GCE

Physics B (Advancing Physics)

Advanced GCE **A2 7888**

Advanced Subsidiary GCE **AS 3888**

Report on the Units

June 2007

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REPORT ON THE UNITS

PHYSICS B Advancing Physics

Introduction by the Chief Examiner

The performance of candidates on the papers in this, the June 2007 session matched closely with performances of the previous year's cohort in June 2006. As has become the norm with Advancing Physics, the different ways of being good at physics were again amply demonstrated across the range of the papers. Superb Research reports were matched by innovative practical Investigations, and performances on the written components reached remarkable heights. Detailed reports by the Principal Examiners and Principal Moderators on each component of the examination follow below.

Report to Centres on 2860 Physics in Action June 2007

The paper was felt by the examiners to be of appropriate difficulty, and showed good differentiation, similar to previous seasons. Because of some novel and challenging questions in section B it was less accessible than previous papers and consequently the facility was slightly lower. Examiners felt that some of the difficulty was of the candidates' own making; some appeared not to read the questions carefully enough, and so were not capable of answering the contextual questions with enough clarity or depth. In several places, others seemed not to have grasped what they had been asked to do, and there was little evidence of any checking by candidates of their answers. A significant minority were rather careless with their handwriting, sometimes to the point of illegibility.

In section C where candidates can exercise their own choice of example, there is a great opportunity to demonstrate quality of written communication [QoWC] through some good explanations and descriptions, but too many candidates are still missing this opportunity. The standards of QoWC appear to be deteriorating. The section C topics were fairly routine (imaging and sensing), so that it was disappointing that some candidates and Centres appeared not to have prepared their examples well, or in some cases at all. In contrast, other Centres over-prepare candidates, who all offer a standard answer that has not been adapted to the particularities of the question asked. Many diagrams, particularly circuit diagrams, were drawn in ink, so that mistakes scribbled out were not merely untidy but often left the intended answer unclear.

SECTION A:

Q1 on mechanical property definitions.

Almost all correctly identified the definition of brittleness, but strength and stiffness were often confused. Many candidates found it hard to recognise definitions of these material properties, even when given them in the question. Several gave overly bland definitions for plasticity; a common error was to just quote 'plasticity' or 'plastic deformation', which did not earn the mark, for which the idea of permanent deformation was required.

Q2 on handling experimental uncertainty values in a calculation.

a) Most candidates were able to perform the conductance calculation correctly but many lost the mark believing that 1 S.F. or recurring decimal (infinite S.F.) was appropriate for the answer. (S.F. was only penalised once in this question here in part a)

b) Most were able to calculate the maximum conductance correctly; using the largest current and smallest p.d. values as specified in the question.

c) A majority managed to find the difference between their two answers above. Some worked out the lowest value (good), but lost the mark by quoting the full range rather than the ± range as the uncertainty.

Q3 was on unit knowledge (from GCSE).

Candidates prepared to think the question through generally got full marks here, if they did not know the answers by rote. Many good candidates wrote down defining equations and predicted the unit equivalents. The W as $J\ s^{-1}$ was the best known and predictably the V as $J\ C^{-1}$ was the least well known of the unit equivalents.

Q4 on describing the effect of mean and median on a portion of an image including an edge and a random noise pixel.

a) Hardly any failed to get the mark for showing how the mean is obtained. Most described the appearance of image sections (b) (i) and (ii) well enough to get the marks. Sadly, many correct answers missed the point about the different effects on the noise of the two processes (mean spreads the noise and smoothes the edge, whereas median eliminates noise and maintains the edge). However some candidates clearly didn't read this question carefully enough and only explained the calculation to get the values, or gave a direct description of the pattern of numbers.

Q5 on the curvature of wavefronts and the optical power required of a correcting lens for a long-sighted person.

With few exceptions, most knew what to do for full marks, or had no idea and tied themselves in knots with the lens equation. The question scored well, but most candidates gave positive answers for the diverging wavefronts, which was not penalised; however answers with negative values for the corrective lens power were penalised. Many who got the first two values incorrect were still able to get the third mark ecf by finding the difference between their first two values.

Q6 on total internal reflection and the Critical angle.

This was answered well by some candidates, others seemed to be drawing on inadequate GCSE knowledge. a) Many were able to get the mark by mentioning total internal reflection or incidence at greater than the critical angle. b) Many candidates had no idea about the equation $n = 1 / \sin C$. For those who knew the equation it was an easy couple of marks. The most common error was to treat the refractive index of water 1.33 as appropriate for the direction of propagation from water to air (instead of 1 / 1.33) and to calculate that C = 35 ° using Snell's Law. Those who calculated sin r = 1.02 (impossible but worth a mark), rarely went on to say that this meant that C must be lower than 50 °. There were not many who found that if C = 50°, the refractive index was 1.305, and therefore C ‹ 50° for the second mark by this route

SECTION B:

Q7 on information storage on a CD.

a) Many candidates counted tracks rather than gaps and divided the 8μm by 6 rather than 5 and therefore made a significant systematic error, which cost them the first mark. Most recovered in part ii) and got the second mark by making sensible reference to the size of the laser spot. Most candidates could also show that CD track is longer than 5 km in part iii). Here weaker candidates tried to divide the number of bits by the separation, and some forgot to convert bytes to bits.

b) Provided good differentiation, with the majority getting a justified ratio of 2:1 as the answer (scoring 2/3), usually by stating that "bits could be separated by half the distance." Only a few candidates scored the full 3 marks here, realising that the tracks could also have half the separation leading to the correct ratio of 4:1.

c) This part brought a variety of responses and a good spread of marks, with most candidates scoring something. Weaker candidates lost marks: by trying to use more familiar ideas about transmission of data (rather than storage), describing resilience to noise or merely stating an advantage and / or disadvantage without justification and lost marks.

Q8 on the properties of an LDR.

a) Most candidates realised that light intensity = P / A from the units given.

b) Many candidates could describe the nature of a log scale in i), the most common mistake was vagueness, just saying that the scales do not go up evenly. There was a mixed response to part ii) – many read the 5 correctly from the log / log graph but forgot the k multiplier with the Ω unit. More candidates got c i) correct, and many got the correct units too, which was pleasing. Most also got ii) correct which was very pleasing.

d) This was marked as a scientific comprehension for restating in their own words the fate of the excited electrons in the LDR semiconductor. It was well answered, the most common error being to refer to the photons lasting in the LDR rather than the electrons.

e) This part was poorly answered, even by the better candidates for whom it was designed. They simply were not quantitative enough in their explanations (which the question demanded), or restated the question, or were far too vague. Good candidates should be encouraged to give quantitative explanations whenever possible, as they are more rigorous and will command more credit.

