GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Report on the Units

January 2007

3888/7888/MS/R/07J

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Section 1

The paper appeared to be of appropriate difficulty being accessible to the majority of candidates who had enough time to complete it. There was good differentiation with a wide range of scores spanning nearly the whole range of 90 marks available.

Section A provided a relatively easy start for most candidates, encouraging them to tackle the rest of the paper. The milli unit multipliers in questions 2(b) and 5 (a) caught out many candidates. Drawing skills need to be practised, in this paper the wavefronts in 3 (b) were sketchy and inaccurate. Candidates need to appreciate the technical aspects of diagrams and keep to sensible scale, and preferably to use a ruler to keep spacing sensible.

Section B provided more differentiation with marks targeted at the higher grade levels, especially in questions 9 and 11 parts (b); there was pleasing evidence that some candidates had learned from past papers.

Section C found many candidates poorly prepared, especially for question 12 on the signal / information transmission system. Weaker candidates chose scanning by ultrasound or radar ranging, which could have been answered appropriately; but candidates wrote prepared answers for imaging, or ranging a remote object rather than the signalling aspects that were requested. Many Centres sadly still prepare their candidates to answer question 13 on materials and applications in common, not supporting the ideal of student choice. These answers can tend to be monotone and lack the colour of individual interest reflected in the best answers. It is still true to say that many students have not capitalised on the opportunity provided by section C for prepared answers on topics of their own choice.

Section 2

Section A:

1 The "easy" starter on units proved more difficult than expected, with many good candidates slipping up somewhere. The most common errors were to put As for power, Js^{-1} for charge or Ω for resistivity.

2 Several candidates could not correctly identify one complete wave of the lowest frequency. Others could not correctly work out the value of their time period – usually they could not work out the scale (lack of ruler again?). When calculating the frequency many forgot to put in the 10^{-3} multiplier.

3 Many candidates correctly calculated the wavelength – the most common error was omitting the M multiplier from the frequency. The wavefronts were usually drawn correctly, although some put them too close together, or drew them carelessly so the wavelength was not constant. The use of rulers for drawing and measurement is to be encouraged in diagrams that have technical content.

4 Most candidates correctly identified ceramics as the materials with the highest compressive strength. Part (b) was very badly answered although the mark scheme was quite generous here. Many otherwise good candidates talked about force rather than stress to break or yield. Part (c) was answered well with most realising the need for toughness in a hammer head even if they had chosen the wrong class of material in (a).

5 Weaker candidates confused conductance and resistance in this question. Several of those who correctly calculated conductance failed to go on to calculate current. Several more candidates omitted the multiplier 10^{-3} in their current calculation and scored only one method mark.

6 Many candidates found this question on the smallest possible encyclopaedia hard to manipulate. The most common error was to equate 1 nm = 10^{-9} cm. Coping with the area by squaring also proved difficult to many. Candidates needed to get as far as 10^{14} bits or nm^2 per cm^2 for the first mark. A few more candidates forgot to convert bits to bytes; so there were many ways to lose the two marks in this question!

7 This question was generally well answered, although there were a number of candidates who just put 'more samples' in part b, rather than more samples per second, or a greater rate of sampling.

Section B:

8 This question on Young modulus of wires was well answered overall.
In (a) most candidates could correctly draw the line on the graph, for a wire of half the length; nearly all passing through the point (2.0 / mm, 90 / N), which was encouraging. However, many candidates could not describe the direct proportion, relationship, giving weaker statements. For example extension increases with force and correlation (much weaker than proportionality); to or rises at a steady rate (better but implying linearity rather than proportionality). Several candidates correctly explained why the Young's modulus would be the same, usually by describing the extension being halved as well as the length. Many candidates could correctly calculate the stress, but fewer correctly calculated the strain – often using extended length / original length, or forgetting the mm multiplier in extension value. Most candidates correctly used their stress and strain values to calculate the modulus, allowing for ecf; and very few did not gain the unit mark.

9 This question was about the difference in resistance of ammeters and voltmeters.
Part (a) on the series effect of an ammeter's resistance was well answered. Centres should note that, in (ii) 2 answers using '4.44 recurring', were given SF penalty (since they imply unrealistic precision in S.F.). Many candidates most pleasingly realised that a good ammeter should have very low near zero resistance.
Part (b) on resistors in parallel was much less well grasped by the majority of candidates, who had difficulty expressing their ideas in words. A common error was to split the p.d. 3 ways because there were 3 equal resistors; others incorrectly wrote about voltages flowing through two resistors in parallel. The best and clearest answers were often where candidates performed numerical examples, for which full marks were awarded. Very few recognised that a good voltmeter needs a high resistance; many thought that the resistance of the ideal voltmeter should also be zero! The question differentiated well.

