GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Report on the Units

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2860 Physics in Action

General Comments

This was as usual an accessible paper, with a high facility (0.52) overall, corresponding to a mean mark of 47/90. Candidates' non-responses to part questions were small and well spread over the paper suggesting few had run out of time, but rather of knowledge or understanding. Only question parts 9(c), the high level calculation of a potential divider voltage, and 12(aiv) a low level mark for identifying the' v' in $v = f\lambda$ as a wave speed; were left blank by more than 20% of candidates. (40/44 of the question sub-groups had under 10% no-responses.) Most of the questions differentiated well, so the standard deviation was high at ± 16/90 (18%). Candidates' total marks were well spread between 0 and 88/90 and there were no "dead" marks on the paper which no candidates gained. The questions that did not differentiate well were generally of high facility: 5(a) reading emf and maximum current from a graph; question 7 - at low level on sound spectrum analysis (facility 0.98); and question 11 where the planned more difficult parts proved to be more accessible than expected..

Section A

Q1 This question was on knowledge of electrical units. Conductance was correct most often, then potential difference, then charge. The candidates who did get all three marks (37%), generally did well on the rest of the paper.

Q2a) This question was about the number of bits needed for a simple alphabetic text messaging system. The correct answer is 5, there were other answers offered such as: 2^5 (=32), 8, 2^{26} or 26^2. The explanation was generally good if they got the number of bits right. Not many counted alternatives, most did $2^5 = 32$.

b) Here candidates had to estimate the amount of information in a short text message, so there were quite a lot of ecf marks on bits per character from (a). Nearly all showed their method, and very few gave bare estimates for which max 1/2 marks was available.

Q3 This was a "show that" on the calculation of an information rate to run a colour tv, and was generally answered well. (facility = 0.80). The only common error being to divide by 25 frames per second (rather than multiply) at the end of the calculation.

Q4 Although in section A, this question on explaining lens action was not well answered, many weak candidates waffled or seriously confused the image point with the focal point, or even the object distance. More candidates managed to get marks for part a) than part b).

Some candidates were able to explain (a) using the lens equation and u = ∞, but there was some confusion about $u = 0$, (rather than $1/u = 0$), for those trying to use the lens equation.

(b) Very few candidates spotted that the object was at twice the focal length from the lens, and therefore this would also be the image distance (behind the CCD). There were many incorrect substitutions into the lens equation, and candidates got confused between u and v. Some candidates correctly calculated f = 5.3 mm (as a reverse argument for the lens that would have achieved the image suggested, could have gained 2/2 marks); but then incorrectly thought that meant the image was formed at 5.3 mm (in front of the CCD) so shooting themselves in the foot! This remains a topic which is poorly understood by many candidates.

Q5 Part (a) asked candidates to read values from a V / I graph and was generally well answered, only a few incorrectly reading the emf as 1.45 V.

Part (b) required more understanding to calculate the internal resistance of the cell, and was more discriminating. Good candidates got the gradient from the graph, some weaker candidates tried, but could not rearrange $E = V + Ir$. Many candidates correctly calculated internal resistance from the V and I values from (a), although it wasn't clear they knew why. Others got a power of ten error because they forgot the current units were mA (scoring only 1), and some incorrectly used a single point from the graph with (V / I), or used I / V and scored 0/2.

Q6 This question tried to get candidates to consider why the strength of a material is given as a stress rather than a breaking force. Few candidates got the 2 marks. Many otherwise good candidates fell into the trap of making incorrect statements such as "the breaking stress of a material depends on the x-sectional area"; but many candidates got one mark for defining stress correctly = force/x-sectional area, which was given to avoid a dead mark.

Q7 This was a low level two mark question on a sound spectrum analyser, with a very high facility of 0.98! but of course only marginal differentiation.

Section B

Three of the four section B questions showed very good discrimination. The exception was question 11 on the LED traffic lights which was "easier", with a mean facility of 0.62, but discriminated less well.than the other questions..

Q8 Candidates found this question about a new material, quantum tunnelling composite (QTC), the most difficult. Perhaps because of the novelty and variety of skills they were asked to demonstrate.

In part (a) candidates had to sketch a nano structure from a written description of the material. There was a good split of 2, 1 or 0 marks answers. The most common errors were too many unlabelled diagrams, non random positions for metal particles (especially placed on the polymer chains) and quite a lot of circle symbols representing polymer chains incorrectly.

In part (b)(i) Many incorrectly chose the feature of the graph as a straight line. Those getting the mark usually noted that the y scale is logarithmic.

In (b)(ii) many got the orders of magnitude represented as 12, but the most common error was to record it as 10^{12}, an understandable but serious error.

In (c)(i) candidates were asked to calculate the resistance of a QTC "pill" using a value of resistivity = 10^{-2} Ωm read from the logarithmic resistivity vs stress graph. This first mark was easy, as was quoting the correct equation from memory for the second mark. The problem came when candidates either used the wrong dimensions (confusing length with width) or their inability to convert the distance units (mm) into metric standard correctly. Part (c)(ii) naming an application of a QTC "pill" was well answered or left blank. A surprising number suggested its use as a variable resistor or voltmeter, rather than as some kind of stress, strain, pressure or force sensor.

Q9 Candidates also found this question difficult and differentiating.

Part (a) on converting graphical information for an LDR response into description was generally answered correctly, although some candidates gave too high or low values for the range of resistance.

(b)(i) Drawing a circuit diagram for a potential divider was disappointing. There were many wrong symbols used for the LDR, e.g. LED, photodiode or thermistor.

In part (b)(ii) many candidates put the voltmeter over the LDR, rather than the resistor, and a few put it across both components or in series.

Many candidates (iii) realised the p.d. was evenly split between the LDR and the resistor, gaining 3 or 2 marks 'error carried forward,' having read resistance from the graph incorrectly. Weaker candidates gave no response to this or part (c). There were a few who forgot about the kilo in kΩ and just gave a value of 2.3 Ω. The really weak candidates got confused with I for intensity and I for current, or tried using the intensity as power in P = IV type calculations.