Q9 This novel question on an electrical nanoswitch was probably the best answered in section B. It was refreshing that most candidates were not phased by the novelty of the material and thought it through and answered sensibly.

a) Most candidates correctly calculated the charge on 30 silver ions. In part ii) most candidates scored one of the two marks usually for stating that the scale of the switch was in nanometres (10^{-9} m), but not describing what was meant by switching action. Some got the switch mark but not the scale mark; only a few got both marks. A point for note is that for a 2 mark question, two distinct points need to be made, and credit will not be given for restating key words without further explanation.

b) Most candidates got the marks in i) for correctly reading 2 nm from the graph, and divided by atomic diameter to get the number of layers (7), non-integers for the number of layers of atoms were not penalised. Some candidates scored the subtle mark for part ii), that subsequent layers in time contain more atoms and would take longer to build up. But several thought that the deposit was getting narrower with time. A majority of candidates also said that the switching time would be shorter or quicker in part iii), although other sensible answers like it would require less voltage or energy to switch were also credited.

Q10 This question on resistivity applied to a strain gauge proved a more significant discriminator than anticipated.

a) Sadly a large minority of candidates were unable to recall the required resistivity equation (and could not work from the conductivity equation given) for part ai); and consequently were unable to correctly calculate the length of wire in part ii).

Only about half the candidates were able to give a sensible reason for the chosen construction of the strain gauge such as compactness or better sensitivity.
b) Part i) tested algebraic skills well, but those who had put the incorrect equation down in part a) tended to get confused, but could still get one mark for getting as far as the substitution A = V / L for constant volume. In ii) most realised that resistivity had to be constant for the argument to work. Only a few very sharp candidates got part iii) by calculating the new resistance for a length increased by 0.3% and showing it to be 0.6% higher. Very few were able to use the relationship $R \propto L^2$ that they had derived to work it out by $R \propto (1.003)^2 = 1.006$.

SECTION C:

Q11 The most common imaging systems described were the digital camera and the ultrasound scanner.

a) The descriptions and diagram were of varying quality, but were more often rather superficial. Most scored 2 or 3 marks for part aii), but a significant minority failed to produce any diagram as instructed in the question.

b) There was also a wide range of answers for part bi), understanding physical resolution remains a problem. Many candidates incorrectly put the number of pixels or pixels per mm for the resolution. A minority of candidates put the correct units and most of these went on to put a correct order of magnitude also. Part ii) on how to improve resolution was poorly answered, with very vague language. The most common misconception remains increase the pixels for increased resolution rather than pixel density.

c) This part was answered rather better, with most candidates putting something sensible down, many gaining the 2 marks available. Here the second mark was commonly lost for describing a benefit of a second different imaging system. For example 'ultrasound scans are very useful for sexing babies in pregnant women and looking for fish' only scored one of the two marks available!

Q12 Most candidates sensibly used a circuit with a potential divider and were able to describe how the sensor worked.

ai) Only the weaker candidates had difficulty here, by not mentioning a suitable physical variable. Common incorrect answers were heat rather than temperature and light rather than light intensity. In aii) and iii), simple potential divider circuits gave candidates less trouble than more complicated bridge circuits with amplifiers. A significant number of candidates lost marks by being sloppy when drawing circuit diagrams. For example, the symbol for a fuse was not acceptable as one for a fixed resistor. There were a few who only used a simple circuit and expected the pd to vary significantly across the single component. Some were rather vague about the direction of change that the pd or resistance would make, and limited themselves to 1 mark maximum in part ii). There was also evidence of the new misconception that as a sensor's resistance varies in a potential divider, the fixed resistor's resistance also varies to keep the total resistance constant.

bi) Was poorly answered – most candidates did not mention the time for the output to settle to its new value in their description of response time. They were also very vague about linearity, many confusing it with proportionality, rather than the existence of a straight trend line. In ii), most were able to earn 4 or 5 marks by describing the calibration process. The most common omissions were forgetting to mention the calibrating thermometer or lux meter to measure the physical variable, or to check that the calibration graph was a straight line.

Report to Centres on 2861 Understanding Processes June 2007

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, but the quality of answers in this section was very varied across the entry as a whole. Total marks obtained by the candidates were distributed across the full range of marks available, around a mean mark of 58/90 with a standard deviation of 16.4.

Section A

This section was generally completed well, with the better candidates scoring up to and including the maximum mark available.

Question 1 involved selecting the graph that would be obtained when specified variables were represented on the y and x axes. The most commonly occurring incorrect answers for parts (a) and (b) were B and C, respectively. In question 2(b) an encouraging number of candidates correctly converted from m s^{-1} to km h^{-1}, but a significant number seemed insecure about the meaning of the unit ‘nm’ and were unable to identify the number that was the best estimate for the wavelength of green light in part (a). Question 3 proved to be quite friendly to the candidates who puzzled out what was going on quite effectively. A ‘unit penalty’ [1 mark deducted] was given to any candidate omitting the unit of the phase difference from both the answers in (a) and (b). Question 4 proved challenging to all but the better candidates. Weaker candidates were quite incapable of giving a physical justification for the equation in line 1, but most were successful in calculating the tension in the wires in (b). Part (c) worked well in providing early evidence of the identity of the stronger candidates. In question 5, it was pleasing to see that candidates across the ability range are now demonstrating the skill of arithmetical testing with considerable facility. Question 6 discriminated well – giving an early opportunity for some to display uncertainty in converting quantities to S.I. units, and for others the opportunity to show a weakness with simple algebraic manipulation. Question 7 was well answered by a majority, but again arithmetic manipulation of $v = s / t$ to obtain $t = s / v$ was too high a hurdle for a significant minority.

Section B

Question 8 This question was about standing waves in air.

Many candidates were able to correctly identify the positions of nodes and antinodes on their diagrams, but there were a surprisingly large number of incorrect wave patterns. In part (a)(ii), candidates were allowed to carry an error forward [ecf] from an incorrectly drawn diagram and gain the mark here for an internally consistent answer. Part (a)(iii) was very well done by a majority of candidates, and in (a)(iv) the answer was calculated by dividing the answer to (a)(iii) by that from (a)(ii), [ecf] applying again. It was very pleasing to see that a substantial number of candidates showed considerable application and determination in successfully getting to the bottom of 8(b)(ii), having sailed through the calculation in part (b)(i).