10 This question was about a recent image of the surface of Saturn's moon Titan.
Part (a) was reasonably well answered, with most candidates getting the number of pixels and bits in the image correct; a few stumbled by x 8 instead of ÷ 8 to convert to bytes. In (iii) a few candidates calculated 5^2 rather than 2^5 for number of levels on the greyscale.
In part (b) many candidates correctly worked out the width of A to be 0.16 m. Again here candidates should be advised to use a ruler to find the number of pixels / mm on the image on the page, to start their calculation. As usual there were lots of mistakes in part c in manipulating the lens equation and the sign convention. Weaker candidates used 1/60 as 1 / *f* (rather than *f*), and did not use 1/-0.85 as 1 / *u* or forgot to do 1/v at the end of their calculation of v etc.

11 Again part (a) of the second electrical question was accessible to most, many candidates used the total range instead of a ± uncertainty as prompted in part ii, but only lost one of the two marks if they had done a clear method. As the difficulty level ramped up in part (b) more confused answers were forthcoming, although students were attempting to explain the subtle differences between random and systematic errors. Some candidates correctly stated that the actual results showed a pattern and therefore were not random, or that the variation was greater than the predicted value, but not both points for the two marks. Not surprisingly candidates found part (ii) difficult to explain: the actual current rises by less than the predicted current as more parallel resistors are added, due to the internal

resistance of the battery which is always in series, making the extra current less than expected.

Despite this many correctly calculated the internal resistance in (iii) at 2 Ω by a variety of methods. A few candidates gave an answer of 2 Ω by a number of bogus methods, and were not awarded the marks.

Section C:

12 There were rather few prepared good answers, despite the regular occurrence of this type of question. However in part (a), most candidates could suggest a suitable signal transmission and carrier, weaker were some quite vague answers like digital code or binary. In part (b) most did not go into enough detail for the description and their block diagrams were too vague. Many candidates chose 'texts' and 'mobile phones', which was entirely suitable, but than lacked any technical information other than some vague reference to converting the signals to binary. Very few actually described how the signal was transmitted e.g. light pulses, varying voltage, frequency modulation etc. Some merely repeated the stem with generalities like: the signal was then 'transmitted' and 'received and decoded', that were not worthy of credit. Many examiners complained of lack of real detailed knowledge or of evidence of personal research. Some candidates gave no diagram at all, despite the request in the stem.

Part (c) was answered better, with reasonable estimates for signal speed and information rate, but many missed the use of 'bytes' as the units of information given in (ii). Part (iii) was also poorly answered – most candidates just said to increase the bit rate (same as information rate stated in question stem) or talked about compression rather than increasing the carrier frequency or bandwidth of the system, removing bottlenecks to information flow relevant to their example etc.

13 Answers to this question were much better rehearsed than those for question 12. Candidates from some centres gave the same prepared answer, copper for household wiring being, rubber for tyres and steel for buildings being typical, not very adventurous examples; this is always disappointing and such answers usually only achieve mediocre scores because interesting detailed knowledge is lacking. Most candidates could suggest a suitable material and application, but failed to describe why their application needed their chosen properties. Many gave definitions of the properties rather than explained why it was important to their application. In part (ii) a wide range of answers were accepted as non-physical properties were accepted. Weaker candidates repeated their explanations from (i).

Many structure drawings in section (b) could have been of better quality; often the scale mark was missing. The choice of material and property affected the quality of answers in part (ii). Some candidates chose awkward materials about which they did not know enough to be able to describe the structure, and how it related to a chosen property. Electrical conductivity was probably the best explained property in terms of free electron metallic bonding structure.

2861 Understanding Processes

The paper was of a similar standard to those in previous sessions and provided good differentiation between candidates of different abilities. The vast majority of the candidates completed the paper in the 90 minutes allocated. Performances in all three sections were sound, with section B being the most discriminating of candidates' abilities. A difference this year was the narrowing of the spread of marks attained across the whole paper, there were fewer candidates who achieved exceptionally high marks 75 + marks (as seen in previous papers) and likewise very few achieving below 20 marks. Interestingly the range of marks within centres was quite narrow, although the average mark for centres varied considerably. However, the general standard of algebraic responses and written prose was encouraging.

