards the end of the paper.

What else may have contributed to this mark profile? Certainly there were many minimalist answers - even from good candidates – who did not want to answer at length or give much detail in suggest and explain answers. Examiners felt that students were unwilling to write more than a couple of words to explain key concepts, e.g. in Q.11(b) many just wrote a key term such as “crack propagation” rather than explaining in more detail processes and mechanisms, and this for a 3 mark answer. There were also several particularly low scoring question parts where candidates answers frequently failed to match the marking points: e.g. 8(e) (how edge detection works), 9(b)(ii) (why batteries run flat) and 10(b)(iii) (calculating conductance of whole circuit). All these were targeted at the more able candidates but with facilities (where facility = fraction of total possible marks gained by all candidates on that part question) coming out in range 0.13 to 0.16, which is lower than desirable for A/B grade marks.

There was pleasing evidence that work from the new parts of the specification had been covered by most centres. In question 3(b) there was evidence of experience of “plot and look” methods. Justified methods using mean, median or mode being credited and that candidates are applying techniques to estimate uncertainties reasonably. However, the significant figures (S.F.) on values was more of an issue, generally uncertainties should only be quoted to 1 S.F.

Also in Q.5(b) most candidates showed an ability to handle the new concept of signal to noise ratio and its limit on the number of bits worth dedicating to a digital sample.

In general there were very good correlations between candidates quartile performance overall and the facility of each question part. Questions with the highest nil response rates (all between 0.1 and 0.2) were scattered throughout the paper (2(c), 5(b) and (c), 8(d), 9(b)(iii), 10(a)(iii) & (b)(ii) & (b)(iii), 11(a) & (b) & (c)) rather than concentrated at the end of the paper, as they were in January 2009. In January the maximum nil response rates were also higher.

Comments on Questions:

Section A

1 The introductory question on electrical units got many candidates off to a confident straightforward start, but provided good differentiation. About 28% of candidates scoring 3/3 marks available, part a (power) being easier than parts b (charge) and c (conductance).

2 This was on response time and sensor sensitivity. Nearly half the candidates scored a maximum of 2 marks for recognising the sensor with the shortest response time and sensibly estimating it from a graph. The remaining 3 marks and involved dividing the change in output p.d. from the graph by the given temperature rise of 75 °C. Many candidates fell into the trap of finding the gradient of the graph which gave a rate of voltage rise in V s^{-1} rather than the sensitivity in V $°C^{-1}$.

3 There was pleasing evidence of experience of "plot and look" methods and sensible suggestions for the existence of the low valued outlier. Justified methods using mean, median or mode were credited, although most candidates naturally went for the calculation of the mean. Many of these had small arithmetic errors, but a method mark was still awarded. Candidates are applying techniques to estimate uncertainties reasonably. However, the S.F. on values was more of an issue, generally uncertainty estimates should only be quoted to 1 S.F.

4 Half the candidates could correctly name the two mechanical properties described, as stiffness and brittleness. Most of the remainder got one correct and the facility of the question was 0.72.

5 This question was about digital sampling for a film soundtrack. Part (a) was fairly high scoring; most candidates going for high frequency loses. Weaker answers were not specific enough: e.g. loses high and low frequencies, you have to sample at 2x max frequency. In (b) (facility = 0.72) most candidates showed an ability to handle the new concept of signal to noise ratio and its limit on the number of bits worth dedicating to a digital sample, most chose the argument that 2^{11} = 2048 to get the mark. The calculation of the bit rate in part (c) proved to be a good discriminator, with only 28% getting the correct answer of 132 000 bit s^{-1}.

6 This question was about a slide projector. As intended a large fraction of candidates (74%) could find the magnification of x30 from $M = v/u$ in part (a). Only the top 20% could go on to complete the calculation of the object distance from $u = v/M$ and hence show that the lens power was about 15D in part (b). Correct reverse arguments starting with 15 D also gained full credit, but many weaker candidates could not manipulate the lens equation, even allowing for ecf on their u value.

7 Here 87% of candidates could recognise the appropriate graph representing Ohm's Law, but only 61% the characteristic graph for decreasing resistance at higher current, other candidates choosing the graph with the opposite curvature.

Section B

8 This was the first section B question to have been set totally in the context of imaging. It involved making a series of numerical estimates of an image of the South Atlantic seafloor and of explaining the image process of edge detection.