Question 9 this question was about the behaviour of quantum objects.

Most candidates were able to secure at least one of the two marks available in part (a)(i) by showing the method being used to calculate the energy of a photon, the second mark being reserved for evidence that the calculation had actually been done. All seemed able to engage with the question posed in (a)(ii) though many were unsuccessful in securing marks for their answers. It was pleasing to see the number of candidates showing that the value 1.8 x 10^{-18} J came from the calculation 2.2 x 10^{-18} – 4.0 x 10^{-19} but it was only the strongest candidates who were able to argue convincingly that the maximum kinetic energy of the electrons emitted would be 1.8 x 10-18 J. Part (a)(iii) only defeated those unfamiliar with the expression for kinetic energy or those who clearly struggle with algebraic manipulation. Part (b)(i) provided a simple calculation and an opportunity to see that the wavelength associated with these electrons was just a little smaller than the interatomic spacing of 4.0 x 10-19 J. However, in the concluding part of the question, it was rare to see a coherent argument presented as a suggestion for the existence of a diffraction pattern on the far side of the foil.

Question 10

This question was about skydiving from high above the surface of the Earth.
In part (a) the calculation to show that it would take about 34 seconds for the skydiver to reach the velocity of sound was competently performed by a majority of candidates. Some elected to deploy a reverse argument, calculating the speed reached after 30 s of freefall and showing it to be less than 330 m s^{-1}. Both approaches were, of course, perfectly acceptable. The significance of the area under and gradient of a velocity-time graph seemed to have been well learned, and most candidates secured the two marks available in (b)(i). A little more detail was required in the answers to part (a)(ii) where candidates were required to translate information from the graphical representation and describe the motion depicted. As elsewhere in the paper, the quality of the descriptive work was disappointing in many cases. In part (c) candidates were required to apply their knowledge and to construct an explanation of the effect described. Those who successfully unpicked the problem highlighted the deceleration of the skydiver as producing a relative velocity which, observed from the point of view of the camera, appeared as an upward acceleration.

Question 11 This question was about wave behaviour

Part (a) was generally well answered, and it was pleasing to read so many credit-worthy explanations of the meaning of the term ‘wave superposition’. Good answers were produced by many in parts (b)(i) and (ii), but (b)(iii) proved to be more challenging. The concluding part of the question required candidates to relate the observations made with water waves, as described in the earlier parts of the question, to the production of an interference pattern when light passes through a grating. Weaker candidates having selected n□= d sin□as the appropriate formula then proceeded to suspend reason and plug in d = 800 as a conveniently handy number to use. A less costly mistake was to fail to use the appropriate S.I. unit for the spacing, and to use d = 1 / 800 in the formula. But there were many completely correct answers seen with candidates demonstrating secure scientific comprehension of the physics.

Section C

The two questions in section C invited candidates to choose the contexts for their answers. In question 12 they were asked to write about a method of measuring the distance to some remote, inaccessible object, and in question 13 to describe and explain a phenomenon in which quantum behaviour is important. Once again, in this session, many excellent answers were seen giving full details and explanations of impressive depth and clarity.

Question 12.

This question was answered very well by a majority of candidates. Many diagrams were well drawn and appropriately labelled, and the descriptions of how the method worked, and how the data could be used to find the distance involved were of a pleasing standard in many cases. Once again, a minority of candidates demonstrated that they had done little preparation for this section of the paper and sacrificed many valuable marks as a direct result.

Question 13.

Many different and interesting examples of quantum phenomena were chosen by candidates this year. It is pleasing that increasing numbers of candidates are being encouraged to follow their own interests and research their answers thoroughly. Phenomena described included electron diffraction, double slit interference, light emitted from a LED, the photoelectric effect, and line emission spectra. The examiners were looking for real world examples of quantum phenomena and not for illustrative models of photon movement involving trundle wheels rotating along paths drawn on sheets of paper. Some candidates successfully described and explained refraction of light (just one of many examples of quantum behaviour) in terms of photons taking the 'quickest' route and large resultant phasors for paths close to the one observed. Others successfully explained single slit diffraction of light using a trundle wheel model. The point is that candidates are encouraged to use rotating phasor models to explain the observations of the quantum phenomenon that can be made with the apparatus they have described, where appropriate. The theoretical model is not the same thing as the quantum phenomenon for which it can be used to provide an explanation.

Report to Centres on 2862 Physics in Practice June 2007

The vast majority of centres should again be congratulated on the manner in which they have set, marked, transcribed marks and posted coursework to moderators. The whole process is time consuming and moderators do appreciate the way in which centres manage, in the main, to do everything correctly. In general the work produced was of a similar standard to that of recent years.

So saying, moderators have noticed a disturbing trend in the increase in the number of arithmetical mistakes in totalling candidate's work and an increase in the number of centres whose marks were adjusted because of inappropriate marks being given. Some of the most common points where marks were often given when centres should have withheld them are as follows: the non-submission of plans in both the Instrumentation and the Material Presentation tasks; the heavy use of Wikipedia without verifying the information elsewhere or specifying the exact web reference, no paper record of talk notes and illustrations being not of a 'scientific' nature in the Presentation, no written evidence of safety and no fitness of purpose in the Instrumentation task; and poorly drawn graphs, especially using computer software packages, in the Data task. Quite often this adjustment of marks occurred to centres that had been warned in previous years about their marking being fairly generous and near to the maximum tolerance allowed by OCR. Centres should be aware that when adjustments take place the minimum adjustment will be by nine marks and this can appear to very severe to individual candidates.

One specific plea from moderators was to ask centres not to place the individual coursework reports in polythene packets because it is so time consuming to remove and replace the work in these packets. The A3 sized GWC coursework folders are more than capable of holding each task and the board provide sufficient of these folders for there to be one per candidate per task.

In the hope of raising the expectations of more students the remainder of this report is aimed at pointing out what a moderator would expect to see from a high scoring (grade A) candidate.