Section A

In Section A, which contained the shorter questions, performances fell into two clear ranges 5-10 and 14 – 18; it was rare to find a candidate scoring higher or lower than this. In general, clear working was shown and gained credit throughout.
Question 1, a familiar start to the 2861 paper, always prompts a spread of marks from 0 to 3 out of 3, and often does not reflect later performance in the paper overall. Part (a) of question 2 was well answered with the majority of candidates following the correct energy calculations; some made life difficult for themselves though with a SUVAT approach. Part (b) was poorly done in general, many incorrect 'energy/cushioning' type approaches were applied. However, it did differentiate between the more able candidates in their ability to actually explain the underlying physics related to how the increased time/distance reduced the force. Question 3 (a) was okay as expected, but disappointingly part (b) was hampered by candidates' inability to select and use standard form numbers and also spot which frequency would give the greatest energy. Seen as one of the most innovative parts of the paper, answers to question 4 were encouragingly good, only part (b) proving more difficult, many not gaining the mark because they stopped short of stating the waves were in phase 'at the start'. Question 5 was missed out by some candidates, possibly wary of the unfamiliar material or context, however in general it was mostly well answered with an average mark of 2 out of 3. There remains an issue though with students' confidence in what constitutes a constant 'within the limits of experimental error', this is a comment which is made year after year in this report and does highlight the need for more focused teaching of this aspect of the course. Question 6 was approached by candidates as expected with common mistakes coming from the incorrect use of horizontal distance (7.7m) in SUVAT calculations. Part b was more consistently answered.

Section B

This section differentiated more than the other two sections, and especially with the A/B candidates. One area where this was strikingly apparent was in candidates' skills at acknowledging each stage of a 2 or 3 stage explanation and fully reading the question and answering appropriately.

Question 7. This question was about the superstition of radio waves.
Part (a) was designed to give a straightforward start to this question, and so it proved to be for the majority. Part (b) highlighted the key theme as mentioned above, and as such was relatively low scoring. In b (i) & (ii) most candidates achieved half marks through their understanding of superposition ideas such as waves in/out of phase or constructive/destructive interference but it was rare to find a candidate that mentioned the (necessary) idea of 'path difference' let alone use it correctly – this was disappointing. In part (b) (iii) common wrong responses were based on a 'not completely out-of-phase' argument rather than the idea of the waves having different amplitudes and not fully cancelling. Part (b) (iv) received very few correct responses; 15 cm being the most common incorrect response, the clear failing here was not based in ideas of superposition but that of not taking into account the reflection distance.

Question 8. This question was about the forces on a rocket propelled model car.
Generally speaking, this question was well done, stronger candidates were able to express themselves well and this often proved the decisive factor in awarding marks, where clarity and precision of language was of great importance. Part (a) was very competently answered and provided most candidates with an accessible start to the question. The main problem with parts (b) & (c) in this question is again with reference to a staged explanation and fully reading the requirements of the question. Some answers were weak because of the imprecise or incomplete nature of the written response. In part (b) good answers clearly identified forces and understood the idea of resultant forces. In part (c) descriptions of the motion were often incomplete, good candidates found the wording to describe the changing rate of deceleration and the associated explanation.

Question 9. This question was about standing waves on a guitar string.
Part (a) was well answered, some misinterpretation of the actual value of the wavelength, but encouragingly good use of the wave equation. Part (b) the absence of values for T and μ meant that many candidates found this question too difficult, but again it provided a good test for higher scoring candidates. Part (c), once an appropriate diagram was drawn – which was not as straightforward as expected for some candidates – the follow up was normally correct.

Question 10. This question was about the relative velocities of two aircraft.
In part (a) candidates were successful at finding the correct way of showing a magnitude of 90km but less so at finding the bearing, sometimes even not attempting to show this. Again in part (b) (i) this was exactly the same pattern, the magnitude of the velocity vector being correctly shown (often by trigonometry) but the bearing/direction rarely even being attempted. However (b) (ii) was well answered.
Answers to part (c) were unexpectedly good, credit could be given for attempts but clearly this was a question aimed at the higher end of the ability range and served this purpose well.

Section C

The two questions in section C invited candidates to answer questions within a wider context. In question 11 they were asked to describe and explain a phenomenon in which quantum behaviour is important and in question 12 they were required to describe ways of measuring the acceleration of a trolley moving down a ramp.