(a) In calculating the area represented by the image, most candidates made a power of ten error and scored nothing. They did not appreciate that a square of side 10 km represents an area of 100 km^2 (= 10 $km)^2$.

(i) Most candidates could calculate the greatest depth of water represented by the value 255 on the greyscale.

(ii) Many missed the obvious point that the sea depth would vary over an area as large as 100 km^2 and so the data would represent an average value. A common error was to discuss the depth quantisation of 33 m, which gained no credit.

(c) The most common correct estimate to gain the two marks was that the seafloor dropped off very rapidly in depth at about 900 km from the Westerly end to a depth of about 6.6 km. The most common error was for candidates not to give numerical values to their seafloor description as requested. All reasonable estimates were rewarded one mark each, up to the max 2. About 20% of candidates scored both marks, and over 30% scored ½.

(d) The candidates had to explain how to estimate the fraction of the seafloor that was less than 4 km deep by reference to a frequency distribution graph. This was a challenge which many weaker candidates (18%) chose to ignore, and only the best could explain clearly the link between seafloor area and the area under the graph given. There was an opportunity to pick up the first mark by noting that 4 km depth was represented by the pixel value 121 which just fewer than 30% managed, so differentiation was achieved.

(e) Very few candidates understood how the edge detection process operates, i.e. by looking for changes in the *gradient* of pixel values with distance. The most common error was to say it picked up sudden changes in value which was not deemed good enough for the mark. Alternatively candidates who correctly described the details of operation of the Laplace Rule were also given the mark. This was an intentionally high level mark but the facility was rather low at 0.14.

9 This question was about the effect of internal resistance in a cell and on the total charge it could deliver.

(a) Most candidates (70%) could calculate the p.d. of 1.45 V across the load resistor using either $V = IR$ or $V = \varepsilon - Ir$. They found it harder to explain why this was less than ε the emf of the cell; about 33% correctly attributed the drop in p.d. across the internal resistance r.

(b) **(i)** This was an intentionally easy question that delivered a high facility of 0.83. Candidates had to describe in words the variation of current with time shown by a graph. The most common, if rare, errors were to not mention the *constancy* of the current for the first 10 hours, or the *rapid* decrease thereafter.

(ii) Suggesting reasons for this variation was much more challenging; very few discussed the initial constant nature of the internal resistance, but quite a few talked about the cell running out of energy (chemical potential energy). Common errors were slack use of terms such as running out of current or power, or misconceptions about temperature effects on resistance.

(iii) Candidates are supposed to be able to find the area under a graph by the method of counting squares. There was little evidence of this mathematical skill (see specification Appendix E) being put to use. Many candidates gained credit by approximating the area as a rectangle and applying $Q = It$. Sadly there were many pitfalls to gaining the full 3 marks. Many missed the milli multiplier in mA on the y axis, many did not convert the hours on the x axis to seconds. Many answers came out in Ah (Ampere x hours) instead of Coulombs. But partial method marks were available so the question differentiated well with about 7% of candidates getting 3/3 marks.

10 This question was about the operation of red and green LEDs.

(a) Nearly half the candidates correctly described the purpose of the series resistor with the LED (not LDR) as a current or p.d. limiter. Many made errors calculating the value of the resistance (280 Ω) by getting an incorrect p.d. value (rather than 6.9 = 9 – 2.1)V, or by forgetting the milli multiplier in mA. Careful application of e.c.f. meant that the follow on calculations of power dissipated were not further penalised, so the accessibility of (a)(iii) was greater than for (a)(ii).

(b) **(i)** In describing a difference in the graphs for the green and red LEDs many weak candidates wrote that the green LED takes more voltage, but did not mention to turn it on or at the same current to make sense of the statement.

(ii) Many forgot to mention the obvious that the red LED would light first, but did gain credit for mentioning the p.d.s at which the LEDs turn on. Many candidates were puzzled by the parallel circuit and made erroneous suggestions or explanations.

(iii) Better candidates gained the first hard mark by noting from the graphs that at 2.0 V across both LEDs the total current is 25 mA. However many then divided by the wrong voltage of 2.0 V rather than the circuit voltage of 7.0 V to get the total circuit conductance, about 5% of candidates got the correct value of 3.6 mS.