In part (c) the best candidates could show that they really grasped the potential divider. Many got the resistance ratio the wrong way round and ended up with a mark error carried forward for reading the light intensity for their incorrectly calculated resistance from the graph.

Q10 Candidates found this question about the stress vs strain graph for a plastic metal highly approachable.

In (a)(i) most realised that graph section AB showed elastic behaviour, but fewer realised that section CD did as well.

Part (ii) section BC showing plastic behaviour was also generally correct, but some got the answers to (i) and (ii) the wrong way round.

Part (b) required reading specific values from the graph. In (i) most realised that slip started at 120 MPa, although there were quite a proportion who chose 130 MPa. Part (ii) was more discriminating although weaker candidates found it hard to read the small value (0.0105) of permanent stress from the graph. Popular incorrect interpretations were: 0.010, 0.015 and 0.0015.

In part (c) to calculate the Young modulus from the gradient of the elastic region(s) of the graph; candidates generally got all 3 marks or none. Many candidates took one or both values for stress or strain from the plastic region of the graph. A few got a power of ten error in converting MPa to Pa and back again. This was not necessary since the answer line units were in MPa : it incurred a one mark penalty.

In part (d) candidates were asked to use diagrams to explain the difference on the atomic scale between elastic and plastic behaviour. It was rather poorly answered; in general candidates are rather careless about their use of technical language. A number of candidates described a polymer rather than metallic structure; diagrams were poor and often unlabelled leading to a zero score. For elastic behaviour, there was also a lot of mention of atoms stretching rather than the bonds or atomic spacing. Very few candidates could explain plastic slip of atomic planes or dislocations satisfactorily, and some candidates got elastic and plastic deformation the wrong way round. Many candidates only described macroscopic features elastic or plastic deformation, this also lead to zero credit. Candidates should be guided to read and answer more carefully the key words in the question, in this case "in terms of the arrangement and movement of atoms in a metal. Labelled diagrams may help to illustrate your answer".

Q11 This was the highest scoring Section B question, where candidates had to interpret an LED characteristic and relate it to a traffic light application.

In part (a)(i) most candidates were able to get both marks by describing the current variation with increasing p.d. A few did not mention the rapid increase of current with increase in pd, and some did not mention the constant or zero current at the beginning. Most did mention the torn-on or threshold voltage (often in other acceptable words) at 1.5 V. In part (a)(ii) most candidates got both marks, using 2.3 V from the graph, with only a few giving a reading of 2.4 V, 2.2 V etc. In (a)(iii) most candidate correctly said that the energy was given off as heat or light / photons.

In part (b)(i) many candidates mentioned the correct advantage of parallel circuits - however there was also some irrelevant discussion about all the LEDs getting the same voltage, or the same current, being of equal brightness etc. In (b)(ii) most candidates were able to correctly calculate power at 115 mW. In part (b)(iii) many candidates scored one mark by mentioning that filament lamps waste a lot of energy as heat, very few went on to discuss the idea about the full visible spectrum being emitted, and much energy wasted in filtering out the other colours. Many candidates talked about resistance of the filament increasing, but this was nor felt worthy of credit. Most candidates were able to suggest a sensible benefit to society of LED traffic lights in the last part (b)(iv) of the question. A few misread the question and gave an advantage of filament lamps!

Section C

Q12 This question was about an image of the candidate's choice, and how it had been obtained and could be processed.

In part (a) Most candidates were able to suggest a suitable imaging system, and state the type of radiation used, typically X –ray, ultrasound or some kind of CCD system was chosen.

However, candidates often had no idea about what order of magnitude X rays or ultrasound were in terms of their frequency and wavelength. They were often some random numbers whose product would give the speed of light or sound! There were far too many candidates who thought that ultrasound is electromagnetic radiation. Most could calculate the $f \times \lambda$ product, but some got the units wrong, and most stated that it was the wave speed.
Nearly all could give a sensible use of their chosen image in part (b).

In part (c) most candidates got 1 or 2 of the 3 marks. Some explanations were very limited – especially X-rays and CCDs. Many candidates believe that X-rays are reflected from bones rather than absorbed more strongly. Ultrasound answers tended to have more details and to score higher marks.

Part (d) was about the benefits of image processing and very few candidates got 3/3 marks here. Weaker candidates got 1 mark, usually for mentioning the name or describing the basic image process involved. Better candidates scored 2 marks for describing noise removal, but failing to achieve the purpose/improvement mark as the answers were too vague. There were also many errors in the pixel value manipulation; two bad misconceptions were evident – that the 'mean/median of surrounding pixels' is taken (not including the central pixel, and that the process is only applied to anomalous pixels and not all of them. Many gave named three different processing techniques, without giving any significant details, which only gained one mark.

Q13 In this question candidates were asked to discuss their own example of signal transmission.

Most candidates scored the mark in (a) for naming their signal and the information carried.

In part (b) most candidates scored 2/3 marks – for the sketches of analogue and digital signals. Only about a tenth of the entry got the third quality mark, for adding diagrammatic or descriptive detail. Common errors were to have crude analogue sketches with signals "going backwards in time", or digital signals on more than two levels. In (b)(ii) most candidates got the sampling mark, those that did not omitted the idea of regular sampling in time. Many did not go onto say that during digitisation there was rounding to the nearest discrete level.

Similarly in the third part many only got a mark for stating that the sampling rate was too low. Some gave good diagrams to show loss of high frequencies. Good candidates got the quantisation error idea and some explained this very well. Weaker candidates waffled about noise in transmission.

QoWC
This season again 3/4 was the most common score, but there were more scores of 2/4 than in previous years, and fewer candidates with 4/4.

