GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Report on the Units

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REPORT ON THE UNITS

2860 Physics in Action

General

Candidates' grasp of the Physics covered seemed quite good this season. The paper achieved good differentiation and a satisfactory mean mark and spread. Section A was well answered with only the weakest candidates scoring under half marks. Section B as usual contained some harder questions with the intention of differentiating top end candidates, and the mean score was down slightly. This was particularly the case for questions 7 and 8 which required understanding rather than rote methods for the solution of the latter question parts. However, the awkward way in which many candidates set out their working often made it difficult to follow. Equals signs very frequently were used incorrectly, and not respected, having more processes added onto the original equality. Neither of the Section C questions fitted into the 'standard' categories but the overall responses were encouraging, giving a slightly higher than usual mean score with some very good and a few very poor responses.

Section A

1 Not surprisingly, the units of toughness were less familiar to the candidates than those of density and stress. Several weaker candidates did not copy correctly the units they had selected from those offered.

2 This was about refractive index and the speed of light, both parts (a) and (b) caused few problems. 'Cancelling' of sines to give an index of 60/36 =1.7 was an error of candidates with little mathematical confidence. Ecf was allowed on incorrect refractive indices from (a) even if giving superluminal velocities in (b) provided methods were correct.

3 This concerned sensitivity of sensors from a graphical comparison. In part (a) candidates mostly showed a working understanding of the concept. However, correctly finding the sensitivity in part (b), was well answered by some centres and less well tackled by others. The most common error was to find voltage/pressure rather than Δ voltage / Δ pressure.

4 Was about polarisation, this is a difficult concept. A score of one out of two for getting across the idea of a transverse wave in words or by diagram was common. Candidates had difficulty conveying their understanding of the unique direction or plane of oscillation in a polarised wave. Common errors were to talk about a unique direction of travel, or motion of the wave.

5 Generally, this question about recognising materials microstructure diagrams was well answered. A few wrong answers may have been due to misinterpreting the diagram labels (which were below each structure) which was a pity.

6 This was an exercise in quality of communication about comparing two sound spectra, which found a significant fraction of candidates wanting. Those who had difficulty expressing themselves clearly lost marks here, and so did the significant minority who interpreted the horizontal frequency axis of the spectrum as one of time. So candidates who wrote that "at the beginning......" lost the mark.

Section B

7 This question was about interpreting graphical data and relationships from a lens imaging experiment. In (a), most candidates stated that the image moves away from the lens as the object moved towards it, though whether that was from memories of doing the experiment rather than from the graph was less clear. In the second part, there seemed more - often confused - recall of experiment eg the image becomes clearer or sharper.

Part (b) was successfully answered by those who could locate the lens formula and could apply the Cartesian convention (candidates from some centres had difficulty here, although real is positive sign convention calculations are still allowed full credit if completed correctly). However, this was the first question on the paper where a calculation involved several steps and which thus gave an opportunity for many candidates to omit stages leaving the examiner unsure that they knew what they were doing.

Very few gained a mark for (c), even fewer earning both. For a lens of double the optical power, most incorrectly drew a curve above and to the left of that given. Only the best candidates realised that the closest approach to the lens would be halved in this case.

Part (d) (i) proved similarly demanding as very few showed knowledge of the straight line format $y = mx + c$. (It was even rarer to find mention of $1/u$ or $1/v$ as curvatures of wavefronts.) Perhaps consequently, those who were able to gain marks in part (ii) seldom did so by using the idea of a straight line having intercepts on axes. Instead, they used the coordinates of one of the plotted points - usually, if they did so, gaining both marks. A common further error here was to take the reciprocals of values from the graph and add them, not noticing that they were already reciprocated!

8 This was a complex question about a National Grid powerline conductor. There were 7/12 marks on this question targeted to discriminate at a higher level.(A/B).

(a)(i) was correctly answered by the majority, although a few missed the kV. Few read (ii) sufficiently carefully to give the destination of the lost energy but in the end the mark was awarded for saying it appeared as heat. Part (iii) was tackled successfully by the better candidates who could distinguish between the voltage dropped across the resistance of the line and the voltage at which the line operates, to gain the show that marks. Reverse arguments were also fully credited.

Most managed to gain the algebraic logic mark in (b)(i) but (ii) was beyond all but a very few. Handling ratios seemed to be the problem for many, who showed no evidence of trying to find one mass divided by another. However, in addition, the large numbers of very large or very small numbers that were presented as the ratio of masses of steel and aluminium cables strongly suggests that our candidates are not good at looking at their calculated answers to see if they are sensible. Some candidates scored 1/2 by stating or showing that the G and L were constant and thus dropped out of the ratio.