11 This question was about using features of the described micro-structure of glass to explain some of its macroscopic properties. Some candidates seemed not to have studied a ceramic material as the specification suggests and couched their answers in terms of plastics and long chain polymers which gained no credit. Other candidates were running out of time and gave brief and rather unworthy answers, often only managing the first mark of three in each part of the question. About 20% of candidates got 4 or more marks out of the 9 available.

(a) Most candidates linked the strength of glass fibres to the strength of the bonds, gaining one mark. But they did not go on to explain the lack of plastic deformation by the impossibility of slip due to the randomised orientations of ion groups or the lack of short range order.

(b) Many candidates got the mark for the weakening of the material by surface scratches. Again they could not go on to discuss the mechanism of crack propagation or the importance of stress concentration at the crack tip. These were the technical terms (or equivalents) that would secure the QWC mark.

(c) Many candidates (about 45%) were awarded one mark for the erroneous but plausible suggestion that glass conducts electricity near its melting point due to the thermal excitation of more free electrons. Only about 8% of candidates correctly ascribed the conduction to the ions gaining mobility and becoming charge carriers for the current and gained all 3 marks.

G492 Understanding Processes, Experimentation and Data Handling

General Comments

A number of centres have complained that G492 was too long, and that candidates failed to complete it. The statistics provided by the on-screen marking process do indicate that this may be the case: for example, the 'omit rate' (the percentage of candidates making no attempt at a question part) for the last part of the final question was 42%. A typical omit rate for a question part aimed at higher grades, such as 8cii or 9biii, is in the 10% – 15% range.

This time issue was borne in mind throughout the awarding process, where the quality of the candidates' responses was assessed when deciding on the marks needed to gain the different grades. The final agreed grade boundaries, which are to be found at the end of this publication, were also very much in line with the proportions of candidates gaining each grade predicted by the candidates' mean GCSE scores.

The Principal Examiners have also carefully considered the possible implications for the January 2010 and June 2010 papers in the Advancing Physics suite, and those question papers are being reviewed to ensure that the time demand is not excessive.

Centres should also bear in mind that this paper was the first in which this new Section C had been examined, so it is to be expected that they would not be totally certain what exact form G492 would take. In parts of Section C it was clear that very many candidates had not been directed to the best (and also quickest) way of finding a percentage error in a final result. This is discussed in detail in the comments on question 13.

Two general points about the performance of most candidates as revealed in this paper.

1. In a number of places, responses in extended prose were expected to explain the physics of the question. This is a feature of examinations which is expected by QCA and Ofqual, but candidates find it difficult. Weaker candidates tend to repeat themselves. This is an area where practice is needed by many. Extended prose does not exclude, for example, the use of bulleted lists: the key feature is that the communication should be clear.

2. Calculations involving the conversion of units to SI base units, which occurs in several places in this paper, were disappointingly done. Candidates must expect, in Physics AS papers, to be able to use equations, involving the change of subject and substitution of values in standard form. Many of the weakest responses displayed a facility with these skills which was less than would be expected on GCSE higher tier papers.

Questions 1-7 (Section A)

Section A discriminated well across the whole entry, with ‘A’ candidates getting 16+/20 and ‘E’ candidates about half marks.

In question1, most candidates realised that power is measured in J s^{-1}, but a surprising number thought that kinetic energy, or mass, was a vector.

Most candidates had no trouble with the calculation in question1; the omit rate of 3% indicated those candidates who were inappropriately entered for AS Physics rather than any obscurity or difficulty in the question.

Question 3 had a tricky unit conversion which lost all but the strongest candidates one mark. It is remarkable that candidates would imagine that a bee has a kinetic energy of 540 J, but it was a common answer.

Many found the first stage of the projectile question 4 tricky, with many resorting to manipulating the data to produce an answer of about 2 in (a).

Questions 5 and 6 were well done by most candidates.

Question 7 (a) again had tricky unit conversions, although most got at least one of the two marks for correct us of the relevant equation with error carried forward from the incorrect units. Part (b) was well done.

Question 8 (Musical instrument)

Most were able to label the antinode and nodes in (a)(i), and most could explain the formation of the antinode, although weaker responses here tended to repeat themselves.

In part (b), about half the candidates recognised that the string length was half a wavelength. Many struggled with the calculation in (ii), including the unit conversion, as described in the general introduction.