Question 11 Phenomena described, and given a quantum explanation, included double slit interference patterns, the photoelectric effect, and light emitted from an LED. As in previous sessions there were candidates who, having earned marks in the descriptive sections of the question, offered an explanation only in terms of wave superposition – this was not credited. Key issues arising from the marking this time were; in part (b) – diagrams were often poor this year, part (c) – generally well answered but some confusion between ‘observations’ and ‘explanations’ limited marks awarded, part (d) this was a key discriminator of candidates’ actual understanding of quantum physics and as such highlighted some key misunderstandings.

Question 12 This was a deliberately more structured Section C question that proved very accessible to all candidates and achieved the aim of being able to differentiate candidates according to their ability and skill to extract the relevant physics and apply it in an appropriate way. The best answers took the question as a whole, clearly showing that the candidates had read the whole question first before answering; the individual parts were then given concise and succinct answers, including in part (b) (ii), well set out re-arranged formulae with clearly defined values. Weaker answers tended to offer vague lists that did not link to the specific quantities required – i.e. distance from x to y, final velocity at y. Another common mistake was to not distinguish between average and final velocity. Those candidates incorrectly considering the F=ma route were penalised in (b) (ii) but given credit elsewhere. The most disappointing aspect of this question was in part (c) (i) where answers were either too vague to be given credit 'i.e. 'inaccuracy of the instrument' or not related to previous strands of the question. Many candidates did also lose marks to the subtleties of friction/resistance not being an acceptable answer.

Again as in previous years the examiners felt that lack of preparation on the Section C topics by a number of candidates who performed relatively well in other parts of the paper, resulted in lower overall marks for them. However there has been an overall improvement in performance in terms of raising the lower marks – the range of marks for Section C in this session was firmly between 13 – 20. This again mirrors the overall trend in the paper where there were fewer very high or low scoring candidates.

2862 Physics in Practice

General Comments

121 candidates presented coursework portfolios in January; this was from an original entry of 183 with many centres withdrawing all their candidates, presumably because these candidates had not provided new or improved work from last summer. It was very helpful that the majority of centres met the 10th January deadline, or were very close to it. A few administrative points are worth mentioning so as to help in the summer session. These points only affect a very few centres, but they can take up an inordinate amount of moderators' time and tend to generally slow the moderation process:

> If your centre has only a small entry then all the work should be sent to the moderator by the deadline date along with the centre's authentication form and other relevant paperwork. If a centre withdraws all of its candidates then please send the second page of the MS1 (the optically read mark form on which you would normally put candidates marks) to the moderator with an 'A' clearly marked beside the candidates names.
>
> Internal moderation is essential and when it takes place could centres please take care to show which is the final mark agreed upon for each skill, quite often centres leave two marks and moderators are left in the position of wondering which is the one actually awarded. On a similar point, when putting ticks inside the mark grids could internal assessors please make clear where these ticks are placed.
>
> It would be most helpful if internal assessors checked their arithmetic on totalling the different strands and in calculating a candidate's total mark. There was one example this year where the MS1 showed a total which was fifteen marks below what the candidate had actually gained, if this had been in a large centre where that particular candidate's work had not been sampled by a moderator then the candidate would have been severely disadvantaged.
>
> It would be most helpful if centres could check to ensure that they are using the latest version of the marking grids. The version supplied by OCR is the latest version and gives candidates the greatest opportunity of gaining the correct mark.
>
> The work done by the candidates had, in the vast 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.

The coursework tasks.

The work seen for the Instrumentation Task and the Data Task tended to be similar to that seen in previous sessions and whilst very few centres were moderated in any way it is suggested to those who did have their marks adjusted may well find it worth their while looking at the last few examiners reports for common themes about what is expected of candidates to gain high marks.

One point worth mentioning concerning the Instrumentation Task is that many candidates are still not addressing the last section on Fitness of Purpose. For high marks this requires at least two quantitative measurements/calculations of the qualities such as resolution, response time, sensitivity, systematic bias etc.

In the Material Presentation Task a few points are worthy of note.

If a candidate presents a poster then it would be helpful if the assessor explained whether the poster was part of a wider presentation or was it simply used for display purposes. It is sometimes difficult for a moderator to assess the overall knowledge and understanding of a candidate and whether the candidate successfully answered questions or not on their particular topic. Also, with a poster presentation, it is more convenient to a moderator if a camera is used to take a photo-mosaic of the poster and this mosaic is sent to the moderator rather than the actual poster. This has the added advantage to both the centre and the candidate that a good poster does not become creased and virtually unusable after two journeys in the post.

Candidates who phrase their title in the form of a question e.g. 'Is glass the best material for optical fibres?' usually do better than candidates who start off with the much more general title, 'Glass'. The question automatically sets out focus and a context.