2861 Understanding Processes

The paper was of an appropriate standard and provided good differentiation between candidates of different abilities. Most scripts were fully worked indicating that the candidates had sufficient time to complete the paper in the 90 minutes allocated. Performances in sections **A** and **B** were essentially sound, and a pleasing range of contexts was evident in the answers produced to the section **C** questions. Those who had prepared themselves well for the Section **C** questions scored well in this part of the paper; the quality of answers in this section has shown a steady year on year improvement. Total marks obtained by the candidates were distributed across the full range of marks available, around a mean mark of 50/90, lower than in previous years with a lower standard deviation of 15.9

Section A

This section was generally completed well.

Question 1 involved selecting the graph that would be obtained when specified variables were represented on the y and x axes. It was rare to see a fully correct answer to this question, almost half the candidates managed only 1 out 3 marks. This is similar to responses in previous years and could be a focus for targeting teaching. Question 2 was generally well answered with 50% of candidates scoring full marks. Common mistakes were poor setting out and incorrect rounding, this was a worrying feature throughout the paper for many candidates. In later questions this also involved inconsistent use of standard form and the incorrect use of 'equal signs (=)' throughout a question. Question 3 proved to be quite friendly to the candidates with over 60% scoring full marks, errors were generally in the form of poor setting out to part (b). The now familiar style of Question 4 has resulted in an increase in candidates' confidence in answering this 'type' of 'data manipulation' question. Although too many candidates were hesitant in their conclusions. Question 5 part (a) first tested candidates ability to use the wave equation and E=hf. Question 5 part (b) required a detailed written explanation, most candidates recognised the reflection/non-absorption of green photons but could not articulate the idea of white light being made up of many frequencies/colours. Question 6, for a multiple choice question, discriminated well giving a good spread of marks. Question 7 involved calculating time periods from two waveforms, was very poorly answered. It was all or nothing; either zero marks (50% of candidates) or full marks (25%).

Section B

Question 8. This question was about standing waves on a stretched wire. The majority of candidates (80%) correctly identified the value of the wavelength and, including those with an error carried forward, almost all candidates were able to use the wave equation correctly in part (a) (ii); a significant improvement on previous years. Many candidates were able to correctly identify the positions of nodes and antinodes on their diagrams. Part (a)(iv) was a good differentiator, with a clear ramped difficulty to access all three marks. Answers ranged from the accurate and concise scoring full marks to slightly 'waffly' answers that had little merit. 8(b)(i) was straight forward and well answered. It was very pleasing to see that a substantial number of candidates showed considerable application and determination in successfully getting to the end of the calculation in 8(b) (ii). Weaker candidates could not access this question, finding it difficult to know where to start!

Question 9 This question was about the motion of a sphere in a viscous liquid and the interpretation of some distance/time data. In 9 (a)(i) most candidates were able to plot an appropriate graph despite the poorly sized grid given on the paper. It was disappointing though that the quality of drawing lines of best fit is somewhat variable. 9(a)(ii) which required candidates to give a description of the motion as plotted on the graph, was generally very poorly answered. An inability to use the correct terms led to confusing statements such as 'accelerating with a constant speed'. This part of the question also highlighted the need for greater attention to detail when reading the question. 9(b)(i) generated an average response with candidates able to describe how the calculation had been made correctly identifying the distance and time measurements but the subtlety of the question was quite rightly only appreciated by higher scoring candidates. Following on from this the responses to (b)(ii), often linked to performance on (b)(i) were more polarised.

Question 10
This question was about a bouncing ball and its component velocities, candidates generally found this Section B question more difficult than the previous one. The start of this question in part (a)(i) saw 70% of candidates gaining the two full marks or zero. This clearly highlighted candidates understanding of vector quantities although there was some misinterpretation of the question from candidates who did not carry out a calculation. In part (a)(ii) the majority of candidates were able to correctly describe a change in direction to score one mark but missed the second quality mark for not identifying the quantity as a vector. 10 (a)(iii) involved, not obviously, the use of F=ma. This completely divided candidates into those who could barely attempt the question (40%) to those who showed real ability in working through this type of calculation to gain the three full marks available (40%). 10(b) was clearly one of the most difficult question on the paper, involving vectors and various algebraic manipulation, it really tested only the most able candidates.

Question 11
This question was about the quantum behaviour of photons of light from a laser. It provided the weakest set of responses and again highlighted a poor understanding of this field of physics and the specific way in which it is taught using phasors. 11 (a) (i)&(ii) required candidates to draw six phasors tip to tail and draw in a resultant phasor amplitude (RPA). This part of the question was often not attempted and when completed by candidates it again highlighted an inability to accurately draw what was required. A large number of candidates lost marks for careless errors. Two thirds of candidates either made no response or gained zero marks for part(a)(iii). This is still surprising even though the concept is abstract and requires high level thinking the mark scheme credits fairly straightforward response i.e. probability being proportional to RPA squared and that certain paths contribute more to this larger RPA. However as soon as the question strays into more familiar territory such as 11 (b) (i) over three quarters of candidates correctly identified the process as diffraction. The table on the last part of question 11 was very challenging and 80% gained zero marks.

Section C

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

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

Question 12
This question was answered very well by the majority of candidates. 12 (a) (ii) contained a mistake on the paper where the incorrect answer line was given. In response to this 1 mark was awarded for an appropriate magnitude for the wavelength and the second mark for correct units. Many diagrams were well drawn and appropriately labelled. Once again, a minority of candidates, less than in previous sessions, demonstrated that they had done little preparation for this section of the paper and sacrificed many valuable marks as a direct result. More striking was the selection of the example of ‘superposition’, as poor choices often did not allow candidates to make three fully explained observations thus losing many marks.