Most could draw three similar ‘loops’ in (c)(i), and many achieved 1/2 for (ii) for recognising the symmetry in the resulting standard wave. Only a small number gained the second mark in (ii) for explaining the reason why touching the strings is a feature of the range of notes produced.

Question 9 (LED torch)

The calculations in (a)(i) and (a)(iii) were done well by most. In (a)(iv), most candidates below grade A failed to realise that the total energy per second was given by the product of the energy of a photon and the number of electrons per second passing through the LED; in those that attempted it, astonishingly huge or tiny values for the power of the LED were presented with no comment.

Almost all candidates identified the blue peak on the spectrum in (b)(i), but many were unable to justify the overall white appearance of the light emitted in (b)(ii).

The two explanatory parts (a)(ii) and (b)(ii), showed that virtually all candidates had an understanding of the quantum nature of light and the relative magnitudes of red and blue photon energies. Only the best answers clearly tackled the question set, by explaining in (a)(ii) that higher voltages provide more energy (per electron), and using conservation of energy in (b)(iii)

Question 10 (Underground train map)

Part (a) of this question was inviting candidates to explain the difference between the real map and the traditional map in terms of simple velocity/time ideas in (i), and appreciating the vector nature of velocity and acceleration in (ii). Most candidates did this convincingly, and were able to suggest a reason for the popularity of Harry Beck's map (*How Science Works*) in (iii).

The more usual physics questions in (b) were much less successfully done, with only the more confident mathematicians able to show that the component of weight down the track was W $\sin(1°) \approx W/50$ in (b)(i). Most were able to explain the effect of the slope into and out of the station as decelerating and then accelerating in (ii), but clear discussion of energy in (iii) was rarely seen.

Question 11 (Jason-1 satellite)

Most candidates could calculate the speed of the satellite very competently in (a)(i), although some did use the circumference of the Earth rather than the orbit; those same candidates often obtained 43 ms, rather than 87 ms, for the time in (ii).

The identification and explanation of an advantage and a disadvantage conferred by the diffraction of Jason's microwave signal in (b) discriminated rather more, with the most able typically getting 2 or 3 marks out of 4, while the least able typically gained 1. Candidates should realise here that 'suggest' and 'explain' means that they should clearly state a factor which is an advantage or a disadvantage (and the same factor can be both) and then explain why it is. The best candidates are remarkable by their clarity in extended prose, but all too often candidates write unstructured responses.

Question 12 (Plot and look)

This question was intended as a gentle introduction to Section C, and those candidates who had carefully read the Advance Notice material scored highly in all parts. Some, rather surprisingly, had difficulty in applying the rule of thumb 'should be less than 2 × spread from the mean of all the rest' to identify an outlier, and many confused the terms **range** and **spread**, although both are used in the course materials, and were also defined in the Advance Notice material.

Explaining, in (b), why the outlier has little effect on the mean but great effect on the spread was most efficiently done by recalculating both, but good prose explanations were also seen.

In (c), the most popular suggestion was that the spring had been compressed too much, but full credit was also given for other plausible suggestions, such as reduction of the angle of projection or using a slightly smaller marble.

Question 13 (Measuring the diameter of an extremely thin wire)

This was the hardest question in the paper, and by a considerable margin the least well done, with only the top quarter of the candidates scoring over half marks. One reason for this is that the demand was clearly too high, but there were also worrying indications in parts (c)(iv) and (d)(i) that many candidates had been prepared in a way which is not that expected by the course and recommended by NPL and the universities. It is worth quoting from the *AS Teachers' CD Further Teaching Notes* on the *Case Studies: Quality of Measurement*:

"We have given little stress to rules about how to combine uncertainties when measured quantities are manipulated to calculate a final result. We have recommended merely that the effect of an uncertainty on the result be estimated by re-calculating the result with a different input."

It has been common for A-level students to be taught the following rules:

- when measurements are added or subtracted, add the absolute uncertainties
- when measurements are multiplied or divided, add the percentage uncertainties.

Unfortunately, if the uncertainties arise from random, statistically independent sources, these rules are wrong. They are only correct in the very unusual case of uncertainties being perfectly correlated."

"Our solution is to focus attention all the time on the largest uncertainty."

In part (a), surprisingly few candidates were able to convert the smallest scale measurement of the micrometer and the supposed diameter of the wire to the same units, and thereby realise that there was an inherent uncertainty of 5% or 10%. (The ambiguity arises because some candidates assumed the uncertainty was ± 1 smallest scale division, while others assumed it was ±½ of the smallest scale division – both were allowed.)