The majority of candidates now use the internet as the major provider of source material. It is expected that if this is the case then the candidate provides a web address which is sufficiently detailed so that the original source can be easily found. Thus search engines (e.g. Google) or home pages for large industrial conglomerates (e.g. Dupont) are classed as suitable. To gain full marks in this sub-skill then at least five good sources are required. Similarly, high marks for illustrations should only be given if these illustrations are of a scientific nature that aid in the understanding of the material or its use and not simply illustrations to fill out the bulk of the presentation.

2863: Rise and Fall of the Clockwork Universe.

General Comments

This paper produced a good spread of marks amongst the two thousand seven hundred candidates entered. The marks ranged from 4/70 to 70/70 with a mean mark of 40 %. The mean mark was about 3% lower than in the January 2006 examination but the general standard of the candidates seemed reasonably comparable. There was little evidence of candidates running out of time and the vast majority of the candidates attempted all the questions. Marks below 20/70 were rare. Candidates tended to perform a little better on Section A than Section B; this is as expected. It was noticeable that the middle-ranked candidates tended to lose marks through not considering exactly what the question required of them. For example, on 'show that' questions it was not uncommon for candidates to lose marks because they left too much for the examiner to complete. This is an area of examination technique that can usefully be reviewed in Centres. The more detailed discussions of individual questions given below will highlight areas in which a little circumspection would have avoided losing marks unnecessarily. As usual, the best scripts were most impressive and showed a thorough knowledge of all aspects of the course.

Comments on individual questions

Section A:

1. This multiple choice question proved surprisingly difficult for many. Candidates found identifying the graph of energy stored on a capacitor particularly difficult – many associate capacitors with exponential decay so strongly that the term 'capacitor' has become a trigger for 'exponential'. This led to many choosing D (which is not an exponential graph in point of fact) instead of graph B.
2. This simple question on representation of gravitational fields proved very accessible although some candidates were penalised for inaccurate drawing of the equipotential line. More care needed here.
3. This was a straightforward question on pressure and only gave problems to the weakest candidates.
4. A question on exponential decay. This was well answered by the majority but, once again, some candidates were penalised for sloppy drawing. A common error was to begin the graph at too steep a gradient so that the curve ducks beneath the straight line during the first part of the decay.
5. This question involved recall of formulae and a little arithmetic. It was well answered by the majority of the candidates. This shows that they have been clearly instructed to learn equations where necessary. However, some candidates once again lost marks unnecessarily through not including the subject of the equation they were asked to state.
6. This recall and arithmetical question was answered well by the majority. Although some candidates tend to use N for number of moles rather than the standard n this was not penalised if the question was worked through.
7. Another simple arithmetical question that was answered well by most candidates. Only relatively few were not aware that 5.6 mC is 0.0056 C.

Section B:

8. This question was about crater formation on the Moon and tested ideas from Chapter Ten. Although most candidates could perform the standard calculations in parts (a) (i) and (a) (ii) the explanations offered about energy transfers in part (a) (iii) were less convincing. Few candidates considered the magnitude of the potential energy of the rock a considerable distance from the Moon. Part (b)(i) proved to be very accessible whilst the more thoughtful calculation required in part (b) (ii) seemed to give middle ranking candidates considerable difficulties. Only a minority scored three marks here. The responses to part (c) were generally acceptable.

9. This question was about oscillations and once again tested concepts from Chapter Ten. This question was the most testing on the paper. Part (a) was about equations describing simple harmonic motion. Many candidates lost a mark on part (a) (i) because they forgot about the negative sign. This lack of appreciation had consequence for (a) (ii) where many candidates did not consider acceleration towards the equilibrium position. Although part (b) should have been reasonably straightforward many candidates struggled. This may have been because of the context of the question. Part (c) was highly differentiating. Candidates scoring well in part (c) usually amassed sufficient marks to gain an A grade on the paper overall.

10. This question was about the Boltzmann Factor and tested ideas from Chapter 14. Parts (a) and (b) involved numerical and graphical work whilst the more challenging part (c) required candidates to explain what equations tell us. Unsurprisingly, the responses to the first two parts of the question were of a high standard where part (c) proved much more difficult. Many candidates tended to repeat the stem of the question rather than producing new ideas. The clearest example of this is found in part (c) (iii) in which many candidates correctly identified that the Boltzmann factor approximately doubles between 293 K and 303 K but did not make the connection between the increase of the Boltzmann factor and an increase in the rate of evaporation – even though this had been flagged up in part (c) (ii). However, good candidates put forward clear arguments that were worthy of credit.