(c)(i) was sadly not tackled by the majority of candidates, and many of those who did scattered the parts of their calculation in randomly selected positions on the page. Examiners had to work very hard to try to decipher how the candidate might have been proceeding. No words, or units, abandoned steps not crossed out were quite common. Quite a few got part credit by finding the conductance of one steel strand (0.29/7 S), or by correct use of the cross-sectional area ratio 30/7.

In (c)(ii), those who remembered that conductances in parallel add gained the mark by adding the values given in (i). Part (c)(iii), which only required a recognition of the benefits conferred by the components of the composite material, was surprisingly, beyond most candidates, or perhaps they had given up on the earlier more difficult parts of the question?

9 This question was about the response time of an LDR light sensing potential divider. Basic knowledge of electrical circuit symbols was seriously lacking.

(a) Here circuits ranged from those which showed voltmeters in series with the resistors or short-circuits across the power supply or sensor to carefully drawn, correct versions. For a topic that is set so squarely on the specification overall this was quite disappointing.

Part (b)(i) was correctly answered by a sizeable minority. Those who got it wrong either failed to grasp that the time scale was in milliseconds or did not see that one complete cycle occupied 20 ms. Some miscounted the number of cycles in 50 ms as 3 rather than 2.5 cycles. However the method mark was gained by many who missed the correct frequency.

In answering (b)(ii), most failed to refer to the <u>two</u> graphs, and many just rephrased the question. However, (iii) on the estimate of the response time of the LDR was answered correctly by the majority.

In (b)(iv), a large number suffered from their poor use of English, confusing speed with time in trying to discuss the response time of the human eye.

Most earned the second mark in (c) by recognising there was only 1/10 of the time to respond. Many stated that the output was lower, not recognising that the minimum p.d. was now higher, those that discussed the reduced range did not fall into this trap.

10 This was about image processing and edge detection. (a) was answered correctly by the overwhelming majority. There was, however, a number of candidates who were not alerted to their mistake when they gave the width of the apple in the diagram to be about 5 000 kilometres wide.... perhaps this should be named the ‘New York question’ for the number of ‘big apple’ responses!

(b) (i) & (ii) were correctly answered by many. The usual fault in (ii) was using the 64 greyscale values when finding the data transfer rate, and not the 6 bits used to resolve the greyscale – in many ways a common sense approach that is almost unteachable was required. In (c) an interestingly high number of candidates scored the ‘column consistency’ marks of the edge detection with values that were not intuitively obvious.

(d) Proved uncommonly difficult, many candidates not realising they had to go back to (a) to pick up and use the resolution value again.

Section C

11 This question was about describing the steps to carry out an experiment of their choice to measure the Young modulus of a metal. in (a), Candidates from some Centres were much more familiar with a standard experiment to measure the Young's Modulus of a metal than those from others, who seemed to be inventing methods on the fly eg bending beams or stretching springs or large lumps of metal. However, fewer showed a feasible means of measuring the small extensions they would produce. Also, many showed a wire suspended from a clamp held out by a laboratory stand - not appearing to appreciate that loading the wire would cause the stand and clamp rod to bend systematically, probably more than the wire was stretching. Curiously, large numbers showed two arrangements, side by side; one to measure strain by hanging weights on a wire, another to measure stress by loading a horizontal beam or plate. Many discussed loading to breaking which was an error.

(b) Amongst those who realised that the cross-sectional area of the wire was needed to find the stress on the wire, few - even those who mentioned the use of a micrometer (screw gauge) - stated that it was the width of the wire that had to be measured. Some said they would use callipers but very few vernier callipers. That the original length needed was that which was going to be stretched (up to a marker) was sometimes unclear. Many seemed to think it was the length of wire cut from the reel.

(c) usually gained at least three of the four marks. The better candidates nearly always proposed plotting a graph of stress against strain and finding the gradient to get YM. (d) rewarded the more thoughtful, and credit was given for suggestions for reducing random errors (to improve precision) and systematic errors (to improve accuracy).

Overall this style of question seemed to produce a better mean score than the "traditional" type of describe your own material Section C question.

12 (a) (i) nearly everyone could name a signal transmission of their own choice..

In (a)(ii), many stated that 'speed' was the 'time taken...' In (iii), the rate of information transfer was often correctly stated, and most got the marks for the estimate.