Part (b) was well done by candidates, although some did attempt to justify the relationship by a method of dimensions, which was not enough here.

Part (c)(i) was done well by those candidates who converted Δx and x to the same units. In (c)(ii), most realised that the 2 s.f. criterion was related to the data they had been given, but only the best pointed out that 2 was the smallest number of significant figures (the largest uncertainty). In (c)(iii), only the strongest candidates explained that x was already the least uncertain measurement, so that it did not contribute significantly to the overall uncertainty: Δx is the measurement to improve. In (c)(iv), many candidates calculated all the percentage uncertainties and attempted to combine them. As explained above, this is incorrect. However, to avoid penalising candidates unfairly, any uncertainty in x or F was treated as neutral in marking, so obtaining 3.8% for the percentage uncertainty in Δx anywhere in the answer gained 2/4 marks; about 25% of all candidates did this. Very few candidates recalculated r using an extreme value of Δx and used this, together with the mean in (c)(i), to find the percentage uncertainty in r. and of these, fewer than half rounded the final answer to 1 s.f.

In (d)(i), few candidates compared the fractional or percentage uncertainties in the more uncertain measurements of Δx and m; again, any attempt to combine uncertainties was treated as neutral. A substantial number of candidates thought that Method 2 was better because it relied on fewer measurements, which is not the reason. A small number of candidates were confused by the incorrect superscript in the summary table; any who attempted to use those figures were given credit. (d)(ii) was done more successfully with many making sensible comments on practicality, although few justified the choice in terms of reduced uncertainty in Δx in Method 1 or m in method 2.

Question 14 (Galileo, gravity and projectiles)

In (a), most stated that Galileo had no accurate timing device, but few commented on his having accurate rulers or measuring tapes (calibrated in ‘points’).

The calculations in (b) were generally well done, but many candidates here were under time pressure, as seen by the fact that about a third of candidates omitted one or more of these parts and went on to part (c). In (b)(ii) a number used reverse working to show that a ball moving at 4 m s^{-1} had less than 0.25 J of kinetic energy: this approach is always acceptable. Rearranging the unfamiliar equation in (b)(iii) was taxing for weaker candidates.

In (c), most calculated the values of D^2 to two decimal places or three significant figures (both were allowed), plotted teh points and drew an acceptable best-fit straight line. Only better candidates realised that the relationship $D^2 \alpha H$ requires a straight line through the origin; those who did gained credit for ‘yes’ or ‘no’, whichever their line indicated.

Part (c)(iii) was omitted by many candidates who clearly found the paper too long. Many of these, however, had omitted questions throughout the entire paper, including in Section A.

G493 Physics in Practice

General comments

The vast majority of Centres are to be congratulated regarding the efficient manner in which they managed the setting, marking and compilation of the coursework portfolios for this session. The high quality of much of the work seen was a testament to how well teachers had prepared their candidates to meet the requirements of the new assessment criteria for the coursework component of the revised AS specification. It is hoped that the comments on the tasks given below will assist teachers in advising their candidates on how the overall standard of work can be raised further.

There were a few issues of administration where centres can assist in ensuring that the moderation process runs even more smoothly in the future. Centres are instructed to send the work of all candidates to the Moderator where the entry is 10 or fewer, and it can speed up the moderation process if this is also done for entries up to about 15 candidates. For larger centres the request for the sample is now generated automatically after the marks have been received by OCR; centres receiving an email giving details of the work required. Although most centres are now aware of the requirement to include a completed Centre Authentication Form (CSS160), failure to do so can delay the moderation process.

There were relatively few clerical errors this session, but their presence can cause considerable delays to the moderation process. Notification is sent via email and centres must then return the correct marks to OCR before moderation can be completed. It would be most helpful if all centres could ensure that the addition and transcription of marks is checked prior to submission. Sometimes the errors arose from the use of + or - symbols to indicate instances where the criteria had either been exceeded, or not quite met. Although this can be useful when assessing the work, it is important that the numerical marks for each strand add up to the total mark awarded. Also, whilst evidence of internal standardisation is welcome, the inclusion of more than one mark sheet can likewise be confusing.