Instrumentation Task:

A good candidate will produce a well written report that starts with a plan, often using the proforma from the Advancing Physics website (*www.advancingphysics.iop.org*), the sensor being placed in a real context. The choice of project will usually involve using a potential divider circuit. The report will be complete in all aspects, not only explaining the Physics of the potential divider but also showing calculations on how each component and its magnitude was chosen. The practical work will have been carefully carried out and there will probably be some centre annotation stating this fact. The report will contain specific sections on how the experimental work was carried out safely and on any problems that were overcome (eg background lighting for LDRs).

The table of results will have columns with quantities and units, the readings will be taken methodically, all will be to the same number of significant figures throughout, the actual observations or raw data will be present and at least one set of repeat readings will be carried out, although more than likely two sets of repeats will be done. The candidate will identify anomalies in the readings and deal with them, possibly by ignoring certain observations but he/she will not just average all readings. When using these results to produce graphs then only the average graph will be drawn, not the first set, the second set and then the average set – this only fills up paper.

The graphs drawn will be at least A5 in size, and have both vertical and horizontal grid lines. The axes will have sensible scales and be labelled with both quantities and units. The points will be small but visible and a line or curve of best fit will be drawn. Thought will have been given as to whether the graph is a straight line or curve and computer generated graphs will not show straight lines on graphs that are obviously curved. Good candidates will have more than just a passing familiarity with the EXCEL graph-plotting package.

Finally, for this task, high scoring candidates will quantitatively work out at least two of the qualities listed under fitness of purpose, normally using their graphs to help them in this process.

Research and Presentation Task:

High scoring candidates will tend to look at materials that are slightly more adventurous than the norm and will start with a title that has both the material and a use of the material in the title, this immediately gives the presentation both a focus and a context. There will be a plan detailing what is to be done. There will be a range of at least five different, reliable sources that will not include GOOGLE which is a search engine or Wikipedia unless this is verified from other sources. Internet sources will give references down to the web page and book sources will give references down to title, author, publisher and page. If references are given to this amount of detail then there is no need to print pages and pages off the internet as proof of research carried out. Reference to these sources will be made within the presentation, for example by numbering the sources and embedding these numbers on say the slides of a power point presentation or the different parts of a poster.

The presentation will show a good knowledge of Physics with calculations where and if thought to be necessary, it will not be simply a list of facts, one way of looking at this is by asking the question “Are candidates showing sound judgement in the choice of information chosen?” Similarly, the illustrations used will enhance the Physics of the presentation and not be there just for effect. The candidate will have carefully structured the presentation so that it flows easily from one point to the next with connections between slides (if a power point). The information about the material will be detailed, relevant and coherent whilst the context and properties of the material will be clearly interlinked and developed together. The context will be interesting and challenging.

If the presentation is either a power point or a poster then the slides or the information on the poster will not be too cluttered with words, to overcome this the candidate will provide the talk notes with the hard copy of the presentation, they may even produce a ‘flyer’ with the information for their audience. The printout of the slides will be large enough to be read clearly so no more than two slides per A4 sheet are printed.

It is expected that the centre will provide clear annotations on how the presentation was given, a good candidate will rarely read from the slides and will also be able to answer questions from their audience; moderators will only know this if they are told by the centre.

Making Sense of Data Task:

In this task the high scoring candidate will work independently and give a considerable amount of critical thought as to what to calculate and plot. More than likely the candidate will approach the data from more than one direction, thus for a trolley rolling down an inclined plane the candidate will look at forces acting on the trolley, take energy changes into consideration and use 'suvat' equations. It is often worthwhile, in this task, to allow candidates to use the apparatus and take measurements but then give them all an idealised set of data, perhaps with an odd anomaly included, this then avoids the problem of candidates having to deal with a rogue set of data. Opened ended experiments tend to give candidates more opportunity to gain high marks than those such as 'Find g'.

A good candidate will show a high degree of ICT skill, not only in word processing the whole report including diagrams but in handling data in tables and drawing graphs. The comments made earlier about tables and graphs in the instrumentation section are even more applicable for this task.

The written account of the experiment will allow a reasonable person, with no idea of the experiment, to be able to carry out the experiment without any other help and produce a similar set of results. The final report will show a clear analysis of the data leading to definite conclusions that fit the evidence and are consistent with basic physical ideas, these conclusions will be generated from interpretations of the graphs and tables produced by the candidate and not just from the raw data. The report will show a good appreciation of the uncertainties within the data.

Report to Centres on 2863/01 The Rise and Fall of the Clockwork Universe June 2007

The paper produced a good spread of marks. The mean mark was about 41 out of 70 and the standard deviation 13. The mean mark for this paper was lower than June 2006 by two marks out of seventy.

There was little indication that candidates ran out of time although some of the scripts were incomplete. The examiners concluded that incomplete papers were due to the weaker candidates finding some questions difficult rather than a problem with time.

The quality of written of communication shown by some candidates was a little disappointing; the examiners rated more scripts at two marks out of a possible four than is usually the case.

Once again, the quality of work at the higher end was most impressive, but nearly all papers had some work of a pleasing standard. It was possible to see the progression from AS level work to A2 standard work in the majority of the scripts and it was encouraging to see candidates handling relatively subtle concepts with confidence and precision.

Lower scoring candidates missed out on some 'show that' marks. It is useful to encourage candidates to show clear and complete working at all times rather than jumping to the answer without showing the route taken. Similarly, 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.

Comments on Individual Questions:

Section A

This section produced the full range of marks although was perhaps more challenging than has been the case in the past. This was in part due to the choice of topics for the short questions.

Question 1, which was about a capacitor was well answered by many. This was standard physics but required quite a bit of work for each mark.

Question 2, which required estimation from a graph of gravitational field strength against distance, was one of the most challenging questions on the paper and many candidates made no attempt at part (a). Although this was a ‘show that’ question it was clear that many candidates did not know that the area between the line and the axes on the graph represented change in gravitational potential. More surprising was the difficulty candidates had in using the given change in gravitational potential to calculate change in gravitational potential energy of a given mass. Weaker candidates reverted to GCSE knowledge and used the equation *gravitational potential energy = mgh*. These candidates took g to be 9.8 N kg^{-1}.

Question 3, using ideas of specific thermal capacity, was answered with confidence by the majority of the candidates. The most common error was to miss the point that the temperature of the milk changed by 65 ^oC.

Question 4 was about the ratio *E/kT*. This was well answered by most candidates but some lost marks in part (b) by not comparing *E* to *kT* with sufficient clarity.

Questions 5 and 6 were both standard calculations and were answered with confidence.

