GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Report on the Units

January 2009

3888/7888/MS/R/09J

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Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

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General

As a legacy specification the cohort mainly comprised re-sit candidates – this meant that the standard of answers and the mean mark was lower than in previous sessions. Despite this, many candidates displayed a good understanding of key elements of physics and the paper achieved a good spread and distribution of marks.

Section A was well answered with most candidates scoring well. Section B as usual contained some harder questions with the intention of differentiating top end candidates. Candidates were usually able to answer the early parts of these extended questions well, but found the later parts of the questions more tricky as these tended to focus on more in-depth understanding – going beyond elementary manipulation of formulae, and requiring candidates to explain key concepts. This was clearly evident in question 10. The Section C questions gave candidates opportunity to discuss aspects of physics which they had studied in depth through the course. Inappropriate examples were less frequent than in previous sessions and many candidates were able to give very effective responses based upon their own examples.

Section A

Q1 The vast majority of candidates managed to select the correct units for density and Young modulus from the list. As in previous papers, the unit for toughness was less well-recognised.

Q2. Was about image processing techniques and most candidates could correctly match an appropriate technique to the stated effect. Occasionally candidates were confused between averaging and median replacement – the most appropriate method for removing random noise.

Q3. This required candidates to identify key information in a given waveform for a musical note. In part (a) most candidates identified a correct time period for the highest frequency component - credit was given for estimating a time period of less than 1ms. Many candidates were able to substitute into 1/T to give an appropriate frequency value. Having plotted this frequency on to the spectrum given in (b), relatively few candidates identified that the amplitude would be lower that that given for the lowest frequency component.

Q4. Was about wave fronts passing through a converging lens. The majority of candidates were able to correctly identify that the focal length should be shorter and draw a wave diagram accordingly, but only the strongest candidates gained the second mark for a diagram with wave fronts that were clearly drawn at a similar wavelength to the original. In part (b) there were some good responses with clear descriptions involving the use of P=1/f ; with f increasing.

Q5. Generally this question about power and energy consumption in a torch using LEDs was well-answered. In part (a) the most common error was to incorrectly round 4.86 hours to 4.8 hours, and there were some mistakes in converting seconds to hours but these were rare and almost all candidates gained the mark for quoting their answer to an appropriate number of significant figures. Almost all candidates were able to give answers to part (b) – usually expressing the idea that the running costs would be lower.

Q6. This question involved a comparison of similar images taken by two different satellite cameras, and the improvement in imaging technology. Good candidates were able to point out in (a) that the more recent image was less pixellated or had better resolution. A common error, as in previous sessions, was to state that the image had "increased resolution". Part (b) was better answered with only the weakest candidates discussing (incorrectly) ideas about improving the power of the lens. Some candidates were confused by the question and thought the first image taken had been improved by image processing techniques to produce the second image.

Q7. Almost all candidates could state a difference in the expected mechanical properties of two polymers, given their internal structure in part (a). In (b) though, most candidates were only able to repeat the information given about the side rings of polystyrene making it difficult for bonds rotate. This repetition was not considered worthy of credit.

Section B

Q8. This question was about inferring mechanical properties for mild-steel from its stress-strain graph. Most candidates could identify the breaking point, limit of proportionality and elastic region (Young modulus) in part (a) and go on to use data from the graph to calculate the Young modulus in (b). A common error was to take stress and strain values from beyond the linear region. Part (c) proved challenging, requiring candidates to estimate the permanent strain of a stretched specimen. Most incorrect attempts simply drew vertical lines to the x-axis, giving a permanent strain of 0.13%, and although error carried forward was allowed to (c ii) for reading this value from the graph, most candidates failed to realise the strain was quoted as a percentage and lost the mark for just stating 0.13.

Q9. This question asked candidates to consider the video capability of mobile phones. Most candidates were successful in parts (a), (b) and (c) which required candidates to calculate the rate of information transfer when sending uncompressed video, estimate a suitable carrier frequency and show that the extra bit rate required for sound is negligible. Few candidates, however could estimate a maximum frequency which could be sampled, and of those that did, fewer still could express the idea that sampling is needed on each peak and trough – those that attempted this part tended to state the Nyquist idea of sampling at greater than twice the highest frequency component – without going on to explain why this is necessary.

Part (d) examined candidates' knowledge and understanding of lenses. Most could correctly calculate the curvature of incoming waves for part (i) but a large number of candidates became confused in between distances and curvatures when trying to use the equation $1/v = 1/u + 1/f$ to find v - trying to substitute as $1/v = 1/ -4.0 + 1/250$ instead of the correct $1/v = -4 + 250$. Those that got this part correct often quoted the value for v as their final answer without going on to find the distance of the image from the focal point.