Annotations by the teacher on the work 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. Examples of positive achievement should be indicated, but it is particularly useful for the centre assessor to point out where they recognise that poor physics or mathematics has been done. The generally high level of annotation on the candidates' work for the Quality of Measurement task was very helpful to the moderation process. However there tended to be fewer comments to support the marking of the Physics in Use task.

Quality of Measurement Task

The majority of the experiments carried out for the Quality of Measurement task were appropriate and covered a good range of the physics concepts in the AS course. Experiments to measure '*g*' were a popular choice for this task, but it is not intended that methods based on timing the period of oscillation of a pendulum are undertaken as the theory lies outside the AS level specification. Guidance for as many as 8 suitable methods for measuring '*g*' is provided in Activities 110E, 120E and 130E of chapter 9 of the Advancing Physics CD-ROM. Many centres chose to guide their candidates towards the sensor projects in Chapter 2 of the course. Whilst this is understandable, particularly in this first year of the revised specification, it is important that the work carried out satisfies the new assessment criteria. For example, there is reference to uncertainties and systematic errors in all four strands. Although these aspects were covered well in most centres, candidates in others did not seem to appreciate their importance and they were sometimes referred to rather cursorily, if at all.

There is useful guidance provided in the Advancing Physics AS book and CD-ROM which may help to clarify candidates understanding of these areas of the course. The *Case Studies* on Quality of Measurement provide useful background information, whilst the section on '*How to deal with uncertainty in measurements*' in the *Data and Measurement Skills* section of the CD gives more specific advice. There are a number of experiments on the CD which can help to develop an appreciation of uncertainties in measurements at an early stage of the course. For example, ideas of '*Plot and look'* can be introduced through Activity 110E: '*Using a digital multimeter to measure resistance*' in Chapter 2 or Activity 100E: '*Measuring breaking stress of materials*' in chapter 4. Candidates understanding can be enhanced through such activities as 195E and 200E, relating to the power and magnification of lenses in Chapter 1 or Activity 150E, relating to measurements of Young modulus and breaking stress in Chapter 4. Ideas of progression in experimental work can be addressed though, for example, Activities 250E-253E '*Measuring wavelength better and better*' in Chapter 6. Final preparation for the Quality of Measurement task might be done though the briefing for the '*Team sensor task'* or '*Team measurement task*' (Activities 400E in Chapters 2 and 9 respectively).

In some centres it appeared that candidates worked together in pairs, or small groups, when carrying out the practical work for the Quality of Measurement task itself. This is not what is intended, as it does not allow them to demonstrate evidence for strand A '*Quality of practical work in the laboratory*' or strand B '*Quality of thought about uncertainty and systematic error, and attempts to improve the measurements*'. In a number of other centres all candidates carried out the same experiment, a particularly popular choice being the measurement of the resistivity of a metal wire. Whilst this latter approach is acceptable, if the work is carried out by the candidates independently, it often lead to the methods, tables of data, graphs and reports being very similar. It is the responsibility of the centre to ensure that the work submitted for assessment can be authenticated as being that of the individual candidate concerned. It may be easier to do this if a range of possible experiments were provided, allowing the candidates at least some element of choice. This would then also provide a better preparation for the Practical Investigation component of the A2 course.

In strand A '*Quality of practical work in the laboratory*' it is expected that candidates provide written evidence that they have addressed 'safety' to satisfy the descriptor dealing with '*careful methodical work*'. This was sometimes lacking, even in cases where there were obvious potential hazards with the experiment. It is also expected that '*data are carefully recorded as they are taken*' if maximum marks are to be awarded here; important details in raw data are sometimes omitted by candidates in 'tidied-up' accounts of the experiment.

In strand B '*Quality of thought about uncertainty and systematic error, and attempts to improve the measurements*' it is expected that the candidates show some evidence of progression in their experimental work. Some candidates did not seem to have grasped that the focus of this task is to identify the sources of uncertainty and, if possible, systematic error in their measurements. They should then suggest and try out possible improvements to the experimental methods and apparatus used. This shortcoming was particularly evident in centres which had continued with the 'sensor project' type task, without fully addressing the demands of the new specification.

In strand C '*Quality of communication of physics in the report*' errors or omissions in the recording and presentation of data were not always noted by the centre assessor, and the marking of this aspect was often too generous. This commonly applied to missing/incorrect units and/or to inconsistent/ inappropriate use of significant figures in tables of results. Similarly, graphical plots sometimes lacked clear labels, uncertainty bars or appropriate best fit lines. This tended to apply particularly to computer-generated graphs.