Answers to (iv) generally gained 2/3 of the marks, but the third eluded most candidates as they failed to label at least the time axis of their sketch graphs.

Part (b)(i) distinguishing between signal and noise was often well answered. The quality of answers to (ii) tended to be more Centre specific, and some serious misconceptions were apparent eg digital is immune to picking up noise. Many candidates incorrectly discussed sampling or digitisation in this part without making relevant points.

2861 Understanding Processes

The entry for this paper was 1505 which is approximately the same as in previous January sessions. Candidates from across the whole range of ability were in evidence and a majority found the questions to be accessible. Most scripts were fully worked and good discrimination was achieved between candidates of different abilities. The Mean mark for the paper was 51 out of 90, and the standard deviation of the distribution of marks about the mean was 15.1.

Section A

Section A is intended to present candidates with the opportunity to score readily accessible marks. A number of key shortcomings were evident in the responses of a significant number of candidates and many of them failed to score adequately here. The first question provided a straightforward start for all, but very few candidates responded appropriately to question 2. Many quoted the answer of 2.4 m, but the physics behind this number was rarely thought through beyond an indication that the 'energy' would double if the height was doubled. Barely a handful of candidates argued in terms of the work done by the frictional force, and an assumption that the frictional force remained the same. Question 3 was a good discriminator but question 4 was poorly answered. Here many started off with a $v^2 = u^2 + 2as$ approach but would not, or could not, substitute correctly for $a = F/m$. The algebra that followed was beyond many who did make a correct substitution. Most candidates responded well to questions 5 and 6, but question 7 elicited many correct 128 Hz answers that were based on the principles of buying a lottery ticket – the reasoning and assumptions were just ignored or completely wrong.

Section B

Question 8

This question was about using a diffraction grating to produce a spectrum.

Part (a) was well done by a majority; some worked out the spacing in mm and then converted to m using the appropriate multiplying factor while others chose to convert to lines per metre before calculating the spacing in m. In (c) it was not uncommon for candidates to miss any connection between the purple zeroth order and the red and blue lines. In (c)(i) candidates had to determine an angle from a diagram using a straightforward trigonometric relationship for 'tan θ Astonishingly, many candidates did not know how to do this, got the ratio upside down, had their calculator in radian mode, or decided that the sides of the triangle given best supported a $\sin^{-1}$ or a $\cos^{-1}$ relationship. The trigonometric blind spot was also evident in part (b). Those candidates who do physics by the formula 'life belt' approach came unstuck in (c)(ii). Having selected to use $d \sin\theta = n\lambda$, many clearly had no idea what the d represented. Clearly a length they presumed, and so why not the 3.0 m since it was given on the diagram.

Question 9

This question was about the motion of a cricket ball from a bowling machine.

This question was generally answered more competently than the preceding one. But again a significant number of candidates had trouble with the algebra and were unable to rearrange $s = {}^1/_2 gt^2$ to make t the subject. The required match in fall times between the calculated and graphical values in part (a)(iv) was often missed. Many candidates were successful in answering part (b).

Question 10

This question was about radio waves reflected from the ionosphere.

As with question 8, this question involved more about electromagnetic waves and the ‘starter’ for two marks in part (a) using $\lambda = v/f$ was beyond the competence of a substantial number of candidates. There were frequent powers of ten errors even when the correct formula had been used. To explain adequately the reason for the formation of the maximum and minimum signals required the precise use of scientific terminology that many candidates did possess. Fortunately many redeemed themselves in part (c) by approaching the problem using the correct $v = s/t$ method, and at worst only lost 1 mark for omitting the factor of ½.

Question 11

This question was about a new type of efficient light bulb that emits photons only at two frequencies, in the red and green regions of the visible spectrum.

Many candidates found this question to be quite challenging in that they had to correctly identify the red and green peaks from an intensity spectrum. The penalty for failing to distinguish the red and green was not too severe in part (b) where the marks were for reading values of frequency from the axes of a graph, and using the values to calculate the photon energy. The third mark was for correct identification of the colours. However, in part (c) the correct working from part (b) values was required. Candidates who had been given the benefit in (b) despite confusing the colours frequently resorted to a random arrangement of the numbers used earlier in the question in a quest to arrive at a ratio of about 2. As a consequence, many meaningless quantities were calculated such as ‘energy x power, frequency x power, and so on.