Section B

The longer questions in this section proved quite discriminating although most candidates attempted all questions.

Question 7
This question was about some of the physics of the rocks constituting Saturn’s rings.

Part (a) proved accessible to all except those candidates who did not state which side of the ring was moving away or toward the Earth, in other words not *showing* understanding of redshift.

Part (b) required simple arithmetical work and was answered well by most candidates. Recall of the equations for centripetal force and gravitational force was unproblematic.

Part (c) also proved accessible and the majority of candidates set out the algebra with clarity and therefore earned both marks. Some candidates attempted to show this by calculation. This was not given credit.

Part (d) was a little more discriminating. The majority of the higher scoring candidates gained full credit for this part but there was some muddled thinking evident amongst the lower-ranked responses. Such responses as ‘velocity is equal to the square root of 1/r’ were common from poorer candidates. This lack of precision in mathematics and explanation would cost them a number of times in the paper as a whole.

Question 8
This question was about the physics of radioactive decay and alpha particle emitting smoke alarms.

Parts (a), (b) and (c) were answered with confidence by the vast majority. These questions were all standard arithmetical problems that the candidates will have come across many times in the course.

Part (d) was a little more discriminating. This required an understanding of the limitations of using the equation $\Delta N = -\lambda N \Delta t$. Good candidates gained both marks by realising that the activity would change little over 5 years but much more so after a few hundred years because of a significant change in N.

A common error amongst weaker responses was to state that the decay constant would only be constant for a short period of time, implying that it is the changing value of λ that limits the use of the equation. Very poor responses trawled pre-GCSE knowledge and suggested that the equation works for an 'average' value which ceases to apply when the time passed becomes a significant factor.

Part (e) produced a range of quality of responses. Only the better candidates realised that there two points had to be made – that five years is much shorter than the half life so that the activity will not be far different from the original, and that there must be another reason for changing the detector. The examiners expressed some surprise that these two points were not more commonly seen as the question expressly stated the two aspects.

Weaker candidates often suggested 'changing batteries'. This showed that they had not read the question with sufficient care as it stated that the *detector* might need replacing.

Question 9
This question about diffusion was more discriminating than questions 7 and 8.

Part (a) required the candidates to use an equation given in the question. The majority achieved this but a minority forgot to convert temperature in degrees celsius to kelvin.

Part (b) considered the distance travelled by a particle as it moved 0.1 m up the tube. Most candidates managed to calculate this correctly and go on to the second part of the question in which they calculated the average number of collisions made by a particle as it moved 0.1m up the tube. The calculation yields very big numbers but this did not put the candidates off. Most candidates chose to use simple arithmetic for this but the answer could also be reached by considering the physics of the random walk.

Part (c) required candidates to consider the effect on the rate of diffusion if the bromine were replaced with a gas of less massive particles. A common error was to consider that less massive particles would be much smaller and therefore collide less frequently with air particles. However, most high-ranking candidates identified that the lower mass particles would have greater mean speed at the same energy.

Question 10
This was the most discriminating question and many candidates struggled with the later parts. This is an area of the course that many find difficult and is often taught at the beginning of the A2 year. There seems to have been some evidence to suggest that candidates did not prepare this area as thoroughly as other areas. The evidence for this is that weaker candidates struggled to gain marks from the introductory parts of the question which were relatively straightforward.

Part (a) proved accessible for about half the candidates. There were some spurious examples of arithmetic in (a) (ii) in which candidates worked around to get a value near the given value through a number of routes that bore no resemblance to the physics of the situation. Weaker candidates failed to gain marks on (a) (iii) because their answers were too vague – 'all forces are balanced' is an example of such vagueness. The statement is not incorrect but neither is it explanatory.

Part (b) required an understanding of a force-distance graph. The first sub-section was straightforward and only gave problems for the weakest candidates. The second sub-section was more challenging. Candidates needed to identify that gravitational potential energy was transferred to kinetic energy and elastic strain energy. This made the question more discriminating than usual questions in which objects fall and gain kinetic energy alone. Once again, good candidates managed this relatively easily either by taking the correct area from the graph or by performing calculations involving gravitational potential energy, kinetic energy and elastic strain energy. As this was a 'show that' question the examiners had to read a number of inventive but incorrect methods of reaching the given value.

Part (c) was not well answered even by strong candidates. The question required a clear definition of simple harmonic motion so that the candidate could then go on to compare the motion of the ball to s.h.m. Such a definition was lacking in all but a small proportion of responses. Those candidates that did attempt to define s.h.m. often omitted to state that the acceleration of the oscillator is always towards the equilibrium point (acceleration proportional to – displacement). A greater proportion of the candidates explained that the graph showed this relationship over a given range of values. These candidates gained credit for this but it was disappointing that more did not score full marks because it was apparent that their physics was secure but they were not used to setting up explanations of the length and depth required by the question.

Part (d) proved more accessible. A common error was to use the equation for acceleration of a simple harmonic oscillator with the wrong value for amplitude. However, most candidates simply calculated the time period and took the reciprocal to find frequency or recalled the equation for the frequency of a mass on a spring.

As stated in the general comments, the marks for quality of written communication were a little lower than usual. This may have been because this area was assessed on slightly more discriminating questions than has been the case in recent sessions. It is difficult to write with clarity about misunderstood areas of the course.

Report to Centres on 2863/02 Practical Investigation Coursework June 2007

There was an entry of approximately 2700 Candidates from 290 Centres in the June session. Moderators again noted a further increase in the number of Centres that missed the deadline for submitting reports or MS1 forms.

Having seen a broad spectrum of the work done, the consensus view of the Moderating teams is that many Centres are expecting too little of their Candidates and the challenge presented by many of the tasks undertaken is really below that expected at the A2 level. For example a rehash of the AS Data Analysis task is unlikely to provide sufficient demand. The specification for this component suggests ten hours lab based work, with a similar amount of time on other aspects e.g. data analysis, report writing etc. Unfortunately too many Candidates are adopting the "set it up, did it, took results, end of investigation" approach. These Candidates essentially perform one experiment with no extension or appropriate development at all and should not have access to the higher ratings in strand B. Appropriate development is not to be mistaken for repeating the same experiment with another piece of wire, plastic bag or type of oil etc. An investigation that can only illustrate its findings in the form of a histogram is unlikely to be of a standard expected at the A2 level. Frequently Candidates are uneasy about what they have achieved and much of their discussion centres on what they would have done given more time, which raises the question: "was the time available usefully filled?" The scarcity of results forces many Candidates to bulk out their reports with extensive textbook or internet derived preamble, empty tables of results to illustrate what results will be taken, the inclusion of numerous graphs all displaying, in essence, the same information in a reworked manner, enormous quantities of computer data print out and Excel generated equations with no attempt to interpret the physics involved.