Question 13
This was a more structured question that the previous one. Part (a) was generally well answered as a variety of response warranted credit. 13 (b) could gain full marks for very straightforward answers yet often candidates threw away marks either from a lack of attention to detail or from not being specific enough or often just an inability to follow the ‘describe’ and ‘explain’ instruction. Part (c) provided an opportunity for most candidates to show their understanding of the equations of motion. Common mistakes, other than simple errors in algebraic manipulation, were based on the misconception that a simple distance over time calculation provided ‘final velocity’. The majority of candidates, over 50%, achieved zero marks for both parts of 13 (d), poor answers gave weak or vague statements about ‘inaccuracies in the measurements’ and there were many incorrect answers based on resistive forces.

The overall Quality of written communication for section C was slightly lower than previous years and reflected the overall comments from examiners about a concern that candidates are placing less emphasis on the setting out of work and presentation.

2862: Physics in Practice (Coursework)

General Comments

The vast majority of centres should be congratulated on the professional manner in which the marking and completion of relevant paperwork was carried out. Also, in the way in which virtually all of the work was delivered within the time scale required. Unfortunately there are still a few centres where the addition of totals for each task and the transfer of this mark to their MS1 form led to mistakes, these errors can inevitably lead to delays in the moderation process.

As in recent years, very few centres were adjusted and where adjustments were necessary then it is to be hoped that the following notes will help in the future.

Instrumentation Task:

The majority of centres are now following advice given in previous moderator reports and their candidates are using potential divider circuits. It was noticeable that candidates who used more 'complex' circuits involving, say, transistors as amplifiers or Wheatstone bridge networks often scored considerably less marks than those who used more traditional AS equipment. Those using transistor circuits often finished with circuits in which the only observation was a bulb being on or off and those using a Wheastone bridge circuit could rarely explain the Physics behind the circuit. Conversely, candidates who used very simple circuits such as a thermocouple connected across a multimeter should not expect to score highly in use of resources. Good candidates give a clear understanding, with relevant equations, of the Physics of a potential divider and an explanation of how the value of the fixed resistor was chosen. Candidates who include an ammeter in their circuit and proceed to measure both the p.d. and current to calculate the resistance appear to miss the point that the p.d. is a measure of the input variable and there is no need to calculate the resistance.

In Skill A, proof of planning and a statement about safety were often missing. If there is no plan then a candidate should not gain full marks in A(i) and similarly if there is no statement on safety written by the candidate, then full marks cannot be awarded in A(ii) even if the procedure is inherently safe.

It is in Skill D 'Analysis' where there is the greatest misunderstanding of what is required. Under 'Systematic Measurement', candidates are expected to take at least three sets of readings for high marks and these readings should all be to the same number of significant figures. It is then perplexing to see candidates making no comment about significant differences between sets of readings and just averaging whatever has been taken instead of pointing out, repeating or removing obvious anomalies and taking steps to minimise their effect. There also seems little point in plotting graphs for each individual set of readings as well as a graph of the average, it is the average that is important and the others are little more than page filling. The 'Fitness of Purpose' section of this skill is not just a discussion on whether the particular sensor will fulfil a particular job, it is aimed at quantitatively calculating at least two of the properties listed in the mark grids, e.g. sensitivity, response time, resolution etc.

Material Research Presentation:

This task produced some excellent work that must have helped candidates not only in their understanding of a particular material but also in the Key Skill of Communication. Candidates whose title includes a material and its use in a particular context e.g. 'Silicon and its use in semiconductor chips' automatically start to score in both the focus and the context boxes. A few other useful points are as follows:

It was with concern that it became apparent that a few candidates did not do an actual presentation of any type, if this is the situation then they should be heavily penalised in both C(ii) and D(ii).

In section A(i) candidates are required to submit a written plan, otherwise they cannot score more than three marks in this section, a pro-forma for a plan can be found on the Advancing Physics website.

In A(ii) candidates must provide a list of their sources and if this list includes page references from books and webpage addresses from the internet then this will also act as proof of doing research in D(ii). These references should then be linked into the presentation. Without the original list of sources candidates cannot score any marks in A(ii) and also penalise themselves in D(ii).

In C(ii) the illustrations used should enhance the Physics e.g. by showing the structure of the material.

In D(ii) the paper record should include talk notes as well as power point slides and bibliography.

Making Sense Data:

Centres are advised that it is the interpretation of the data that is important within this task and not its collection, thus it is probably better to show candidates the required experiment, and by all means let them use the apparatus, but to then provide one common data set for the whole class. This should make marking easier and should also avoid individual candidates getting spurious results.

The greatest area of concern in this task is the production of computer generated graphs. If a computer package is used then candidates are still required to produce graphs to the same standard as those that may be hand drawn. Thus graphs should be of a reasonable size, at least half an A4 page, say, must have both horizontal and vertical grid lines, small points whose values on the x and y axes can be read from a suitable scale and have labelled axes with both quantities and units. Lines of best fit, whether hand drawn or computer drawn should be genuine straight lines or smooth curves, not dot to dot. Failure to follow these guidelines should lead to penalties in A(ii), Use of ICT, as well as the sections particularly relating to graph drawing. This advice for graphs also applies to the Instrumentation task.

Another concern in this task applies to only a minority of centres, this is the manner in which all candidates, from these centres, follow exactly the same steps in the analysis of their data and are then awarded high marks for the independence of their work. It is, of course, expected that centres will give certain guidelines before candidates start on their analysis but if this is so prescriptive that all the work is virtually the same then the independence of the work must be brought into question.

2863/01 Rise and Fall of the Clockwork Universe

General Comments

The paper produced a wide spread of marks from the candidates ranging from single figures to the maximum 70/70. The mean mark was 42/70 and the standard deviation was 12.1. The vast majority of the candidates attempted all parts of the question paper. There was little evidence of misunderstanding the requirements of the questions. The majority of the candidates had been carefully prepared for the examination; there were very few examples of candidates who clearly had not covered an area of the course.