Section C was a saviour for a substantial number of candidates. Whilst there is evidence that some Centres still dictate a narrow diet of exemplars for their students, many allow the freedom of choice to their students who produce refreshingly interesting and original work. In answer to question 12 many elected to choose standing waves on stretched strings observed in stroboscopic light. Cause and effect were confused by a significant minority of these candidates who regularly stated that ‘the oscillator is at a set /fixed frequency and by adjusting the stroboscope the standing waves are formed’. There were a few implausible methods suggested in answering question 13 but most candidates presented a valid ranging method to determine the distance to the remote object.

2862 Physics in Practice

General Comments

97 candidates presented coursework portfolios in January, this was from an original entry of 134 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 summer session:

- As was asked in previous years, 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 to confirm this. These withdrawals also suggest that a number of candidates may have had the intention of resubmitting better coursework in the Autumn Term but, for whatever reason, did not finally get round to doing the work.

- The resubmission of previous coursework gave rise to another problem in 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. Centres must realise that the January module is viewed by OCR 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 a small entry (less than 10) then all the work should be sent to the moderator before the deadline date along with your MS1 form and other relevant paperwork

- It is essential that a Centre Authentication form is enclosed with the work. This is the form signed by the internal assessors responsible for the course. Centres are expected to keep the student's Authentication forms on file until the whole results process is completed.

- 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 Moderator's 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. Only a small proportion of Centres had to have their marks adjusted and it is clear that Centres now 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 which are worth re-iterating:

- In the Instrumentation Task there are a significant number of students who do not include a safety statement, causing a loss of marks in strand A(ii). Only very weak candidates now use direct measurements from, say, a thermocouple connected across a multimeter, the majority should and do place their sensor in a potential divider circuit, where possible explaining how they chose the value of the fixed resistor. Also, many students 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) candidates are expected to make at least two quantitative measurements.

- In the Material Research Task many candidates do not submit a plan of their research and presentation, this is really necessary to score well in 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. It should be emphasised to candidates that this is a Physics course and not Chemistry and they should therefore only go into great detail on the production of a material if this production is directly linked to its Physical properties. For maximum marks in D(ii) candidates must provide a printed copy of slides used in a power point presentation along with talk notes.

- The Data Task is often the task that is assessed most leniently. There were often instances where the essential physics of the experiment had not been clearly discussed (B(ii)) and where the analysis was rather superficial (strand D) and yet the work was still rated highly. With this task, it is very helpful to moderators when centres provide the information or data about the experiment 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

General Comments

The paper proved slightly easier than in some previous sessions.

Some scripts were of exceptional quality, and relatively few candidates seemed to be wholly unready for the examination. Most candidates were successful at 'show that' questions but some do not show their working with clarity.

There were a significant number of blank parts in Q.11, but it is not easy to be sure whether a candidate ran out of time or found the question too difficult.

Comments on Individual Questions

Section A

This section produced a good range of marks, although many of the questions were somewhat more straightforward than has been the case in some recent sessions.

Question 1 related to the identification of units of physical quantities. This was mostly well answered, but the identity of the joule and the Nm was not appreciated by many candidates.

Question 2 concerned a graph of velocity of recession against distance for a number of galaxies. Apart from a number of candidates who confused the doppler effect with the cosmological red-shift, this question was well done.

Question 3 required a calculation of activity using a given value of half life. Most candidates evaluated the answer successfully; a significant number used the half life to evaluate the decay constant, and some of these used a rounded value which meant their final result lacked precision.

Question 4 asked about the centripetal force involved in an amusement-park ride. Most candidates answered this with confidence, although some poorer candidates omitted the formula required in (a) or were confused between mass and weight in (b).

Question 5 required the calculation of the working temperature of a filament lamp, and Question 6 required the evaluation of the amount of air in a room of given volume. These were both done well by most candidates: the most common errors were in the rearrangement of the equations involved.

Question 7 asked candidates to link ideas of resonance to the operation of a musical instrument. The low scores on this question suggested a lack of knowledge of the basic ideas, and this impression was reinforced by the number of responses which added little to quotations from the question. Only better candidates clearly stated in part (a) the requirement for driver and driven frequencies to be equal, or made clear links to the rate of energy transfer in part (b).

Section B

Question 8
This question was about the escape velocity from the Earth and the Earth's atmosphere. The responses to the question as a whole were discriminating across the entire range of ability. The first two parts of the question were done poorly by all apart from the most able. Part (a)(i) expected an explanation for a given minimum kinetic energy of escape. Many weaker candidates confused force, energy and potential; others failed to give an adequate explanation of the sign being positive rather than negative. Part (a)(ii) asked why this was a *minimum* energy; very many candidates simply repeated the explanation they had already given in (a)(i).