11. The last question on the paper was about the Hubble Law and tested ideas from Chapter 12. It proved to be more accessible than other questions from Section B but, once again, candidates lost marks because of insufficiently detailed or complete responses. Part (a) required the description of a mathematical test for proportionality. Whereas the majority of responses correctly described the arithmetical operation required many did not go on to state what the results of the operation would show. Interestingly, although the figures clearly showed that proportionality was not present, many candidates remained committed to the idea that the data did show such a relationship. Part (b) proved to be rather difficult for the lower ranked candidates. Middle to high-scoring papers showed ease with the conversion from light years to metres and only lost marks through not making the comparison with the modern value for the Hubble constant. Part (c) showed that most Centres are distinguishing clearly between redshift due to the expansion of space and redshift caused by objects moving through stationary space.

2863/02 Practical Investigation

There was an entry of approximately 2700 Candidates from 220 Centres in the January session. Moderators noted a significant increase in the number of Centres that missed the deadline for submitting reports or MS1 forms. Overall about 20% of Centres were late.

Many Centres understand fully the requirements of this component and appreciate that an investigation should be an **independent** piece of work giving Candidates a framework within which they can show **progression and development** in **practical work**. Many Centres however do not. For example there must be some doubt as to the independence of the work presented from a Centre with an entry of nine when all the Candidates carried out the same investigation. This is possibly a worst case scenario but many Centres allow Candidates to investigate the same, or very similar, topics. This behaviour contrasts sharply with those Centres entering in excess of one hundred Candidates that show commendable skill in ensuring that no two Candidates attempt the same investigation. To gain access to the higher marks in strands A and B it is expected that Candidates show progression and development appropriate to the A2 level. Frequently Candidates incorrectly mistake progression for the collection of data with no apparent purpose other than as fodder for Excel to draw as many graphs as possible. Typically such Candidates do not have any continuous variables and their results are often presented as histograms showing for example a physical property of brass, steel and copper etc. This is the result of repeating the same experiment with different materials and does not represent the required progression at this level. Being firmly of the belief that with the correct approach almost any topic is suitable for a practical investigation I find it disappointing that some Candidates circumvent any real practical involvement by effectively doing a computer simulation of a physical situation e.g. two spatially separated masses on one spring. Alternatively a Candidate may have a sophisticated piece of equipment that can generate pages of Fourier components using a microphone and an electric guitar. With the use of flashy ICT skills the reports of such investigations act as smoke screens to hide the fact that there is no practical physics involvement at all.

I have great respect for those Centres that, for whatever reason, enter their Candidates for the January round. These Candidates have to overcome two distinct difficulties. Firstly the range of topics available to them is limited; for example much of electromagnetism and induction will not have been covered. Secondly the cumulative acquisition of practical skills and techniques will not have been completed. As a consequence Moderators are of the view that the overall achievement levels in the January are lower than in June. Having had to review some Centres where Moderators have recommended very large reductions in a Centre's assessments I have become aware that some Centres timetable the A2 practical investigation in June the previous year i.e. just after the AS assessments. Not unsurprisingly some of these investigations appear to be a simple rehash of the AS tasks, perhaps extended slightly. This is not what is intended and Centres should not use the same experiment for both tasks.

The communication aspects of strand C(ii) include the assessment of graphs. This has become such an issue in recent years that it is perhaps worth emphasising that graphs should be of sufficient size (A5 minimum) to convince the reader that the results have produced a consistent trend. There should be both vertical and horizontal grid lines, the axes should be labelled with the correct quantity and unit. Background shading is an unnecessary distraction but if one set of axes contains a number of graphs a key is essential. A trend line is often better judged than left to the vagaries of software. New this year has been the appearance of graphs without any points at all; best avoided. The written communication skills of some Candidates are such that Moderators frequently have difficulty understanding what a Candidate has done. Often the title, rather than posing a question, conveys nothing e.g. Pendulums. By including at the outset a simple sketch of the apparatus used for the preliminary experiments it can be made clear what is being measured and how. Photographs, although welcome, do not always convey the essence of what is being done and Candidates should be reminded that the external reader was not there in the lab.

On the coursework assessment form in strand D(ii) there is a criterion that has no balancing statement. It says; “The work is interesting, achieving results new to the student”. This is frequently ticked by internal assessors without much justification; after all if you start off knowing nothing any results will be new. There are, however, still those investigation reports that reflect a high level of experimental competence and subject knowledge from Candidates whose enthusiasm shows through and who genuinely have found out something that they, and possibly we, were not expecting.