As in previous sessions, most candidates tackled straightforward calculations with ease but found more open-ended calculations and estimations more difficult. Candidates were required to explain ideas in a number of the questions and this proved difficult for many. These questions showed that many candidates had basic misunderstandings of physical concepts. As some of these questions are worth four marks it may be useful to go through the mark scheme with future candidates to help them prepare for questions of a similar style. Not all candidates seemed to realise that the number of marks awarded for each part of a question is a reasonable indicator of the amounted of detail required.

The best papers were extremely impressive and showed an excellent understanding of the physics tested. The quality of writing in the best scripts was also encouraging; concise prose allowed the points of physics to be communicated with clarity. However, experienced Assistant Examiners did report that the overall standard of written communication was disappointing. Many candidates made little attempt to aid the reader through careful use of punctuation and grammar; on occasions this may obscure the scientific and technical content to such an extent that meaning is lost.

Comments on Individual Questions

Section A

Question 1 proved surprisingly difficult for many candidates. The most common error was to confuse seconds (s) with seconds^{-1} (s^{-1}).

Question 2, involving a simple momentum calculation, was accessible to the majority although very weak candidates found the second calculation more troubling.

In contrast, Question 3, on capacitor discharge, was answered with much more confidence. It is clear that this part of the course is carefully taught. 2(b) produced a variety of methods of reaching the answer required.

Question 4 was less accessible. Not all candidates could calculate the speed of the mass as they could not find the circumference of a circle of radius 2.2m. In part (b) some candidates could not recall the equation for centripetal force, although the equation for centripetal acceleration is given on the data sheet.

Question 5 proved to be accessible to all but the weakest candidates.

Question 6 produced encouraging responses although a sizeable minority suggested that making the hole in the can smaller would speed up the flow – there may have been some guessing going on here. Part (b) was well answered but there was a proportion of the candidates who chose ‘$cm^3\ s^{-1}$’ rather than ‘s^{-1}’ as the unit.

Question 7 was about resonance. The majority of the candidates correctly identified the natural frequency of the strip but only a minority stated that the peak amplitude would shift to lower frequencies if a longer strip was used. Many candidates gave rather hazy answers to this question such as ' the amplitude will increase'. These were not mark worthy as they did not link change of *peak* amplitude with frequency.

Section B

Question 8
This question was about the forces on a rocket that takes tourists to the 'edge of space'.
Part (a) asked the candidates to explain why it was helpful to 'piggyback' the rocket onto a larger plane until such a height where the atmosphere is 25% of the surface pressure. This was well answered – most candidates giving a reason and linked explanation. The second and third parts of the question were also accessible to the majority. In part (c) most responses used $E = mg\Delta h$ to calculate the energy required to lift the craft to 100 km above the surface. Others found the change in gravitational potential from the graph. Both routes to the final answer were acceptable.

Part (d) proved more difficult. The best responses found the net force on the craft (74000 N – (3800 kg x 9.7 N kg^{-1})) and used this result to calculate the acceleration. Less convincing answers calculated two accelerations and subtracted one from the other – this led to an arithmetically correct answer but the route to the answer was not correct physics. However, many candidates simply ignored the force of gravity on the craft and calculated an acceleration from the thrust of the craft alone.

Part (e) (i) produced many answers concerned with the force on the craft rather than energy arguments. Both were acceptable.

Part e(ii) was extremely discriminating and showed that many candidates hung on to the notion that gravity vanishes outside the atmosphere. The best responses were a joy to read but only a small minority of the candidates gained all four available marks. Many correctly stated that outside the atmosphere the only force on the craft was gravity and also that when the craft re-entered the atmosphere the craft experienced a decelerating force that was not experienced by the tourists. Unfortunately, only the best candidates realised the significance of these statements in the question.

Question 9
In contrast to the novel situation in question 8, question 9 was about the very familiar situation of a trolley oscillating between two springs. However, although the situation may have been familiar the question was not without its problems for many candidates.

Part (a) was surprisingly poorly answered. Once again, there was evidence of guessing in many responses or insufficient detail to gain the mark.

Part (b) was answered with more confidence but 'show that' questions do require clear working to gain full merit and many candidates failed to handle the negative signs in the equations and were left with the job of calculating the square root of a negative. Somewhat surprisingly, this proved unproblematic as the sign was simply ignored. This led the candidate to the correct number but the route had not been clearly shown.

Part (c) was answered well. The most common error in part (i) was to give an answer such as 'the maximum p.e. is 0.8J' without stating that the KE was zero at this point, and that KE + PE = 0.J.

In c (ii) candidates could either choose two pairs of energy values and show that the sum in both was 0.8J, or use $E = ½ kA^2$ to reach 0.82 J.

Part (d) discriminated well. Weaker candidates gave rather hopeful responses about p.e. and k.e. adding together to give twice as much total energy. Only the best candidates 'saw' the equation behind the question and used the knowledge that total energy is proportional to $amplitude^2$ to explain the data given in the question. Part (e) gave good candidates another chance to show their understanding in linking damping to a reduction in the total energy of the oscillator. A sizeable minority of the candidates were bogged down with a confusion between the amplitude of the oscillation and the 'amplitude' of the energy graph – this confusion was made more evident in those responses which included a sketch graph of a damped oscillator showing the y variable going below the x axis. Such graphs were clearly displacement –time plots rather than energy-time plots.

Question 10
This question was about molecular collisions.

The first part of the question was straightforward and most candidates gained full marks for parts (a) and (b).

Part (c) modelled molecular collisions in a manner that may well have been novel to many candidates. It was very encouraging to see that many coped with this new idea and were not put off by the very small and very large numbers involved. Most candidates trusted their arithmetical skills to stick to the seemingly large number of 3.7×10^{10}.

Part (d) gave few problems although some candidates did not state, for example, 'rise in temperature' but used 'change in temperature'. This lost them marks. A second omission was to explain that higher temperature led to higher kinetic energy but not to link this to higher velocity. Many candidates linked increase in pressure to increase in collision rate but did not link this to decreased inter-molecular spacing.