Q10. Expected candidates to demonstrate their understanding of refraction and reflection of light in the context of raindrops forming a rainbow. Parts (a) and b (i), (ii) was successful in allowing candidates to show they could manipulate Snell's law to calculate the angle of refraction of a ray at the surface of the drop. Part (b iii) was tricky as it needed candidates to demonstrate geometrical skills – many candidates talked about the idea of Z-angles and other geometric concepts without convincing the examiners that the angles were equal. Most of the successful answers clearly described radii forming isosceles triangles.

Part (c) was challenging. Pleasingly, there were many successful calculations of the critical angle for water in part (i), but parts (ii) and (iii) were less well answered. There were disappointingly few explanations worthy of any credit in response to (ii) which asked for a description/explanation of what happens when the light ray reaches the water-air boundary at the rear of the drop. Some candidates appeared to understand that some light is reflected, some refracted, but were not able to convince the examiners that there was *partial* reflection, and that the refracted ray is at 45^o. Part (c iii) was not answered by a large number of candidates - some of those that attempted it came close with "different wavelengths change direction by different angles", but missed the link to wave speed required for credit.

Q11. This question involved comparing the properties of three filament lamps. Generally candidates answered part (a) well – being able to calculate the resistance and length of a filament without difficulty. The most common error was made in relating power to filament dimensions. – candidates often omitted the direction of change – stating for example "radius" rather than "larger radius".

In (b i) many candidates incorrectly stated that as current rises, resistance falls – recalling ideas from early work in the course and Key Stage 4 using V=IR and hence mistakenly assuming that the filament is an Ohmic conductor. In (b ii) the vast majority of candidates did not realise that the lamps were connected in series and that the lamps were therefore operating at 6V, not 12, leading to an incorrect answer of 48W. Most candidates were able to sketch a graph to show the characteristic of lamp C, but very few could then interpret this graph when the lamp was connected in series with lamp A. A bare answer of "lamp A has greater voltage" was often seen, but not deemed sufficient to score a mark without the clarifying statement "at a given current". Again, very few candidates spotted that the lamps were in series which would have allowed an alternative lead in to the question – "(as they are in series) both lamps have the same current, at a given current Lamp A has a higher p.d. …"

Section C

Q12. This question gave candidates opportunity to describe a sensor circuit of their own choice. In (a), nearly all candidates could draw a circuit diagram and explain how their circuit operates. There were fewer incorrect symbols than in pervious sessions and the majority of responses involved a potential divider circuit, although some more complex bridge circuits with amplifiers were drawn and explained, although many of these included at least one error – often a "hanging" voltmeter with only one connection. Circuit operation was generally well explained, but weaker responses were often a little vague - omitting the direction of change of the resistance with respect to the physical variable was common, with candidates just stating, for example, as temperature changes, resistance of the thermistor changes".

In (b i) nearly all candidates could explain in general terms how to calibrate their sensor. Better answers were more specific and included detail about measuring both the physical variable and the output p.d. Not many candidates gained the final mark for a good graphical illustration – often this was omitted entirely (despite the pre-printed axes), and when completed it usually missed out either plot points or a line of best fit. Part (b ii) asked how the uncertainty of the sensor could be estimated and was poorly answered by all but the most able candidates. There was much confusion here with sensitivity and very few candidates could express ideas beyond repeating readings or vague discussion of the resolution of the instruments used.

Q13. Nearly all candidates could select and discuss a material and particular application of their choice in (a). Candidates though found difficulty in accurately choosing and defining two physical properties of their material. Common errors included confusion between the intrinsic material properties required by the question and the consequence for a specific sample of the material – so, for example, conductivity was often confused with conductance. Units proved tricky for candidates too. The best answers usually involved candidates picking a clearly defined property – e.g. tough(ness), which made it easier to gain marks for the definition and unit. Most candidates could say why a property was important for their chosen application, but rarely went on to explain in detail for the second mark.

Part (b) required a description and of the structure of the material chosen, along with an explanation of how the structure determined one of the properties chosen in (a). Diagrams were well-used by candidates to illustrate structure and bonding and annotations were often helpful. Candidates did seem to treat this part of the question in isolation from (a) though and often good descriptions of structure were not clearly linked to a property in chosen in (a) – this was particularly true when a metal had been chosen - good bonding diagrams including positive metal ions and free electrons, but then discussion of moving charge carriers when mechanical properties had been chosen in (a) rather than electrical ones.