Part (a)(iii) required candidates to equate the formula for kinetic energy to the value in (a)(i) and carry out algebraic manipulation to show a given result for v_{esc}. This was well done by most candidates; the most common errors were a lack of clarity in manipulation, particularly in relation to a negative sign.

In part (a)(iv) candidates were expected to quote an equation for g and use it demonstrate a formula for v_{esc} in terms of g and r. Many candidates did this well, but a significant number attempted to use incorrect equations eg $F=mg$.

The next few parts were all done very well. These were: the substitution and evaluation in part (a)(v); the calculation of the velocity of a nitrogen molecule of given kinetic energy in part (b)(i); commenting on the retention of nitrogen in the atmosphere in part (b)(ii); and the evaluation of a numerical value of the Boltzmann factor for hydrogen in part (c)(i).

Part (c)(ii) was much more demanding. This required an explanation of why the earth has lost almost all its atmospheric hydrogen. The best candidates were able to draw on ideas from the course relating to random collisions, 'getting lucky' and the Boltzmann factor, and many middle range candidates were able to make a sensible comparison with the data for nitrogen. But too many candidates simply wrote in terms of the value of the Boltzmann factor being 'very large '.

In part (d) candidates were asked to suggest the impact on the atmosphere of a dramatic rise in the Earth's temperature. Some responses by poorer candidates were general comments on 'global warning', but most candidates were able to suggest that there was a greater rate of loss from the atmosphere, and suggest an explanation. The best candidates were able to comment on the comparative effect on different molecules.

Question 9
This question related to the dynamics of a toy operated by compressed air. This question also showed good discrimination: weaker candidates were able to show some positive performance, but only the best candidates could answer all parts adequately.

Part (a) required the candidates to calculate the mass of the gas in the car. Since this was a 'show that', many used proportion rather than clearly stating that the mass is proportional to pressure. Attempts to use Boyle's law led candidates in the wrong direction.

In part (b)(i), nearly all candidates knew how to calculate the momentum of the air leaving the tank per second, but a relatively high number did not make the required conversion from grams to kilograms.

Part (b)(i) required an explanation of how Newton's second law applied to the force on the toy car. This was generally well done. Those candidates who looked at a different aspect - the link between the force on the *car* and the momentum gained by the *air* - were able to gain credit for a clear explanation using Newton's third law.

The calculation of the initial acceleration of the car required in part (b)(iii) was almost always well done - allowing error carried forward from part (b)(i).

Part (c) asked candidates to suggest and explain reasons why the acceleration of the toy was not constant. The two marks available for each reason were structured so that identifying a factor and its effect gained one mark, and a fuller explanation of the link gained the second mark. There was a full range of marks on this part: virtually all candidates had some success, but only the best were able to secure full credit. Some candidates referred only to force, rather than making the link to acceleration as required in the question.

Part (d) considered the effect of cooling the air on the tank. Most candidates were able to identify that there was a lower pressure in the tank and hence lower acceleration. It is a pity that more candidates did not clearly link this to the reduced escape velocity or reduced rate of mass escape.

Question 10
This question about the simple harmonic motion of a piston was generally well done.

Part (a) required candidates to insert numerical values to the axes. This was generally done correctly; the most common error was the confusion of 'amplitude' with 'peak-to-peak' values.

The calculation of displacement in part (b) was generally started correctly, but a substantial number of candidates did not set their calculators to 'radian' rather than 'degree' mode, hence making an error in evaluation. Some of those who calculated the number correctly then suppressed the negative sign.

Part (c)(i) expected candidates to explain how the equation for velocity gave its maximum value. Most candidates were able to gain credit here, although detail was often sketchy. The numerical evaluation of this maximum velocity in 9(c)(ii) was almost always well done.

In part (c)(iii) candidates were expected to identify the maximum gradient on the graph as giving the maximum velocity; partial answers - identifying either the point, or that the gradient was required, but not both - were reasonably common.

Part (d) asked candidates about the acceleration of the piston. Both points were quite well answered: in (d)(i) a point of maximum acceleration was usually correctly identified, and in (d)(ii) the appropriate formula was quoted and substituted. A number of candidates used an incorrect amplitude (often that evaluated in (b)): but the correct answer was very often given to a wholly unjustified number of significant figures, which were penalised at this point.

Question 11
This question was about capacitor discharge. It had a ramp of difficulty - many candidates struggled with parts (b) onwards.