Part (e) was also discriminating. The most common error was to imagine that a particle gains energy in every collision so that it is merely a matter of time before it will have twenty-five times the average energy. It was clear that most candidates had been carefully taught about the Boltzmann factor and (in the words of the Students' Book) 'getting lucky' but had not thought carefully enough about what it actually implies.

Question 11, the last question, was about cosmology. The facility with which this was answered was more centre-dependent than other questions. Some Centres had clearly enjoyed this part of the course whereas others may have rushed it a little. Many candidates showed understanding of the nature of cosmological red shift and there were few confusions between this and classical Doppler Shift in the responses to part (a). Part (b) was well-answered although some candidates failed to change the velocities of recession from km to m and thus calculated a value of H_o one thousand times too small. About a third of the candidates reasonably ignored the low value of the Hubble constant, describing it as a spurious result. This was an acceptable point but a straightforward calculation of the mean was also worth a mark.

c(i) and c (ii) were accessible to all but the least confident candidates.

2863/02 Practical Investigation Coursework

There was an entry of approximately 2750 candidates from around 300 centres for the June 2008 session. There were a few issues involving the slight delay of the arrival of MS1 forms at Centres. The moderating team also reported an increase in the number of administrative problems in other areas, particularly the omission of the CCS160 Centre Authentication form. A phone call or letter to the Centre generally resolved such problems, but a few persisted until very late in the moderation process. It is worth reiterating that the absence of form CCS160 ultimately leads to the withholding of grades by OCR.

As in many recent sessions, the most frequent comment from moderators concerned the multitude of competent and worthy investigations on familiar topics, but few genuinely original pieces of work. Generally the most suitable topic is a clearly defined problem, which offers scope for genuine investigation, rather than routine, mechanical and unimaginative work. This was also reflected in the reduction in the number of scripts nominated by Centres for the Institute of Physics Prize - in a few instances moderators took it upon themselves to nominate scripts which demonstrated the flair and originality expected of a prize winning script, even if minor shortcomings meant that the script did not quite merit full marks. Perhaps in the ever more pressurised world of teaching, some Centres have simply forgotten this straightforward mechanism for gaining recognition for their best students. The nomination form is available from: http://www.ocr.org.uk/qualifications/as_alevelgce/physics_b_advancing_physics/documents.html

For a large number of Candidates, Strand D proves something of an Achilles Heel, and is often significantly over-assessed by many Centres. It is probably a fair observation that many Candidates first come across the imprecise art of dealing with errors/uncertainties when they come to analyse the data collected in their Practical Investigation. In the revised Specification under ***Experimental and data handling skills***, the expectation is that: "***In experimental work, candidates should choose and use appropriate materials and equipment, recognise the limitations of instruments, recognise and quantify the uncertainty of measurements, identify and make attempts to reduce important sources of uncertainty and identify and make attempts to remove possible systematic errors***." The specification also states these are "***generic skills that develop throughout the course".*** It is abundantly clear that there are plenty of Centres where these skills are taught thoroughly, with the result that even the weakest Candidates make creditworthy attempts at quantifying and dealing with uncertainties, including estimating the percentage uncertainty in derived quantities. However, there is a very wide variation in how well this aspect is dealt with, resulting in many Candidates producing essentially GCSE level evaluations which are little more than a list of possible improvements to the method, given more time, better laboratory facilities or an unlimited budget!

A better preparation would be to expose Candidates to elements of repeatability, and inherent uncertainties as a result, as part of standard experiments covered early in the course. Similarly, data analysis might provide the opportunity for discussion of the harsh analysis of graph plotting packages with auto equation facility (e.g. an Excel equation quoted as $y = x^{-1.8}$), in comparison with the elegance of testing for inverse square relationships by plotting y against $1/x^2$ and drawing a straight line through error bars. This then provides opportunities for discussion of the limitations inherent in the data and the interpretation of relationships in terms of underlying Physics, both important aspects of Strand Di. Under Strand Dii, it should be borne in mind that the statement 'The work is interesting achieving results new to the student' is part of the 5 mark descriptor under 'Conclusions' and should not be used as a stand-alone statement to give additional credit, thereby artificially inflating the mark awarded in this strand.

2864/01 Field and Particle Pictures

General Comments

The distribution of marks earned by candidates for this paper was very similar to that of previous years, with many candidates able to earn most of the marks. It was good to find that even moderately weak candidates felt able to tackle every single question, even though they often failed to earn many marks for their response. As ever, weak candidates lose marks heavily wherever they are required to write an explanation or justify a calculation. They can do the sums, draw the lines and sketch the curves, but not provide the words.

Comments on Individual Questions

Section A
Unlike Section A at AS level, this paper has questions which are hard as well as others which are easy. This is to leave enough easy parts of questions in Section B to help weak candidates navigate it hopefully. So some questions test factual knowledge or the ability to perform routine calculations, whereas others require explanations or careful thought.

1 This paper always starts with a question on units. Most candidates had no difficulty in scoring both marks.

2 Weak candidates often failed to read the question carefully and suggested winding more turns of wire, laminating the iron or rotating the magnet faster - all of which had been precluded in the question stem. Candidates who wanted to improve the magnetic circuit by increasing the cross-section area of the core or decreasing its length needed to choose their words carefully; "larger core" did not earn the mark.

3 The majority of candidates sketched a correct trajectory. It was rare to find a path which did not take the alpha particle closer to the nucleus, but sometimes it would end up parallel to the original one. The table provided good discrimination.

4 This was the first time that the idea of current-turns as an indicator of flux density has been examined in this paper. In part (b), too many candidates mentioned permittivity instead of permeability.

5 Candidates always struggle with risk calculations of this sort. Some didn't notice that the dose equivalent was in mSv, others forgot to include the % with their answer, and many thought that they had to divide their final answer by 100 to make it a percentage.

6 Each part of this question was harder than the last. It was good to find that many candidates were able to get all of them right.