2861 Understanding Processes

The paper was of an appropriate standard and provided good differentiation between candidates of different abilities. Most scripts were fully worked indicating that the candidates had sufficient time to complete the paper in the 90 minutes allocated. Performances in section **A** were more varied but in **B** were essentially sound. A reasonable range of contexts were evident in the answers produced to the section **C** questions. Total marks obtained by the candidates were distributed across the full range of marks available, around a mean mark of 52/90, slightly higher than in previous years and with a lower standard deviation of about 13   The greatest loss of marks overall was due either to candidates not reading the question properly and ignoring the information that was provided or an inability to use algebra to transform equations. It would also appear that candidates are weaker on vector diagrams and quantum physics (again).

Section A

This section was reasonably well completed, with some varied performance on certain questions as detailed.

Question 1 involved selecting numbers which were best estimates. All three sections were well answered and this provided candidates with a good start to the paper. Question 2 was generally well answered with most candidates using a correct equation of motion and making valid assumptions (e.g. negligible air resistance). About 10% of candidates were penalised on this question for quoting too many significant figures in their answer.

The response to Question 3 was disappointing due to the poor use/understanding of vectors. Most candidates were able to calculate a magnitude for the velocity, many were able to find the correct angle but less than 10% could draw and label the correct vector resultant. Some seemed to have misread the question and only gave the magnitude. The first part of question 4 proved too difficult for about half of the candidates mainly due to an inability to manipulate the appropriate equations. A significant number of candidates provided an incorrect answer to 4 (b) mainly because they were unable to convert nanometres to the correct power of ten. Question 5 differentiated between candidates with less than 25% attaining the full three marks. It was slightly disappointing that so few candidates could read the graph correctly to give a value of 11 and then recognise the 10^6 scale. Part (b) was not answered well; the use of F=ma was generally realised but obtaining the weight from the graph and then converting this to mass in many cases was a step too far. Question 6 discriminated well giving a good spread of marks; 6 (a) received about a 75% correct response. 6 (b) was clearly more difficult, many candidates recognised the speed difference but could not articulate how the comparison of length of path (a distance reference was required) in water and air gave a shorter total time. Question 7 proved to be quite friendly to the candidates with over 80% scoring two or three marks, errors were mainly for incorrect use of wavelength in part (a); part (b) was well answered.

Section B

Question 8. This question was about standing waves on a stretched rope. It required candidates to use a variety of equations and ideas. There was a very good distribution of marks with all candidates gaining at least a minimum of two marks and the majority scoring well. The majority of candidates (90%) correctly calculated the 'show that' values in parts (a) and (b). Part (c) was a good differentiator, with a clear ramped difficulty to access all three marks. Answers ranged from the accurate and concise scoring full marks to slightly 'waffly' answers that had little merit. 8(d) (i) was straight forward and well answered; in (d) (ii) successful candidates (25%) not only recognised the fact that wavelength was increasing but could relate this to the wave equation whilst noting that the frequency was constant. 8 (d) (iii) was generally not well answered; the reasons for the tension increasing and the mass per unit length decreasing were not generally understood but a correct change was often linked to the equation.

Question 9; this question was about a double slit experiment. In 9 (a)(i) (ii) most candidates were able to describe and explain the fringe pattern. Only half of the candidates could calculate the spacing in 9 (b) (i) and this subsequently hindered progress on part (b) (ii). Very few candidates were able to explain what happens when a double slit becomes a single slit.

Question 10. This question was about a motorcycle moving along a road. All three parts of 10 (a) were extremely well answered with a good understanding shown of resistive forces and power calculations. Part (b) again distinguished between those candidates who could manipulate equations (40%) and those that couldn't. The six marks available for 10 (c) were really only accessible to the most competent candidates. For others it showed a lack of mathematical ability, particularly algebraic transformation but more worryingly a lack of use of the information in the questions that ultimately lead to non mathematical answers.

Question 11; this question was about the quantum behaviour of photons. It appeared to be the most difficult question on the paper and reinforced the generally weak understanding of quantum physics compared to other aspects of this component. The start of this question in part (a)(i) saw 80% of candidates gaining the two full marks or zero. In (a) (ii) and (iii) increasingly fewer candidates were able do the calculations and very few (less than 10%) understood the principles for part (iv). The most common incorrect answer was that some of the photons did not have enough energy. The information about the wavelength was quite a long way back at this stage, so they may have forgotten it. A slightly better response was recorded for 11b, however here there was much confusion between what was a photon and an electron.

Section C

The two questions in section C invited candidates to choose the contexts for their answers; in question 12 to describe and explain an example of a method for measuring the distance to a remote object and in question 13, through a more structured approach, to give a method of measuring acceleration for a given example of a trolley travelling down a slope.

Once again, in this session, many very good answers were seen giving full details and explanations of impressive depth and clarity. Although quality of communication was not as good as in previous years in terms of the highest marks available.

Question 12.
This question was answered very well by the majority of candidates. This is a now familiar format/question. The only real weaknesses noted in responses were in the clarity of communication including diagrams and the generally poor attempts to 12f (see also 13c).