2864/01 Field and Particle Pictures

General Comments

As always, this paper has few candidates for the January sitting, mostly resits from the previous June with only a few brave centres submitting more than a handful of candidates. Nevertheless, candidates managed to earn almost the full range of marks available, from 20% to 94%, suggesting that the paper was accessible with few marks that were impossible to earn.

This paper had about 16% of its marks awarded for a candidate's ability to sketch flux loops, field lines, equipotentials, energy levels and graphs. It was distressing to note that many candidates routinely lost about half of these marks by careless drawing. This was not wholly confined to weak candidates - some otherwise strong candidates were also guilty of this. This could be quite serious as the gap between grades is about 8% of the total marks, so time spent doing a sketch carefully could make a lot of difference to a candidate's final outcome.

An important feature of the four Section B questions are "show-that" calculations. They are always inserted to allow candidates to perform further calculations, and encourage weak candidates to either get started or to keep going. As ever, weak candidates are fond of answering these "show-that" calculations by trial-and-error. Sometimes they can do this by combining numbers from the question in non-physical ways to obtain the required answer. When this is detected, it earns no marks. It was pleasing to see that many candidates had been trained to present their answers in the format rule-substitution-evaluation, so that the derivation of their answer was clear.

There was no evidence that candidates had run out of time in the exam.

Comments on Individual Questions

Section A always contains a number of short questions, providing wide coverage of the specification. Typically, they are generally, but not always straightforward.

1 This paper always starts with a question about units. Although most candidates identified Wb m^{-2} as the correct unit for flux density, too many fell for the strong distractor of Wb C^{-1} as the unit of induced emf.

2 Too many candidates lost marks by careless sketching of the field lines. The four lines were expected to appear, at first glance, to be evenly spaced and perpendicular to the plates. With three marks at stake, each to be dealt with at an average rate of one a minute, candidates should have invested more time on this and showed that they knew that the field was uniform. Of course, candidates who correctly showed the effect of the small hole in the middle or the outside edges of the plates were given full credit, although this was not expected.

3 Although most candidates knew that they had to determine the gradient of the flux linkage-time graph, (the required formula was in the Data Sheet), too many failed to notice that the time was measured in milliseconds. It was expected that candidates would draw a straight line on the graph to measure the gradient - too many didn't bother. The rough approximation of peak flux linkage divided by one quarter of the period earned half marks. However, it was pleasing to find so many candidates able to correctly sketch the emf-time graph - the majority of centres have clearly done a good job in imparting this skill. Interestingly, many candidates wanted to increase the thickness of the wire in the coil to increase the emf induced in it, suggesting that they were confusing emf and current.

4 The vast majority of candidates were able to complete the equation correctly and identify the unknown particle as a neutron. Some candidates seemed to answer the questions in the wrong order, deciding that a beta particle was required (presumably because the equation included an antineutrino) and entered the charge and nucleon numbers accordingly.

5 It was good to see that many candidates had no difficulty in correctly identifying the electric field strength-distance and activity-time graphs.

6 This was another question where candidates had to demonstrate their skill in sketching, this time of an equipotential. Although nearly all candidates knew which way the line curved, too many didn't bother to make sure that, at first glance, their line crossed all the field lines at right angles.

7 This question requires candidates to perform a calculation using a formula which is not in the Data Sheet. This automatically makes it impossible for weak candidates whose centres have not required them to memorise formulae. Only a minority of candidates could successfully combine $E = qV$ and $V = \frac{kQ}{r}$ and correctly insert values for q and Q to obtain an energy of 3.0×10^{-13} J.

Section B contains four longer questions, each exploring in depth a small portion of the specification. Each question has a context, normally explained at the start. It is important that candidates keep this context firmly in mind as they work through the various parts of the question, and realise that their answers to later parts will need to draw on answers to earlier parts. Too many weak candidates cannot do this, treating each part of a question as a separate item, not relating it at all to the earlier parts. Perhaps they don't meet this type of question on their course, apart from past paper practice?

8(a) The vast majority of candidates were able to show that 14 eV is 2.2×10^{-18} J, some possibly by randomly multiplying and dividing the numbers provided until they obtained the right number, and correctly sketch the two missing energy levels. As expected, only a minority of candidates knew that the convention for electric potential to be zero for infinite separation of an electron-proton pair is one of the reasons why the energy of an electron bound in an atom is negative.