7 Part (a) was a straightforward but long calculation which most candidates could get right. Part (b), as expected, was poorly answered by most candidates. Weak ones assumed that the energy required was either binding energy or energy required to break apart the nucleus. It was rare to find a candidate correctly using the idea of coulomb repulsion to justify the kinetic energy required of the colliding particles. Too often they mixed force and energy in their argument without invoking work or potential.

8 Although this question has the style of one which might appear on a GCSE paper, candidates found it hard. They found it difficult to correctly relate the properties of the radiation to their penetrating power.

Section B
As always, there are four questions in this section, with each one leading candidates through part of the module specification. Weak candidates often fail to keep the context of the question in their mind as they prepare their answers, resulting in confusion. The quality of written communication was generally good, but many candidates locked themselves out of maximum marks by avoiding the use of capital letters at the start of sentences and full stops at their end.

9 Few candidates earned all of the marks for their sketches of flux loops and flux-linkage time graphs. The standard of the latter was very high, indicating that centres have given their candidates plenty of opportunity to practice this skill. It was expected that candidates would have difficulty in relating the area under the emf-time curve to the peak flux linkage, given the common misconception that the peak emf coincides with the peak flux linkage (despite their having correctly drawn the flux linkage for the previous question!). However, it was disappointing to find that many candidates, having successfully calculated the area, failed to divide by the number of turns to convert flux linkage into flux. Strong candidates realised that for part (c) the transformer rule gave the correct answer, so proceeded accordingly. The majority of candidates were able to score high marks on the final part; it has appeared many times in earlier papers.

10 Although the majority of candidates drew the arrows in the correct direction, careless drawing of the equipotentials often lost them a mark. They needed to spend more time planning the route of their lines so that they crossed each field line at right angles. The calculations of part (b) were straightforward, but weak candidates lost marks by simply doing the sums and failing to invoke some physics to justify their calculation. Both questions asked candidates to show, not just calculate. Part (c) was intended to see how well candidates could apply their knowledge to an unfamiliar situation. The majority rose to the challenge and often earned most of the marks.

11 The first and third parts of this question about energy levels of electrons in molecules caused most candidates no difficulty at all. The second part required them to justify an expression for the energy levels. Weak candidates often failed to start with $p = h/\lambda$, and if they did so would attempt unconvincingly work back from the answer. As ever, candidates often scatter algebraic entities throughout the answer space, making it difficult to follow their argument. The last part of the question involved a two-part calculation which most candidates successfully negotiated, but too many failed to relate the energy of this photon to the difference in energy between the levels. Most assumed that the photon could not be absorbed because its energy was below that of the lowest energy level. Very few candidates could state that the photon could only be absorbed if its energy was an exact match to a difference in energy levels of the molecule.

12 It was good to find that the majority of candidates worked out that the proton number of uranium had to be 92 and included the relevant number of neutrons on both sides of the nuclear equation. Calculation of the potential outside the nucleus was straightforward for candidates who had selected the correct formula and remembered the 46 protons involved, but calculating the energy of the other nucleus due to this potential proved to be more difficult, probably because there wasn't a helpful formula in the data booklet. Many weak candidates failed to understand the last part of the question, talking about chain reactions which led to an increase of neutrons (the normal bomb scenario) instead of a steady number of neutrons (as required in a power station).

2864/02 Research Report Coursework

In May 2008, 407 Centres returned the marks of over 5000 candidates for this coursework component of the Advancing Physics course. The majority of Centres managed to meet the May 15th deadline and included all the requisite documentation. It should be noted that where the entry is small (up to about 15 candidates) centres should send all of the scripts without waiting for the request from the moderator. This will cut out any unnecessary delay in the early part of the process.

One of the administrative duties of the moderator is to ensure that the marks have been correctly totalled on the assessment grids and transcribed to the MS1. This process proved remarkably challenging for a number of centres this session. Such transcription errors will have triggered the receipt of an amendment form (CW/AMEND) used to ensure that the students get the marks the centres originally intended. Centres submitting marks direct to OCR using electronic methods are advised that they still need to submit a hard copy with their sample for use by the moderator for the same purpose.

Centres have developed considerable expertise in the application of the assessment criteria for this task. Even the weakest candidates are made aware of the need to reference their work appropriately. Embedded referencing techniques and suitably detailed bibliographies continue to characterise the best reports. Reports without a clear focus, involving little detailed physics tend to mark out the work of the weaker candidates. The need for this piece of A2 coursework to be built around a physics topic of appropriate demand still eludes some candidates. Chaos theory, time travel and mobile phones continue to feature regularly as titles despite, I suspect, the best efforts of teachers to discourage them. The end result can often be descriptive and contain little or no physics at all. It is not the intention of the specification to be too rigid but teachers are well advised to guide their students away from these 'physics free zones'. The Report title, if carefully chosen should enable the student to demonstrate a good grasp of the A level physics that it might reasonably be expected to contain.

Centres are now alert to the dangers of plagiarism and students have clearly got the message about the likely consequences of bulk 'cut and paste'. Moderators reported few cases in this session where reports included substantial copying that had been overlooked by the centre assessor. The evaluation of the source material used by students however, continues to be an area where many fall down. Strand D (Evaluation and connections) requires students to comment on the suitability and reliability of the sources they have used. Few students will do this instinctively and careful guidance about how best to do it is strongly advised. Some centres suggest that their students make their evaluation comments an integral part of their bibliography.

Most large centres seem to be aware for the need to moderate this work internally to ensure the consistency of their assessments across groups. Moderators are instructed to sample across the sets as well as across the mark range in order to confirm that such consistency is maintained. Some evidence needs to be provided that this process has been carried out. A short note explaining the process is all that is expected.

The Moderators task is made significantly easier by those centres that annotate the scripts assiduously. A number of centres still submit scripts that show no signs of having been marked at all. The more evidence that centres can provide in support of their assessments the less likely the moderator is to consider an adjustment. The majority of the changes recommended in this session occurred where little or no evidence was provided by the centre to justify the marks they had awarded.