Question 13.
This was a more structured question that the previous one, and similar to June 2008. Part (a) was generally well answered as a variety of response warranted credit. 13 (b) (i) could gain full marks for very straightforward answers yet often candidates threw away marks either from a lack of attention to detail or from not being specific enough or often just an inability to follow the 'describe' and 'explain' instruction. Candidates also often lost marks by not naming the measuring instruments. Part (b) (ii) provided an opportunity for most candidates to show their understanding of the equations of motion. Common mistakes, other than simple errors in algebraic manipulation, were based on the misconception that a simple distance over time calculation provided 'final velocity'. The majority of candidates, over 50%, achieved zero marks

for both parts of 13 (c), poor answers gave weak or vague statements about ‘inaccuracies in the measurements’ and there were many incorrect answers based on resistive forces.
Overall in Q13 it was felt that the question was often not read properly and many candidates did not appreciate that the car came to rest at Q. There was a definite lack of coherence in answers and experimental techniques were not appreciated or understood. This is disappointing in that these were the same areas of weakness last summer.

2862 Physics in Practice

General Comments

133 candidates presented coursework portfolios in January. This was from a larger original entry with many centres withdrawing all their candidates. It was very helpful that most centres met the 10th January deadline – or were very close to it. A few administrative points are worth mentioning and these are raised to help in the introduction of the new scheme in the summer session:

- It would be helpful if Centres who do withdraw all candidates still send their MS1 forms to the Moderator, with ‘A’ clearly marked by the candidates’ name, this avoids Moderators having to telephone the Centres.

- The resubmission of previous coursework raised the problem that certain Centres only sent the reworked part of the student’s portfolio and not the work that had been submitted in the Summer examination period. The January module is classed as a totally new module and therefore the whole coursework portfolio for any student entering this module must be sent to the Moderator for moderation.

- If your Centre has only a small entry (less than 10) then all the work should be sent to the moderator before the deadline date along with the completed MS1 form and other relevant paperwork

- It would be most helpful if internal assessors checked their arithmetic on totalling the different strands on the mark forms and in calculating a candidate’s total mark, a considerable amount of time is taken up in sending amendment forms back to Centres because of arithmetical errors.

The work done by the students had, in the large majority of cases, been carefully marked by the internal assessors and, in the main, was helpfully annotated. Annotations genuinely help in the moderation process because they help moderators know how the marking points have been made. Only a small proportion of Centres have had their marks adjusted and it is clear that the majority of Centres fully understand the requirements of the module and are providing good advice to candidates on how to maximise their performance. There are, however, some points worth re-iterating.

Instrumentation Task:

In the Instrumentation Task there were a significant number of candidates who did not include a safety statement, causing a loss of marks in strand A(ii). In D(i) to gain high marks for the ‘accuracy’ part of this strand, candidates must, at least, repeat their readings to the same number of significant figures and note if there are any major discrepancies between the readings. Also, many candidates do not really consider the ‘fitness for purpose’ aspect in sufficient detail ie actually make measurements from their graphs etc, to score well in D(ii), to gain maximum marks in the section it is deemed necessary for candidates to make two quantitative calculations of relevant fitness of purpose quantities.

Material Research Task:

In the Material Research Task many candidates do not submit a plan of their research and presentation and this should lead to zero marks being awarded for this particular sector of strand A(i). However, candidates are getting much better at linking their sources to their presentation and many should be congratulated on the standard of their work. For maximum marks in D(ii) candidates must provide a printed copy of slides used in a power point presentation along with talk notes.

Data Task:

The Data Task is often the task that is assessed most leniently. In skill A(ii) the statement in the grid ‘eg Use of a calculator’ should not be taken as the only necessity required for maximum marks, candidates are also expected to show other good ICT skills. Annotation on the scripts for skill A(ii) is a great help to show why the marks were allocated for skill in ICT. Graphs that lack horizontal or vertical grid lines should be regarded as showing poor use of ICT. As with last year there were instances where the essential physics of the experiment had not been clearly discussed (B(ii)) and where the analysis was rather superficial and led to no clear conclusion (strand D), in these cases the work should not be rated highly. With this task, it is very helpful to moderators when centres provide the information about the experiment or the data that has been given to the candidates.

The topics chosen for all three tasks tended to follow work seen in previous sessions.