In strand D '*Quality of handling and analysis of data*' it is expected that information should be extracted from the gradients, intercepts or other features of graphs, rather than simply from calculations of tabulated data, if high marks are to be awarded. Any interpretation should be qualified with reference to uncertainties and possible systematic errors. For example the gradient of a graph might have +/- values associated with it, leading to a well-founded claim about an outcome such as the candidate's best value for a quantity such as '*g*'. The analysis should demonstrate an understanding of the physics involved such as why a graph of, for example, 's *against* t^2' might produce a straight line in a '*g by free-fall*' experiment.

Physics in Use task

In the Physics in Use task there was a lack of evidence for the presentation provided by some centres. Annotations on the candidates work for this task also tended to be less thorough than for the Quality of Measurement task, sometimes making the moderation process rather difficult. In the case of a PowerPoint presentation comments on the printouts of the slides themselves are particularly helpful.

In strand A '*Research and presentation*' it is expected that the chosen material is set in a clear context at the start to satisfy the first descriptor of this task. It was disappointing to see the presentation of a substantial number of candidates starting with a title such as 'aluminium', 'diamond', 'gold', 'Kevlar', 'nylon' or 'rubber'. Whilst all of these are all suitable choices, it is not sufficient for candidates to simply write about the general properties of a material and then to suggest possible uses almost as an afterthought. The work of high scoring candidates tended to have a title such as 'toughened glass in transport' or 'silicon carbide in tank armour'. It is also helpful to couch the title as a question, such as 'Why are carbon fibres used in making tennis rackets?', as this immediately focuses the candidate on the properties needed for that application.

In the second descriptor a large number of candidates did not appreciate the need to fully identify their sources of information and this part of strand A was often leniently assessed. It is worth pointing out that the specification states that the sources used should be '*clearly attributed*' for the award of maximum marks here. In particular it is expected that the bibliography should identify the sources in sufficient detail for them to be followed up if desired. Thus it was disappointing to see rather vague references to sources such as 'answers.com', 'brittanica.com', 'matweb.com', 'physicsworld.com' 'wikipedia.com', 'wisegeek.com', 'youtube.com' and even 'google.com'. The full web address should be quoted for internet-based sources, preferably with a meaningful description of the author/company concerned if this is not evident from the web-address alone. For a journal, such as New Scientist, it is expected that reference should be made to the particular issue consulted, and that the authors name, date of publication and relevant page numbers should be given where possible. For books the author, date of publication and relevant page numbers should be quoted, rather than merely its title. Candidates should also indicate the contribution that each source has made to their presentation, for example by simply linking the source to the slide number concerned. Also, candidates should be encouraged to provide their bibliography in a separate Word document rather than, as was so often the case, as the final slide in the presentation itself. This would also help to address some issues regarding legibility.

It was difficult to judge the quality of the work produced by some candidates as the printout of their slides was too small to read. Candidates who do not produce a clear record of their presentation should not be awarded high marks for the third descriptor of strand A. Although presentations are enhanced though the inclusion of illustrations and images, at least some of these should be of a scientific nature, helping to explain the macroscopic and microscopic properties of the material concerned. Relatively little credit should be given for the inclusion of photographs or 'clip-art'.

In strand B '*Use and understanding of physics*' it is expected that a range of both macroscopic and microscopic properties of the material are discussed for the award of high marks here. It is also important to explain why the properties are important in the chosen context. Thus any failure to place the material in a specific context at the start is likely to result in candidates being penalised here as well as in strand A. Candidates should provide evidence for their understanding of physics on the PowerPoint slides, talk notes or other documentation. Teachers can assist the Moderator by commenting on the oral aspects of the presentation and by annotating printouts to highlight aspects of both good and poor physics. Otherwise it is assumed that any errors not noted have been overlooked when awarding marks.

Grade Thresholds

Advanced GCE Physics A (H158/H558)
June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
G491	Raw	60	36	31	26	22	18	0
	UMS	90	72	63	54	45	36	0
G492	Raw	100	62	54	47	40	33	0
	UMS	150	120	105	90	75	60	0
G493	Raw	30	24	21	18	16	14	0
	UMS	60	48	42	36	30	24	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H159	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H159	21.3	35.5	51.4	67.8	82.1	100	5824

5824 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

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