There were a pleasing number of scripts nominated for prizes by their teachers this year. The most talented individuals continue to produce impressive reports on a diverse range of topics. The Institute of Physics gives prizes annually for the best reports. Centres can be rightly proud of the high quality of work that they elicit from their students and submitting such work for prize consideration is a way of gaining recognition for all of the hard work involved.

Centres that remain concerned about their understanding of the criteria for the assessment of Research Report might consider attending one of OCR's Training sessions usually held in the autumn term. Another way that Centres can seek reassurance that their interpretation of the criteria is sound can use the consultancy service. This is provided free of charge and allows centres to submit a sample of marked scripts for detailed analysis and feedback from an expert moderator. It should be noted that a 6 week lead time is involved so the onus is on the school to submit the work early in the assessment cycle. Details of this consultancy service and dates for the Training sessions can be found on the OCR website.

2865 Advances in Physics

General Comments

This year's paper started with two questions demanding extended prose descriptive answers based on the first part of the advance notice article. This proved challenging for many candidates, who found it difficult to organise their ideas and write clear and coherent answers, although some excellent answers were seen. There was some indication that candidates spent too long on these two questions and then had to rush the remainder, but most candidates completed the paper.

More mathematical questions were done significantly better by both the strongest and the weakest candidates, although only the stronger candidates were able to cope well with calculations involving more than one stage of reasoning.

Once more, it was clear that most Centres had prepared their candidates well for the Advance Notice section of the paper, although there were candidates who gave no indication of having prepared the topics covered at all.

Comments on Individual Questions

1 (Viking navigation) A surprising number of candidates were unable to state that waves that can be polarised must be transverse, although most could describe the changes on rotating a polarising filter. In part (b), some candidates tried to used Gilbert's model to explain how compasses can be misleading near North America, saying that the land attracts it. Better candidates were able to explain the reduced compass errors in Europe with the aid of sketches.

2 (Gilbert's model of the magnetic Earth) Stated similarities and differences between magnetic fields and electric field were often at a level more appropriate to Key Stage 3 than A level. In part (b), Gilbert's own drawing, which was in the Advance Notice article, was misunderstood by a significant minority of candidates who did not realise that N and S were on the sides. Many candidates were clearly using a mental model whereby the earth has a giant buried bar magnet within it, with its S- (south-seeking) pole somewhere near Canada: these were given full credit. Sensible flux loops were seen rarely. In trying to use Gilbert's model to explain magnetic deviations near the American coast in part (c), good candidates did gain credit by referring to the difference in 'magnetic conductance' of the sea and the continent in the model, or by simply stating the greater effect of the nearby continent of America; weaker candidates were confused between flux lines and meridians, or tried to refer to the presence of the magnetic north pole.

3 (Densities of the Earth's interior) Most candidates could do the straight-forward calculations of parts (a) and (b) well, although many lost a mark by confusing gravitational force with gravitational field, and then surreptitiously putting in a 1 to make the numbers work. Only the better candidates were able to structure part (c) and calculate the volume, mass and then density of the mantle and crust combined. In this question, calculation of the required value was taken as sufficient justification of the statement about densities given.

4 (Wave speeds in the Earth) Although this question stated clearly that it was about the velocities of S and P waves, a number did not use changes in speed to explain refraction in parts (a) and (d). Many candidates were penalised in part (c) for expressing their answers to an excessive number of significant figures, when the data clearly indicate a maximum of 2 (3 were allowed). Although many correctly reasoned that the elastic modulus was a more significant variable than density in part (b)(ii), they frequently assumed in part (c) that density was the only variable factor.

5 (Energy losses from the core) Calculations of the energy released by solidification of the Earth's core were generally done well, but a surprising number then failed to draw the conclusion required in part (a)(iii) that there must be other sources of energy to account for the measured release of energy from the core. The calculation of energy released by the decay of potassium-40 required in part (b)(ii) was unstructured, and successfully done by the best candidates.

6 (The geodynamo) Most candidates were able to attach the descriptive comments about the mathematical derivation of induced emf to the correct equations, although some did not write them on the dotted lines as instructed, but in the spaces next to the equations. Most candidates were able to identify characteristics of both Venus and Jupiter likely to be responsible for their weak and strong magnetic fields respectively, and stronger candidates were able also to explain clearly why these may be responsible; marks were awarded in each case for factor + explanation, or for two independent factors. In part (c), most gained one mark for stating that the geodynamo was analysed by computer on account of its complexity or the inaccessibility of the Earth's core, and the best candidates were able to develop this to give more detail on the complexity involved, or to model slow processes in short times.

7 (Radioactive tracers)This question, not based on the Advance Notice, was generally well done by most candidates. The calculation of dose equivalent was done well by better candidates; this type of calculation, with several steps, needs practice.

8 (Oscillations) Most candidates were successful at the calculations of spring constant, period of oscillation and electron velocity, and could draw field lines, although these were often not very uniformly spaced, and the direction often wrong. Using the ideas of constant acceleration vertically and constant velocity horizontally to explain parabolic motion was done only by the very best candidates. In the car suspension part, a variety of acceptable factors were suggested for the equilibrium position of the piston, and many could suggest how to increase the 'spring constant' of the system without being able to explain why. Better candidates were also able, in the final part of the question, to use the ideal gas equation [without knowing the number of moles of gas present] to explain why the temperature of the gas must have increased, by realising that nR must be constant.

Grade Thresholds

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

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2860	Raw	90	62	54	46	39	32	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	62	55	48	41	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	98	88	78	68	58	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	98	88	78	68	58	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	91	81	71	62	53	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	91	81	71	62	53	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	61	55	49	43	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	24.3	43.9	63.3	79.6	91.0	100	6942
7888	32.3	54.0	73.5	88.2	97.3	100	5166

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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