8(b) Many candidates failed to realise that they were required to use their energy level diagram from **(a)** to show why the electrons emerged with an energy of 1×10^{-19} J, earning no marks for general arguments about inelastic collisions. Similarly, when asked to calculate the energy of the photons emitted by the sample of gas, they used the initial energy of the electrons instead of the energy delivered by them to the sample. In other words, they forgot about the context of the question. It was therefore not surprising that only a minority of candidates could convincingly explain how two energy levels above the ground state could give rise to photons of three different energies.

9(a) In part **(i)** candidates were required to use three numbers provided to calculate a fourth. Good candidates calculated the mass of a single nucleus, and then divided this into the mass of the sample to obtain the number of nuclei. Weak candidates, who first divided the total mass by the nucleon number and then divided the result by *u* were clearly trying to obtain the answer by trial-and-error on their calculator, and were penalised accordingly. The majority of candidates were able to calculate the decay constant and activity of the sample.

9(b) Although the majority of candidates knew that the alpha particles could not penetrate the plastic case of the detector, many failed to relate this to the highly ionising nature of alpha particles to gain both marks.

9(c) This part of the question proved too complicated for the majority of candidates. Not only were six extra quantities introduced, candidates also had to use results from **(a)**. Although the calculation was straightforward, few candidates were able to correctly calculate the annual dose equivalent and many missed the point of the last part and discussed the relative risks of absorbing radioactive material and dying in a fire, instead of discussing the shortcomings of the model and relating the risk of other sources of radiation, such as background. The failure of this question to operate as intended was probably reflected in the drop of marks required for grade A on this paper!

10(a) The electromagnetism question is often the first one of Section B, and requires a lot of free writing of the candidates. This time it was placed later, but still seems to have operated quite well. The vast majority of candidates knew that flux loops stay within the iron as much as possible and don't cross each other, and could explain the forces on the iron bar in terms of the contraction of flux loops.

10(b) Most candidates knew that reducing the air gap improved the magnetic circuit, increasing the permeance and hence the amount of flux. However, in **(ii)** too many candidates lost marks by failing to discuss modifications to the apparatus which would increase the flux density. So increasing the voltage in the circuit earned a mark (just), but increasing the current did not.

10(c) Candidates were not expected to have met this phenomenon before, so it was good to find that the majority could work out that the sudden drop in flux resulted in a pulse of emf across the coil, momentarily increasing the current.

10(d) Many candidates recognised that this question was about eddy currents, and responded accordingly. Unfortunately, only a few candidates went into enough detail to earn all three marks, often ignoring the transfer of electrical energy in the current to heat energy.

11(a) As ever, some candidates insist on using the wrong rules for calculating the wavelength of particles. This loses them some marks. They should use $\lambda = h/p$ and not a combination of $E = hf$ and $c =$

$f\lambda$. Many candidates were able to show that the electrons needed to pass around the accelerator ring 2500 times to attain the required energy.

11(b) The vast majority of candidates recognised the kink at 45° as being due to diffraction, but only a few were able to provide an explanation i.e. that the waves could pass either side of the protons giving rise to a path difference, allowing phasors to arrive at the detector in various combinations depending on the angle of scatter.

11(c) Again, this question required candidates to do two things. Many concentrated their answers on the internal structure of the proton and ignored the description of observations.

2864/02: Report to Centres on Research Report Coursework

There were 117 candidates entered from 25 Centres for this component of the **Field and Particle Pictures** Module. 12 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. 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 does 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. 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 06. It seems that Centres are becoming more expert at ensuring their candidates include suitable, well developed physics, embedded referencing, a suitable evaluation of sources and contents pages to aid the clarity of presentation.

2865: Advances in Physics

Due to the low entry for this unit no Report for Centres has been written.

Advanced GCE Physics B (Advancing Physics) 3888/7888
January 2007 Assessment Series

Unit Threshold Marks

Unit		**Maximum Mark**	**a**	**b**	**c**	**d**	**e**	**u**
2860	Raw	90	64	57	51	45	39	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	60	53	46	40	34	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	56	48	36	0
2863A	Raw	127	96	85	75	65	55	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	96	85	75	65	55	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	87	77	68	59	50	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	87	77	68	59	50	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	49	44	39	0
	UMS	90	72	63	56	48	36	0

Specification Aggregation Results

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

	Maximum Mark	**A**	**B**	**C**	**D**	**E**	**U**
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	12.4	34.0	59.2	81.2	95,2	100.0	251
7888	11.5	38.5	73.1	94.2	96.2	100.0	53

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

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