One of the cornerstones of the Physics B investigation is that each Candidate's work should be demonstrably independent. Increasingly Moderators' reports to Centres express concern over the number of similar topics used for investigation. Often the same experimental set up is used by a number of Candidates and it is only the slightly different results obtained that just about avoid accusations of malpractice.

Fortunately there is still a strong core of Centres whose staff monitor their Candidates' work from the outset and avoid the above problems. Their Candidates follow best practice. The work comes simply stapled at the top left, with continuous pagination, a title in the form of a question, embedded references, decent sized graphs with grid lines, a simple diagram of the initial experimental set up and tables of results with headings, consistent decimal places and acceptable significant figures. Most importantly the work is driven by a concern to explain and the analysis of one set of results suggests the next stage. The analysis is competent and the discussion centres on the Candidate's findings. In short a good read.

Report to Centres on 2864/01 Field and Particle Pictures June 2007

General Comments

Although the paper proved to be slightly easier than in previous years, there was no significant difference in the way that weak candidates were losing marks. As with previous exams, candidates would routinely select and apply an incorrect formula from the data sheet, fail to take enough care and attention over the sketching of graphs and trajectories, forget to include appropriate powers of ten in their calculations or omit to answer all of the question. However, it was good to find that many candidates wrote sensible answers to all of the questions, although not always earning the marks, suggesting that they found the paper accessible. There was no evidence that candidates ran out of time.

The paper had the same structure as in previous years. Nine short questions in Section A, testing small parts of the specification, at a variety of levels of difficulty. Four longer structured questions in Section B, each testing candidates' understanding of part of the specification in depth. In general, the Section B questions aim to have a gradation of difficulty, so that only candidates operating at grade A or B can earn most of the marks. Nevertheless, weaker candidates were unaware of this and often continued to supply answers for the hard parts without realising that they were earning nothing.

The comments which appear below refer to the performance of the majority of candidates who were operating at grade E or above. It seems pointless to comment on the performance of candidates who were clearly unprepared for the exam, guessing their way through the questions and picking up marks at random.

Comments on Individual Questions

1 The first question on this paper is always about units and quantities. This module is not short of quantities with names which can be easily confused, in both the domains of electricity and magnetism. Many candidates confused the unit of electric potential with that for electric field strength, but the majority correctly identified Wb m^{-2} as the unit of magnetic flux density.

2 Questions which require candidates to sketch paths of particles scattering off a nucleus are set at regular intervals, so they should have had plenty of practice at perfecting this skill. Although the vast majority of candidates realised that reducing the kinetic energy of the particle resulted in a path which kept it further away from the nucleus, only a minority

were able to sketch a path with the correct symmetry and an increased overall deflection. There was no evidence that candidates were using guide lines to construct their sketches. This was surprising, as the path is very difficult to draw by eye without some initial decision as to the final path to be followed.

3 This question was a straightforward calculation of the electrical force between two charged particles, and many good candidates earned all three marks. As ever, a significant proportion of candidates were unable to correctly calculate a quantity involving an inverse square. Providing they had written down the calculation before entering it into their calculator, they could still earn most of the marks. However, too many weak candidates copied the formula for electric potential from the data sheet and earned nothing.

4 This question was well answered by the majority of candidates, suggesting that they had a good understanding of not only the behaviour of flux in iron rings, but also the different meanings of the terms flux, flux density and flux linkage.

5 Very few candidates earned both marks for part (a). Although the vast majority could earn a mark for their knowledge of the physics of beta particles or gamma photons, most omitted to mention the nature of the risk they posed for humans i.e. cancer or cell mutation. For the calculation of part (b), a surprising number of candidates used the information provided to calculate the original number of atoms, worked out how many atoms would be left undecayed 56 years later and finally re-calculated the activity of this sample. It would have been far simpler for them to use $A = A_0 e^{-\lambda t}$ or $A = A_0 (0.5)^{t/T_{1/2}}$ directly. As expected, weak candidates often failed to notice that the activity was given in kBq instead of Bq.

6 Most candidates had little difficulty correctly identifying the correct graphs for binding energy and electric potential.

7 It was depressing to find so many weak candidates identifying *E* as energy instead of electric field strength, with *V* interpreted as velocity and *d* as displacement. A significant number of candidates did not appear to realise that the formula only applied to a uniform field, as found between parallel conducting plates.

8 Unlike previous years, most candidates were able to calculate the risk correctly, with only a minority getting confused over the meaning of percentage. Candidates who expressed their answer as a decimal instead of a percentage (0.024 instead of 2.4% could earn full marks).

9 It was expected that many candidates would lose the second mark for the direction of the electric field, but this was not the case. Not only were most field lines drawn perpendicular to the equipotentials, they pointed correctly in the direction of decreasing potential.

10 This was the first of four longer structured questions in Section B. Although it was not expected that candidates would have been familiar with the diagram of part (a), it was depressing to find that only a minority of candidates knew that the other nucleon could only be ${}^{1}_{0}\text{n}$. The mythical particle ${}^{8}_{3}\text{p}$ was a very popular incorrect response. Many candidates had little difficulty with part (b), correctly explaining why a proton had to contain two up quarks and a down quark, and a surprising number also correctly identified the quark-antiquark pairs which make up a π^0 meson. Part (c) was a standard calculation of the binding energy per nucleon of a nucleus, in three stages. It is distressing to find that even at this stage in their physics education, candidates cannot correctly extract the number of protons and neutrons from the symbol for a nucleus. Candidates who rounded up their answers to intermediate calculations of nuclear masses often lost a mark - it is important in this type of 'show that' question that candidates write down the answer to their calculation with at least one more significant figure than is provided in the stem of the question, just to show that they have performed the calculation. The last part was intentionally harder than the others, requiring candidates to do three things - convert mass to energy, convert joules to electron volts and then divide by the number of nucleons. The last step was omitted by many weak candidates. Part (d) explored candidates' inadequate understanding of binding energy. Too many of them still think that energy is required to bind nucleons together, and that separating the nucleons somehow converts that energy into mass.