2863/01 Rise and Fall of the Clockwork Universe

This paper produced a good distribution of marks, with some candidates scoring nearly full marks whilst others failed to reach twenty out of seventy. Section A was completed by the vast majority of the candidates and most attempted all of section B, although a few candidates left some parts of the last questions unanswered. As the last questions were quite challenging it may be that some candidates were rushed at this stage whilst others found the questions too difficult at the end of the paper. The mean mark of the paper was 40/70 which compares well with January 08 (42/70) and January 07 (40/70). Once again, some candidates did not seem ready for the examination in the January session and demonstrated clear gaps in knowledge of the specification. However, there were many very encouraging scripts that showed an excellent level of understanding of the more demanding material tested in the examination. Some examiners reported that the standard of writing was a concern, with some answers requiring careful deciphering and others showing a rather cavalier attitude towards basic punctuation and grammar. Candidates showed confidence in answering arithmetical questions but did not always take care to demonstrate each step in an arithmetical or algebraic argument. As in previous sessions questions requiring descriptive answers were less confidently answered.

Section A

A good proportion of the candidates gained most of the marks available in this section although some incomplete work was evident.

Question 1 proved surprisingly challenging, with many candidates choosing an exponential decay curve for the graph of charge against potential difference for a capacitor. In contrast, question 2, which also relied on understanding graphs, was very well answered.

Question 3 required standard capacitance calculations and the majority of the candidates worked through it with ease although many used the exponential equation to calculate the current remaining after RC seconds rather than multiplying the original current by 0.37.

Question 4, concerning the ideal gas equation, proved straightforward for the more able candidates but it was noticeable that a proportion of the responses suggested that particles always gain energy in collisions. Question 5, on Newton's gravitational equation, was a standard calculation that proved accessible to many. Some, however, did not quote the equation correctly as they either emitted the subject, F, or confused force and field strength.

Question, on momentum change, was discriminating. Only the best responses gave a sign to the change of momentum.
The last two questions of the section proved accessible to all but the weakest candidates.

Section B

This provided a good range of responses, with some excellent answers to questions contrasting with evident misunderstandings.

Question 9 concerned the newly-designated dwarf planet Pluto. Part (a) proved to be a good, easy starter. Part (b) (i) required some simple algebraic manipulation and recall of an equation. Many candidates failed to gain credit for this as their algebra was incomplete or spurious - a characteristic that was seen in later questions. Parts (b)(ii) and (iii) discriminated between lower and medium-ranked candidates. Weaker responses showed mistakes in reading from the graph. However, one of the most discriminating parts of the paper was (c) (ii) which required candidates to describe how to calculate the velocity of Pluto at its closest approach. Whilst about half the responses gained two out of four marks for rather trivial statements about KE and PE interchanges relatively few candidates showed more than GCSE understanding of the situation, and many persisted in considering potential energy as mgh.

Question 10 was about radiocarbon dating. This was the most accessible question in the section and provided weaker candidates with the majority of marks in the section or, for some, the paper as a whole. Marks were lost for poor line drawing on the graph or misreading the x-axis scale. The rest of the question gave very little difficulty to the majority of the candidates. Part (c)(ii) required a calculation of activity after (approximately) nine half-lives had passed - most candidates gained the marks here but few used the elegant method of dividing the original activity by two to the power of nine.

Candidates found question 11, about the forces on a helicopter, quite challenging. Many answers were written in hope rather than certain knowledge and dredged up ideas from GCSE rather than those covered in the A2 course. However, the greatest area of weakness was in the clear algebraic statements required for (c) (i) and (ii). Many responses to (ii) stated that F = ma, and 'in this case, a = v'. It is clear that force as rate of change of momentum is a concept not well understood. Part (d) was answered with more confidence, although most candidates repeated the calculation path in (b) (iii) to reach the answer to (d) (ii); this gave them full marks for the question but did not show the mathematical sophistication of using the proportional relationship given in the stem.

Question 12, on the Boltzmann factor, proved the most difficult on the paper and some candidates' responses showed signs of fatigue at this stage. Parts (a) and b were standard calculations that were accessible to many. Candidates failed to gain full marks for the graphical work in part (c) because they did not calculate the ratio of currents but merely stated that it was 'about two' or 'almost two'. Part (d), on the back of the paper, was attempted by the majority but few gained full marks. The connection between the Boltzmann factor and the rate of electrons leaving the surface was seldom explicit and many made vague statements about current or electron flow increasing rather than stating that it doubles.

2863/02 Practical Investigation Coursework

There was an entry of approximately 2900 Candidates from around 230 Centres. Whilst the vast majority of Centres were well organised and submitted the MS1/Investigation scripts to the moderator by the deadline date with all the required paperwork enclosed, a small but significant minority missed the deadline or did not comply fully with the administrative procedures. The most common problem was the omission of form CCS160 (Centre Authentication Form), resulting in the moderator having to contact the Centre to request it.