A number of standard arithmetical problems on capacitor discharge were asked in part (a), and all three were answered well by most candidates.

Part (b) asked for the explanation of a slightly unusual relationship - that the rate of fall of voltage is proportional to the current in the circuit. Most candidates were able to link charge and voltage, but explicit links of the current flowing to the rate of fall of charge stored were much less common. Most candidates attempted to use the link between voltage and current, or the link between charge flowing and a steady current.

Part (c) related to models for the discharge, and as indicated above was often not attempted. Understanding of the iterative process was often weak.

Part (c)(i) asked candidates to show that all the charge on the capacitor would be lost during a time equal to the 'time constant' if the discharge current remained at its initial value. This could be proved algebraically, or by using the numbers in the question.

In part (c)(ii) a more accurate model was introduced, and candidates were expected to evaluate the loss in charge between 2 and 4 seconds. Many better candidates were able to do this successfully. The most common error was to assume the same rate of discharge as in the first 2 seconds.

Candidates were then expected to use this result in (c)(iii) to plot the next part of the graph. There were very many omissions here, and a significant number of responses did not seem to be linked to the result in (c)(ii).

Part (c)(iv) was found very difficult. A substantial number of candidates omitted this part, and those that attempted it often simply restated the question in more elaborate fashion. Some gained credit by pointing out that the model kept the rate of decay constant for a shorter time; other by commenting on the outcome, that the calculation led to a discharge that was made of shorter straight lines and thus closer to a continuous change.

2863/02 Practical Investigation Coursework

There was an entry of approximately 2700 candidates from 235 Centres for the January 2008 session. This represents a significant increase in entry, with the numbers entered for this session now approaching those entered for the June 2007 session. Around 20 of these Centres subsequently withdrew their candidates or marked them ‘Absent’, suggesting that the demands of producing the work in time for the January sitting of 2863 proved greater than originally anticipated.

For Centres changing from the June to the January session, there are certainly a series of additional constraints that need to be carefully considered. The most obvious question regarding the Practical Investigation is ‘when?’ Most teachers of the Advancing Physics course would probably agree that there are substantial dividends to be gained by leaving the task as late as possible for two reasons. Firstly, the greater intellectual maturity of the students as they progress through Year 13 is of clear benefit. Secondly, there is also the consideration that the further the students have progressed through the A2 course, the wider their experience of Physics content and practical techniques which could provide the starting point for an interesting, innovative investigation. Centres which regularly enter their students for 2863 in January will be well aware that there are plenty of opportunities for their students based on Electromagnetism, Electric Fields and Radioactivity, and that some ‘reading ahead’ may be necessary for students who wish to pursue an investigation topic based on one of these areas.

Whilst many Centres will regard the above as a clear statement of the obvious, the Moderating teams are increasingly raising concerns about the number of Centres who appear to be undertaking the Practical Investigation very early in the course - some as early as the end of Year 12 when the students return after the AS exams. Though it is clearly a matter for Centres to decide when they wish to undertake any coursework task, the end result is often a glut of simple pendulums and masses on springs furiously oscillating, interspersed with numerous worthy attempts to measure the Young Modulus of copper wire. This can leave the assessors with a problem - the lack of demand of many of these tasks means that they cannot satisfy the criteria for maximum marks in strand Aii (use of resources), Bi (progression and development of experimental work) and Bii (experimental design), yet the students undertaking them may well invest a considerable amount of time and effort, with the expectation that they will score well. The very limited choice of topics from some Centres also calls into question the independence of the students, with Moderators feeling the need to carefully compare tabulated data to check that students have actually carried out the practical element of the task independently.

Centres with experience of submitting investigations in January will realise that waiting until the latter part of the autumn term ultimately benefits their students. Topics such as Resonance, Damping, Circular Motion, Momentum, Gases and Boltzmann Factor provide numerous starting points which allow the task to be approached in the spirit intended - an opportunity to take a potentially interesting idea and develop it into an open-ended practical investigation taking around ten hours of laboratory time (and often rather more for those students who become genuinely ‘hooked’ and start appearing in the laboratory outside of timetabled lessons!). This is one of the very few opportunities to do some ‘real’ Science where the outcomes are not known in advance.