11 Many candidates earned a lot of marks for their responses to this question. Only a few were unable to earn both marks for part (a), often because they didn't draw a line, as instructed, all the way from the source to the detector. Part (b) required candidates to derive a formula for the momentum of alpha particles moving through a magnetic field. Although this question has been asked many times before, many candidates still fail to show clearly the order in which their starting equations are combined. The usual convention is that processes flow from left to right or top to bottom. Many candidates risk losing marks by putting stages in random locations on the page. Although the vast majority of candidates could explain why one particular value of field strength resulted in a large detector reading, only a minority realised that the small readings at other field strengths probably came from background radiation. The final calculation proved unduly hard for the many weak candidates who were treating each part of the whole question as a stand-alone item. They often did not use the equation which they had derived on the previous page, used the field strength of 50 mT mentioned in the stem rather than the 150 mT shown on the graph, or failed to convert mT into T before doing the calculation.

12 Although candidates have become increasingly more adept at sketching flux loops and graphs for electromagnetic devices, they are as poor as ever at doing magnetic calculations. So for part (a) only a small minority of candidates failed to draw a complete loop through the iron core and did not know about the effects of iron in a magnetic circuit. However, for part (b), although their sketch of a flux linkage - time graph was good, their explanation for the shape of the emf - time graph and calculation of the maximum flux in the core were usually poor. Many candidates described the graph, instead of explaining it. Only a small minority mentioned flux change in the coil as being responsible for the emf, or that the flux changed as the magnet rotated. In the calculation, candidates often assumed that the flux went from its peak value to zero once every cycle instead of every quarter of a cycle. However, it was good to find that the vast majority of candidates could explain modifications to increase the emf and discuss the effects of eddy currents in part (d).

13 To earn all of the marks in the question, candidates had to keep the context clear in their minds-eye until the very end, instead of treating each part of the question on a stand-alone basis. So candidates who chose to use $\lambda T_{1/2} = 0.69$ instead of $A = \lambda N$ to calculate the decay constant in part (c)(iii), lost the mark. As ever, weak candidates could not recall the nucleon number for an alpha particle, though almost candidates were able to correctly balance the resulting equation. Part (b) took candidates through the use of a mass spectrometer to deposit a known number of ions on a metal disc. Although sequencing the steps proved to be straightforward for most candidates, doing the calculation was not, probably because it does not require the use of a single standard formula, but two ($I = \dfrac{Q}{t}$ and $Q = ne$) which need to be combined. For part (c)(i), most candidates assumed that alpha particles from the disc either went up or down, rather than in all directions at random. The calculation of (c)(ii) confused many weak candidates who were unsure about how to use the information about background radiation. Some ignored it altogether, while others forgot to double it when they took account of the random direction of alpha particle emissions.

Report to Centres on 2864/02 Research Report Coursework June 2007

In May 2007 about 400 Centres returned the marks of over 5000 candidates for this coursework component of the Advancing Physics course. Most Centres managed to meet the May 15th deadline and a few submitted samples well in advance. Where the number of candidates is small (up to about 15) centres should send all of the scripts to their Moderator. It makes sense to submit the whole sample without waiting for the request from the moderator as this avoids unnecessary delay for all concerned.

There were a number of instances this year where the marks on the MS1 (OMR Mark sheet) could not be read. Centres should ensure that the scores are indicated as a number as well as the usual series of blobs. One of the duties of the moderator is to ensure that the marks have been correctly transcribed from the assessment grids to the MS1 it is therefore essential that they can be read. A photocopy of the front of the MS1 should be provided where the clarity of the copy is in doubt. Some Centres had made slight transcription errors when transferring their marks triggering the receipt of an amendment form (CW/AMEND). A number of Centres made good use of the latest electronic versions of the required forms from the OCR website. There are several that need to be completed in connection with this work and pre-heading the electronic versions with your centre details obviates the need for much tedious replication.

The most successful Centres encouraged even their weakest candidates to reference their work appropriately. Embedded references continue to mark out the very best reports as do well linked and detailed bibliographies. Reports without a clear focus, not based firmly in the Advancing Physics course continue to characterise the work of the weaker candidates. The need for this piece of A2 coursework to be built around a physics topic of appropriate demand is still missed by some candidates. A number of students insist on tackling subjects without an obvious link to anything in the course. Inter-stellar travel and quantum computers continue to feature regularly as titles despite, I suspect, the best efforts of teachers to dissuade their students from tackling them. The end result is often descriptive and contains little or no physics at all. It is not the intention of the specification to stifle initiative but teachers are well advised to guide their students towards topics that are appropriate for them. The Report title chosen must enable the student to demonstrate a good grasp of the A level physics that it might reasonably be expected to contain. The most talented individuals continue to produce impressive reports on a diverse range of topics.

There were a few Centres sampled in this session where the reports submitted included plagiarism that had been overlooked. In severe cases work was returned to Centres to be remarked in the light of the issues raised by the moderator. It is understood that all students use source material to produce their reports but they are expected to rework it appropriately, selecting relevant material and making it their own. The inclusion of substantial sections of source material verbatim should be discouraged even when it is clearly attributed as such material will not attract any credit. The internet is now the one stop reference library for most students with 'Wikipedia' having claimed the top spot from 'How stuff works' in the last 2 years. This has resulted in essentially the same report from a number of different students for a number of common topics across the country. Wiser students tend to use such sites only for outline material and diagrams and aren't naive enough to claim that they are accurate in their evaluation.

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 their marks.

Some large Centres still seem unaware of the need to moderate this work internally to ensure the consistency of their assessment 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 to the external moderator that this process has been carried out. The best Centres include a short note explaining the details and this is all that is expected.

There were a pleasing number of scripts scoring high marks nominated for prizes by their teachers in this session. The Institute of Physics gives prizes annually to the best 15 reports. Centres can be rightly proud of the high quality of work that they elicit from their best 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 a 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.