The best organised Centres submitted their scripts for moderation with the Coursework Cover Sheet fully completed attached with a staple or treasury tag in the top left hand corner. This thankfully spares the moderator the unenviable task of reassembling scripts which have become jumbled during transit (a task rendered more difficult by an order of magnitude where candidates have omitted page numbers from the report). Candidates who submitted a well organised report with a contents page, page numbering and clear aims at the outset not only made life easier for the moderator but also went some way to fulfilling the criteria in strand Cii relating to the impact and clarity of the report. Several members of the moderating team commented on the tendency of some Candidates to give their reports rather vague or excessively wordy titles. Whilst a book certainly cannot be judged by its cover, a concise title often gives an indication of the clarity of the definition of the problem which is likely to impact on the coherence of the rest of the report. Thankfully very few Centres now submit laboratory books or copious amounts of additional material for consideration, since all relevant material should be described in the final report (perhaps with an Appendix for large volumes of tabulated data).

A lack of annotation by the assessor is frequently a concern, particularly where errors in Physics or in calculation have not been noted. This generally suggests that such errors have not been taken into account by the assessor in arriving at the final mark, and is a common reason for a Centre’s marks being adjusted. Evidence of careful checking by the assessor and of internal moderation between teaching groups inspires confidence that the assessment has been carried out thoroughly.

Amongst the now familiar routine investigation titles such as Squash Balls, Craters and Terminal Velocity of Ball Bearings in Glycerol, it is always refreshing to see novel and ingenious topics which have clearly caught the imagination of the candidate. Various manifestations of Medieval Catapults have proved popular in this session, together with some genuinely novel work on the EMF generated across a conducting solution flowing through a magnetic field, behaviour of Non-Newtonian fluids when vibrated at different frequencies, and the properties of Dry Quicksand.

Comments on Individual Strands:

Strand A
The best Candidates generally start with an attempt to formally identify all the possible variables in the chosen investigation and use this to guide subsequent progress. After many comments by moderators in the reports to individual Centres, it is now unusual to see Safety omitted altogether, but the appropriateness of the statements are often questioned. For instance, the Candidate working with wires under tension who has planned to wear steel toe capped boots but has omitted eye protection cannot really be judged to have given safety ‘due regard’.

Strand B
The most common problems encountered here generally relate to the range and progression in experimentation in strand Bi and the degree of experimental design in strand Bii. Candidates who choose genuinely novel or open ended topics which require preliminary work simply to refine a method of obtaining data for the chosen effect generally satisfy both statements well.

However, the Candidate who essentially carries out a standard A level Physics experiment using standard apparatus where there is little choice over the method used is usually performing a related set of experiments by looking at several variables in turn. If the results of one experiment do not lead to decisions about how next to proceed then the progression element is likely to be absent.

Strand C
The statement in strand Ci relating to range of results needs to be interpreted in relation to what might reasonably be expected in ten hours of practical work. The statement relating to dealing with uncertainties requires a genuine attempt by the Candidate to quantify the tolerance on each measurement, and to be discerning in looking at the spread of values and perhaps choosing to perform additional repeat readings for outliers. In strand Cii the quality of computer generated graphical plots has been raised several times in previous reports but continues to be an issue. Graphs should be well constructed in terms of size, labelling, gridlines and careful choice of line of best fit, and should be equivalent in quality to the hand drawn alternative. The use of ICT also tends to encourage Candidates to produce graphs of every possible combination of variables, which cannot possibly be described as ‘well chosen’.

Strand D
The best Candidates generally deal comfortably with uncertainties, often competently estimating the percentage error in derived quantities and justifying the sizes of error bars on graphs. They may also consider the maximum and minimum values of the gradient of a graph in order to quantify the uncertainty in a quantity derived from the gradient. Candidates who use an auto-trend line often lose that feel for inherent uncertainties. Increasingly Candidates are considering a statistical approach to the spread of values in repeated data, but often do so mechanically with little indication that they have any genuine appreciation of what the standard deviation actually tells them. The use of Excel to produce an ‘equation’ of a line with no physical significance or theoretical justification is frequently over-assessed in strand Di. Hopefully the Quality of Measurement task in Year 12 in the new specification will go some way to providing Candidates with a good grounding in the consideration of uncertainties for future years.

2864/01 Field and Particle Pictures

The comments which follow only apply to candidates operating at grade E and above.

Too many candidates still rely too heavily on the booklet to provide formulae for calculations. As a consequence, they can't earn any marks for calculations involving formulae and rules which they are required to remember.

Many candidates are unable to perform calculations which require more than one step. Although error-carried forward is built into the mark scheme of these questions, this does assume that candidates keep going to the end, instead of stopping in the middle. Lack of words and structure in calculations can make it very difficult for examiners to understand what a candidate is trying to do, putting marks at risk. Perhaps centres should consider giving their candidates more practice at doing multi-step calculations.