For Centres who appreciate that the demand of the task is all-important and guide their students into appropriate activities, a few of the already well-publicised issues still sometimes reoccur. It has long been established that students must discuss safety in the report, even if only to confirm that the chosen activities present no significant hazard, in order to be awarded this mark in strand Aii. A significant number of students continue to misuse Excel to generate poorly chosen, poorly presented graphs without gridlines, arbitrarily chosen error bars, lines of best fit which clearly do not fit, and with an ‘equation’ displayed which they proudly present as having established a relationship. However, it is also true to say that Moderators frequently comment on the fact that they have raised these and other issues in their Reports to Centres, have been allocated the same Centre the next year and noticed that the comments have been acted on - resulting in an improvement in the quality of the work being submitted. It is also gratifying to see that there are still plenty of Centres who obviously relish the opportunities provided by the Investigation. They guide their weaker students towards well-worn but nevertheless appropriate topics such as Aerofoils, Squash Balls or Projectiles, assessing competent but limited practical work appropriately, whilst encouraging their more able students towards undertaking slightly riskier but more challenging topics that require genuine experimental design and innovation.

2864/01 Field and Particle Pictures

General Comments

As ever, the entry for this paper was small, with most centres submitting scripts from just one or two candidates, suggesting that they were retaking the module to boost their marks.

The section A questions were, by and large, quite straightforward compared with those of previous years. It was pleasing to find that most candidates were able to correctly answer those questions which were similar to those which have appeared in previous sessions. However, many candidates still have difficulty in dealing with questions which require them to deal with many different quantities in calculations, explaining the meaning of relationships and showing how relationships can be combined.

The comments below on individual questions will largely concentrate on what many of the candidates were unable to do. This may give the impression that they were badly prepared by their centres. This is certainly not the case. Many candidates produced excellent answers to many of the questions, showing that they were ready for the exam and able to show what they could do.

Comments on Individual Questions

Section A

Q 4 caused difficulties for some candidates who forgot to convert the scale reading in g to kg before multiplying by g to obtain a force. Similarly, many candidates forgot to convert the 25 mm into m before substituting.

Few candidates were able to provide a satisfactory meaning for the term decay constant in Q 5. It was rare for candidates to earn both marks in (a), with many stating that the high penetration of gamma photons improved the safety of the patient - an irrelevance.

It was distressing to find that many candidates were unable to recognise that the relationship given in Q 8 only applied to a point charge or charged conducting sphere.

Section B

Q 10
Only a minority of candidates knew that the current and flux were in or out of phase with each other, as well as having the same waveform shape. Many candidates were unable to explain the shape of the emf-time graph - too many stated that the emf was proportional to the flux instead of the gradient of the flux. The calculation of the peak emf proved to be too complex for all but the most able candidates.

Q 11
It was pleasing to find that the majority of candidates were able to successfully complete the two stage calculation of the accelerating potential difference. However, many were unable to show the algebraic manipulation required to obtain the formula for the radius of curvature of the path in the magnetic field region. Candidates often lost a mark for their sketch of the proton trajectory, by still giving it a curved path outside the magnetic field region.

Q12
A surprising number of candidates were unable to complete the nuclear equation correctly. Almost none of them were able to explain the different penetrative powers of neutrons and electrons through solid materials - it was distressing to read answers which discussed the neutron's ability to slip through the gaps between the atoms. The final calculation of the question defeated all but the most able candidates, probably because they omitted to show clearly the steps involved. It is quite possible that many candidates get lost in their own calculations because they do not put enough detail down on paper. This skill is crucial where a calculation involves more than one step and involves many different quantities.

Q13
As always, weak candidates were unable to recall the formula for electric field, so used the one for electric potential on the data sheet instead. There was a lot of careless drawing of the field lines between the sphere and the plate, with only a minority of candidates attempting to draw the lines at right angles to the plate. The last part of the question was a new style of question for this paper, asking candidates to suggest an experimental procedure to verify a relationship. Too many answers contained enough detail to earn more than half of the marks, with many candidates failing to provide any method of processing the results to establish the truth of the given relationship eg a series of calculations or a straight line graph.

2864/02 Research Report Coursework

General Comments

There were 79 candidates entered correctly from 31 Centres for this component of the Field and Particle Pictures Module. 15 of these centres entered in error, really meaning their students to have their coursework marks carried forward. It is not of course necessary to redo the Coursework component in order to retake this Module; centres should simply ensure that they enter their candidates using the right entry code. A few centres withdrew candidates who had been correctly entered without explanation.

There were more large entries this year than in previous January sessions making up the bulk of the entry. Most of these came from centres that have chosen 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 can restrict the range of topics available to the candidates and leads to a tendency to offer titles more firmly rooted in the AS course than is wholly desirable. Students need to demonstrate an understanding of some A2 Physics in order to ensure favourable assessment in this A2 Coursework.