Report to Centres on 2865 Advances in Physics June 2007

Once again this year, most candidates had been well prepared for the questions based on the Advance notice article, and scored highly on Section A. Three serious shortcomings commented on last year are still very much in evidence, and bear repeating here:-

- Candidates lose marks by not clearly working out an answer to a 'show that' calculation and just writing out the expression to be evaluated (or even just attempting to manipulate the given data to get a value similar to the required one) and then following by the value given in the question. Showing that about 3000 J of work is done when 1 kg of water falls through 270 m is <u>not</u> shown by

  $$9.8 \times 270 = 3000 \text{ J}$$

  where a convincing answer should read

  $$\text{work} = mgh = 1 \times 9.8 \times 270 = 2650 \text{ J} \approx 3000 \text{ J}$$

- Extended answers in continuous prose still prove demanding for many, so that marks were lost due to lack of clarity in explanations. Examiners all reported their disappointment with the poor use of English by many candidates, giving the impression that some may have had the right ideas, but failed to communicate them adequately. If candidates were to write in correct sentences using proper physical terms, it would help them organise their thoughts and tackle the questions better.

- Many examiners also complained that the poor handwriting and layout of calculations made interpreting some candidates' answers very difficult, and sometimes impossible.

Details of individual questions:

Section A

Question 1 (Joule's waterfall experiment) Lack of clear expression prevented many candidates gaining marks in parts (a) and (b)(i). Parts (b)(ii) and (iii) were well done by most, although explaining the difficulty in detecting a small temperature rise in (b)(iv) was accomplished only by better candidates.

Question 2 (Heat engine efficiency) Many candidates did not seem to recognize that water froze at 273 K and that steam engines required liquid water. An encouraging number of candidates could calculate the efficiency and entropy changes, using the correct □Qs, but only the best candidates realized that entropy must be measured in J K^{-1}. Increasing the efficiency of a heat engine by raising the temperature of the source, or reducing that of the sink was correctly identified by most candidates, with the best answers clearly explaining how this follows from Carnot's equation.

Question 3 (Gas molecules) Part (a) was well done by nearly all candidates. In (b)(i), good candidates recognised that there would be no change in the velocity as the pressure must halve. Other good candidates quoted $\frac{1}{2} mc^2 = {}^3/_2kT$ (kinetic energy $\approx kT$ was also acceptable) and gained full marks with a simple explanation. Only the very best answers showed an understanding of the magnitude of 2^N in (b)(iii).

Question 4 (energy levels) In part (a), a common error was to state that he circles on the energy level diagram actually were atoms, rather than representing the number of atoms at each level. Calculations involving the Boltzmann factor in part (b) were generally well done, showing candidates had been well prepared in the use of exponentials and logarithms.

Question 5 (Evolution of the Universe) Cosmology continues to provide difficulties for candidates, with the mean score on this question being the poorest in the paper. Many candidates were able to cite cosmic microwave background radiation as an observation that the Universe had cooled from an initial hot state in (a)(i), but few could correctly account for the relationship between the wavelength and energy changes from the initial, hotter conditions. In a similar way, a complete explanation the deduction of the expanding Universe from cosmological redshift in (a)(iii) was not often seen. Candidates who were careful in the presentation of their mathematical arguments gained three marks for explaining the changes in photon energies in part (b) easily.

Question 6 (Nuclear fusion) The calculations using the Gas Laws in (a) were well done, although forgetting to square the velocity was a common problem in (ii). In part (b), the energy was read without difficulty but remembering to convert to joules and multiply by the nucleon number proved too challenging for many. The assumptions that were described in parts (a)(iii) and (b)(iii) were rarely correct.

Section B

As in previous years, question B proved more taxing, as candidates had no indication of the topics in this section beforehand. However, the difference between the mean scores in sections A and B was less that in previous years.

Question 7 (Space tethers). This question was marred by a type-setting error in the equation $v = \sqrt{\frac{GM}{r}}$ with the *M* replaced by *m*. Accordingly, in part (b)(ii) where an explanation was sought for the way in which this equation could not apply to the 10 kg mass at the end of the tether, many alternative answers were accepted based on that misreading. In the event, it seemed to mislead few candidates. Parts (a) and (b) did, however, reveal many misconceptions about forces, indicated particularly by the labelled force arrows in (b)(i).

In part (c) the resistance calculation was well done, but the harder calculation of induced emf was unconvincing in many cases, where candidates had clearly just multiplied the data provided to give a value near the 'show that' value; to gain full marks needed justification for the calculation, either in terms of discussion of change in flux linkage per second or a quotation of $\varepsilon = BLv$. One mark from (c)(ii) was reallocated to (d)(ii) to give candidates more credit for what they could do in this question, so these two parts were each marked out of 2. In part (d), most candidates were able to complete the calculations well, but few gained both marks in part (iii) for explaining that the force would slow the satellite and so result in it falling to a lower orbit (The most successful candidates quoted Lenz's Law here.).

Question 8 (Piezoelectric transducers) Calculation of the wavelength in (a)(i) was done well, but explaining fully why the crystal should have a length of ½ λ in (a)(ii) was poorly done; many identified the presence of a standing wave, but inaccurately claimed that the ends of the crystal would be nodes rather than antinodes. The damped oscillation of about 6 periods was accurately drawn by those candidates who had clearly read the instructions – many had not, drawing two or three periods only. In part (b), weaker responses (which gained no credit) failed to realize that the depth of the crack is half the distance travelled by the ultrasound in 25 μs.

In part (c), better candidates were clear in their explanations, drew the loci of possible crack positions as seen from the two detectors in parts (ii) and (iii), and gave clear explanations, mostly illustrated with sketches, of possible three-dimensional displays in (iv). Weaker candidates were more clearly rushed for time on this question and left incomplete answers.

Advanced GCE Physics B (Advancing Physics) 3888/7888
June07 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2860	Raw	90	61	54	47	40	34	0
	UMS	100	80	70	60	50	40	0
2861	Raw	90	70	63	56	49	42	0
	UMS	110	88	77	66	55	44	0
2862	Raw	120	97	85	73	62	51	0
	UMS	90	72	63	54	45	36	0
2863A	Raw	127	97	86	76	66	56	0
	UMS	100	80	70	60	50	40	0
2863B	Raw	127	97	86	76	66	56	0
	UMS	100	80	70	60	50	40	0
2864A	Raw	119	94	84	75	66	57	0
	UMS	110	88	77	66	55	44	0
2864B	Raw	119	94	84	75	66	57	0
	UMS	110	88	77	66	55	44	0
2865	Raw	90	60	54	48	42	36	0
	UMS	90	72	63	54	45	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	25.3	44.7	63.2	78.6	90.8	100	6692
7888	30.6	53.5	73.5	87.9	96.5	100	5132

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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