The paper contained two questions where candidates had to write extensively about physics for up to four marks each. Too often, candidates would just embellish the information provided in the stem of the question, providing very little added value which could be awarded marks. Candidates need to focus more on providing more than is supplied - and not just stop writing at the end of the space if they have more to say.

Weak candidates fail to keep track of the storyline in the four Section B questions, failing to use results from earlier parts in later ones. Perhaps they should be encouraged to spend a few moments absorbing the context before launching forwards into these questions?

Section A

1 Although the majority of candidates were able to recall the unit for magnetic field strength, some couldn't manage the unit for electric potential.
2 As always, weak candidates plucked the most likely formula from the booklet and earned on marks for this calculation. A minority failed to use the correct charge of the particles.
3 Although most candidates could sketch a correct equipotential and identify the potential gradient, only a minority reflected this in the spacing of the extra two equipotentials.
4 Most candidates found this question very straightforward.
5 Some weak candidates simply restated the stem and failed to mention charge conservation. The calculation was, as expected, quite hard, with many candidates getting lost halfway through.
6 Many candidates earned full marks for this complex sequencing question.
7 This question required candidates to have a clear understanding of the terms flux density and flux linkage. Many weak candidates did not.
8 Although the vast majority of candidates correctly identified the amplitude of the standing wave as determining the probability of detecting the electron, most of them wanted to use it as an indicator of the momentum as well. Only a minority correctly suggested the wavelength instead.

Section B

As always, each of these questions is couched in a different context. It is not expected that candidates will have met any of these contexts before, but they should be able to apply their understanding of physics to explanations and calculations. Too many candidates are unable to do this, suggesting that they have spent insufficient time on the course applying the concepts they have learnt to explain new situations.

9 Many candidates found the qualitative aspects of this question very straightforward. The use of a flux linkage-time graph to determine a value for peak emf was beyond most of them, often because they didn't measure the gradient carefully enough. Too many candidates lost a mark by using the peak flux linkage divided by a quarter of the period rather than by drawing a tangent and calculating the gradient. The sketches of flux loops and emf-time graphs were generally good.

10 Only a minority of candidates earned all the marks for a(i), mainly because they didn't discuss enough different aspects of the information provided, despite the bullet points in the stem. The majority could correctly complete the nuclear equations for alpha decay and neutron absorption, but only a small minority remembered to include the anti-neutrino for beta decay. The calculations of (b) proved difficult for many, probably because they involved rules which were not in the booklet. In particular, many candidates (as expected) forgot to take account of the 210 nucleons in the nucleus when calculating the mass of polonium-210 required.

11 This question has appeared before in different guises, but, as ever, many candidates find it difficult to say anything sensible about the motion of charged particles in magnetic fields. Most failed to recognise that (a)(iii) and (b)(i) required calculations for full marks, and only a minority recognised that the latter was a question about centripetal force. Very few candidates took the trouble to calculate the transit time for (b)(iii) before using the current to calculate the number of protons in the ring, suggesting that most weren't focussed on the context, but treating each question as a stand-alone item, not requiring any information from elsewhere.

12 The majority of candidates earned most of the marks for (a), showing a good understanding of electric fields. Only a minority, however, earned more than half the marks for (b), often because they failed to add much to the information already provided in the stem. Worryingly, many candidates thought that the electrons were absorbed by the mercury atoms when they raised the latter from the ground level to an excited state.

2864/02 Research Report Coursework

Comments

There were about 140 candidates entered from 31 Centres for this component of the **Field and Particle Pictures** Module. 11 centres entered in error, really intending their students to have their coursework marks carried forward. A few centres withdrew their single candidates possibly because they had failed to submit any work. Only 10 of the centres Moderated in this session had entries involving more than 1 student.

Some centres have obviously made the decision to tackle the course in reverse order. (Chapters 15-19 first - Electromagnetic machines, Fields, Radioactivity followed by 10-14 - Models, Space and Thermodynamics). Making this choice restricts the range of topics available to the candidates who consequently offer titles more firmly rooted in the AS course. There was no shortage of high quality work from the candidates sampled and reports on a wide range of interesting, diverse topics were presented.

Some Reports continue to be submitted with very little evidence that they had been marked at all. Centres not providing supporting evidence for their assessments are more likely to be adjusted. Supporting comments, particularly where the Physics is dubious, should be considered an imperative. Centres are becoming expert at ensuring that their candidates include suitable, well explained physics, some kind of embedded referencing system, and a suitable evaluation of the sources used. Some centres also insist on a contents page, although this is not compulsory it certainly aids clarity and contributes significantly to the overall quality of the presentation.

No work was recommended for an IoP coursework prize in this session.