Some work is still arriving from centres with very little evidence that they have been marked at all. It cannot be overemphasised that centres not providing supporting evidence for the marks that they submit are more likely to risk adjustment. All of the centres adjusted in this session fell into this category. Supporting comments, particularly where the Physics reported by the candidate is dubious, should be considered an imperative.

Only a few pieces of the work received for moderation in January failed to achieve 20/40 marks but a higher proportion achieved good marks (greater than 35) than was the case in January 07. It seems that Centres are becoming more expert at ensuring their candidates include suitable, well developed physics, embedded referencing, and a suitable evaluation of sources and contents pages to aid the clarity of their presentation.

2865 Advances in Physics

There was only a small number of candidates as every January, although the 79 entries was the largest entry we have had for the January session. Most were re-sit candidates, although one particular centre entered a substantial entry, as it has each January. Most candidates were well-prepared for the questions set on the article, with few scoring very low marks, and there were relatively few examples of candidates omitting entire questions. There was some indication that the fact that section A had 7 questions instead of 6 made the paper a lengthier task for some candidates, although the marks allocated to section A was the same as in previous years.

The one common factor observed in many scripts is that, whenever an extended prose explanation was needed, the answers tended to be unclear or confused.

Section A

1 (The orbital period of the Earth) Most candidates competently completed calculations based on the Earth's orbit, and many gained some credit for explaining the 'leap year century rule'. In part (b), only the better candidates realised that the number of significant figures of a result was limited by the smallest number of significant figures in any of the data.

2 (Water clocks) Tests for exponential change were done well by most candidates. In part (b), correct calculations involving the Boltzmann factor were done by most, but relatively few then invoked molecular ideas to explain the difference in evaporation in Egypt and Scotland.

3 (Mechanical clocks) Although nearly all candidates applied the constant ratio test for proportionality, only the best realised that a continuous increase in the ratio suggested that the two quantities were not directly proportional. Most obtained some marks for the pendulum part of the question, although many missed the fact that the 'seconds pendulum' described has a period of 2 seconds.

4 (Quartz crystals) The standing wave part of this question was well done, but few candidates obtained full marks for the use of the given piezoelectric equation, often omitting to find the electric field from the data provided.

5 (Ammonia molecular clocks) Virtually all candidates recognised the inertial effect of a larger attached mass on the end of a bond, but very few indeed explained in detail, which required either the principle of conservation of momentum or Newton's Third Law to explain why the more massive nitrogen atom does not move significantly. Quantitative responses to the effect of replacing a hydrogen-1 atoms with one of hydrogen-2 were also very rare. The potential energy curve for the oscillator was interpreted well in terms of finding the two stable positions, but not in terms of using the curve to find the direction of force.

6 (Caesium atomic clocks) Correct frequency/energy/wavelength calculations were well done by most, but few then justified the description of 'blue', and few made clear comparison between the two energies involved in (a)(ii). In part (b) a continuing typographical error (one second in ten million years, instead of one second in a million years) meant that all candidates with a sensible method of working gained the mark. The signalling aspect in (c) was generally well done, although lack of clarity in explanation was present in many.

7 (GPS) The calculations of distances, times and signal rates was done well by most. Only the strongest candidates gave convincing reasons for the need of a third or a fourth satellite.

Section B

8 (Wind turbines) This question was well answered. In part (c), which effectively required vector subtraction, few candidates recognised the nature of the situation; many gained one mark for an attempt at vector addition with the two given vectors represented reasonably.

9 (Loudspeakers) This question was the least successful on the paper, and this indicated time pressure for many candidates. The circuitry calculations in part (a) were well done, but the magnetic field representations in (b) were generally very poor. There were few reasonable suggestions in (c) as to why a baffle in front of a loudspeaker could increase its loudness, but most candidates recognised that a wall in (d) could reflect sound, and the better candidates then invoked wave superposition.

Grade Thresholds

Advanced GCE Physics B (Advancing Physics) (3888/7888)
January 2008 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2860	Raw	90	61	54	48	42	36	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	65	57	49	42	35	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	54	45	36	0
2863A	Raw	127	97	87	77	68	59	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	97	87	77	68	59	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	91	81	71	61	52	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	91	81	71	61	52	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	48	42	37	0
	UMS	90	72	63	54	45	36	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	10.6	29.5	58.0	81.6	96.3	100	379
7888	10.0	38.3	65.0	90.0	98.3	100	60

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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