2865 Advances in Physics

General Comments

As has been the case in every January session, the numbers sitting this paper were small. This year there was a very good range of marks, and some excellent papers were seen, indicating that the candidates concerned had prepared the advance notice material well.
The usual topics gave difficulty: magnetic fields, circular motion and explaining answers at length. Extended writing and unstructured questions requiring calculations using several stages will be required in the new A2 papers, and in the few instances where either of these were required here candidates found them demanding.
It is worth bringing to the attention of centres that the article and question paper dealt in part with relativistic effects in particle accelerators (as did the January 2006 paper) and so may be of value in preparing candidates for the new specification.

Comments on Individual Questions

Section A

1) **Rutherford alpha-scattering**

(a) Most candidates could quote at least one of Rutherford's conclusion form the alpha-scattering experiment

(b) Most candidates scored well on balancing a nuclear equation, but a surprising number did not know the nucleon and/or proton number for a proton.

(c) Relatively few candidates could explain why alpha particles do not approach close enough to a gold nucleus to produce the nuclear changes that occur with nitrogen.

2) **Proton energies and nuclear changes**

(a) Most candidates realised that the p.d. in volts accelerating a proton was numerically the same as the energy in electron-volts, and could then convert that into joules.

(b) Most candidates could calculate the energy released in the disintegration of beryllium-8.

3) **Field and potential in linear accelerators**

(a) Most could interpret the electric field lines, infer a potential and draw equipotentials.

(b) Very few candidates attempted to use the ideas of vector components, as instructed, in explaining why linear accelerators tend to produce a beam down the centre.

(c) Few candidates could find an explanation for the limited p.d. than can be applied to a pair of electrodes.

4) **Energies and velocities in linear accelerators**

(a) The need for alternating potentials to keep a proton accelerating along a LINAC was well explained by most candidates.

(b) Virtually all candidates calculated correctly that 40 accelerating stages were required, but few supplied an assumption, such as the lack of energy losses, or a negligible starting kinetic energy.

(c) & (d) Many were able to label and put suitable scales to the energy-time graph, but few could cope with the extended writing explaining the shape of the corresponding velocity-time graph.

5) **Synchrotrons and high-energy particles**

(a) & (b) Drawing field lines required to produce a circular path (the sense was not important) was found difficult, although many candidates could correctly derive $p = eRB$.

(c) This part treated the relativistic behaviour of protons in the synchrotron, and showed clearly the difference between candidates who had prepared the relevant part of the advance notice article and those who had not.

6) **Medical uses of particle accelerators**

(a) & (b) Few candidates realised that electromagnetic radiations of similar wavelength should have similar quality factors, and a number did not seem to realise that a quality factor of 1 was actually the least damaging. This was repeated in the explanation for the higher quality factor for protons, although the dose equivalent calculations were often done correctly.

7) **Synchrotron radiation**

(a) & (b) The demonstration of polarisation was often reasonably well described, although candidates did find it difficult to explain clearly (as required). The diffraction grating calculation was usually done well, but only the best could explain why an ultraviolet wavelength might be observed in the middle of the first-order visible spectrum.

Section B

8) **Biometrics**

(a) Most candidates made good estimates of the numbers of pixels in the fingerprint image and could explain why a single bit per pixel was sufficient to encode it.

(b) Better candidates cold draw good ray diagrams, with rays refracting at the lens and crossing at the focus. Calculating the size of the image (from v/u) was rarely done correctly.

9) **Spitzer IR space telescope**

(a) Almost all candidates showed good recall of the electromagnetic spectrum.

(b) Calculation of the gravitational force on Spitzer from the Sun was well done by most. Most candidates repeated the calculation to reveal the much smaller effect of the Earth; few tried to compare the two effects by considering the relative effects of distance and mass, and those that did were mostly unsuccessful.

(c) Candidates revealed better understanding of the reason for gravitational potential energy being negative than in previous sessions, and some gave good reasoned responses about the effect of the presence of the Earth (either 'makes it more negative' or 'has a negligible effect' were acceptable).

(d) Only the most successful candidates referred to Boltzmann ideas to explain how liquid helium cools the sensor, but most realised why this resulted in a limited lifetime for Spitzer.

Grade Thresholds

Advanced GCE Physics B (Advancing Physics) (3888/7888)
January 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2860	Raw	90	53	47	41	36	31	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	64	58	52	46	40	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	54	45	35	0
2863A	Raw	127	96	86	76	66	57	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	96	86	76	66	57	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	88	78	68	59	50	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	88	78	68	59	50	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	48	43	38	0
	UMS	90	72	63	54	45	35	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3888	300	240	210	180	150	120	0
7888	600	480	420	360	300	240	0

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

	A	B	C	D	E	U	Total Number of Candidates
3888	11.2	35.0	59.3	84.7	98.4	100	589
7888	11.1	37.0	69.1	91.4	100	100	83

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.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553