RECOGNISING ACHIEVEMENT

GCE

Physics A

Advanced GCE **7883**

Advanced Subsidiary GCE **3883**

Reports on the Units

January 2010

3883/7883/R/10J

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Advanced Subsidiary GCE Physics (3883)

REPORTS ON THE UNITS

2824 Forces, Fields and Energy (Written Examination)

General Comments

The experience and maturity of many of the candidates was very evident in the scripts. There were very few weak scripts out of the 180 offered, showing that most had prepared thoroughly for the examination. The questions with the fewest correct answers were Q1(c) about the two pairs of forces involved in the Newton's laws question; the sharing of the charge between the two capacitors in Q3(c); the voltmeter in Q5(b) measuring the speed of flow in the liquid sodium pump; the internal energy of a real and ideal gas in Q7(a). Most candidates answered all questions fully. Very few candidates did not make a full attempt at Q7 and most appeared to have sufficient time to write all they wanted in every question.
Almost every candidate was penalised on the paper for making a significant figure error by giving an answer to only 1 figure where numerical quantities were all clearly given to two or more figures. The standard of presentation was good and most scripts were clear and well presented. There were a few notable exceptions. The standard of spelling in most cases was good.

Comments on Individual Questions

1 **(a)** Candidates lost marks in this introductory part by failing to draw their arrows carefully or to label them with more than a meaningless symbol. Most were able to calculate the difference in the forces when the racket accelerated but gave their answer only too often as 0.1 rather than 0.10 N, losing one mark for a significant figure error. This is only penalised once on the paper. Many went on to make the same error on at least four more occasions.

(b) Very few failed to calculate the speed of the ball correctly and its momentum just before impact. However too many failed to find the change in momentum correctly but still could gain the final mark through the error carried forward rule.

(c) Very few candidates appreciated that the other force of the pair to the weight is the pull of the ball on the Earth. The idea of pairs of contact forces was also not well known.

2 **(a)** Most candidates were able to define the *gravitational field strength*, to write down the algebraic expression and to calculate the mass of the Earth using data from the graph. The most common error was failure to read the scale on the x-axis correctly. In part (iv) it was necessary to state that the line passed through the origin to gain the mark. Anyone who made the same omission in Q4(a)(ii) did not lose a mark for the repeated error. Part (v) was done well with most candidates obtaining a correct answer for at least one of the distances.

(b) Good candidates gained full marks easily but others lost marks through their inability to make their methods clear. For example, appreciating that the mass of the Moon is 81 times less than the mass of the Earth without full reasoning only gained one of the three marks.

3 **(a)** The majority of the answers to this part were correct. Only two or three candidates misquoted the formula. Some only gave the magnitude of the charge to one significant figure.

(b) The *time constant* was well known. A minority wrote directly that 1.2 x 1.2 equalled 1.5 and so failed to gain the mark being penalised for a rounding error. A few misunderstood part (ii) and used $Q = It$ instead of $V = IR$ to arrive at the initial leakage current. Some of these repeated the same calculation in (iii) whilst others gave no answer or an inadequate one. Part (iv) was well done. The common error was not to follow through the argument from finding the value of charge remaining to deducing the value of charge lost.

(c) Very few gave the full argument as to why the charge left on the plates was one thousandth of the original. It was appreciated by most that the capacitors were connected in parallel and that the total charge was constant. However few stated that the reason why the charge is shared in the ratio is because the voltage is the same across both and hence the charge stored is proportional to the capacitance. The lack of understanding was often shown in (ii) with nearly as many answers of 5000 V or 0.005 V as the correct value of 5.0 V

4 **(a)** Most candidates defined simple harmonic motion correctly. Some repeated their answer to (i) in (ii) rather than relating their answer to the straight line through the origin with a negative gradient.

(b) Most stated the amplitude correctly and more than half were able to show correctly and fully that the period is about 0.4 s

(c) Very many candidates gained full marks for this part. Some of the cosine waves were not very accurate but were adequate sketches to be awarded the mark for the shape.

5 **(a)** It was the norm for candidates to score full marks in this part. If they had not already been penalised for a significant figure error then here was another place where 3 N rather than 3.0 N was the common answer.

(b) Most could quote Faraday's law but then were unable to give any realistic detail to justify why the *induced e.m.f*. is proportional to the *speed*. Again in (ii) it was necessary to explain how *flux* is related to *flux density* before a mark was awarded for stating that the voltage doubled. Many confused *flux* and *flux density*. Another common error was to keep a factor of N in the equations showing that no thought had been given to the meaning of the equations that were being quoted.

6 **(a)** Most candidates scored high if not full marks for this part.

(b) Many attributes were given to the symbol N apart from *undecayed nuclei*; for example, *nuclides, nucleons, atoms, molecules*, and *particles*. Few could define the *decay constant* accurately. Most were almost correct but failed to indicate that the nucleus to decay in the next second was a chosen one. In the last part most showed their ability to manipulate exponentials successfully. Again many answers were given as 0.01 rather that 0.11, but this never incurred the significant figure penalty as it had already been collected earlier in the paper.

7 **(a)** Most candidates have learnt a definition for internal energy which was written down, sadly sometimes with important words missing, namely *of the atoms* or *molecules*. Others wrote *of a molecule* or *of particles.* Most were aware that the internal energy of an ideal and a real gas are different but had difficulty in expressing the difference in an acceptable manner to gain two marks.

(b) Some candidates gave excellent answers quoting eight suitable marking points. The most common omission was to discuss the changes in potential energy at phase changes. The most common misconception was to believe that either the kinetic energy was transferred into potential energy or that the potential energy increased as the atoms became closer together. Most of the better candidates gained at least half marks for this part.

The quality of presentation and the standard of writing varied from excellent to average. There were few scripts with poor spelling or lacking in punctuation.

2825/01 Cosmology

General Comments

This is now a legacy examination and the entry of 100 candidates was approximately half that of January 2009. Despite this smaller entry, candidates showed a full range of achievement across all questions and a significant number of scripts demonstrated comprehensive and detailed preparation.

Comments on Individual Questions

1 **(a)** Most candidates knew at least 2 of Kepler's laws. Common errors included no reference to the Sun being at one focus of the ellipse or stating that the planet moves equal distances in equal times.

(b) This part was well answered but some candidates were penalised by stating that the Copernican model assumed constant velocity, as opposed to constant speed, for a planet. It was evident that a few weaker candidates believed that all planets had the same speed.

(c) **(i)** This question has been asked in previous papers, but it was not well answered this year. The most common error was to refer to a temporary change in direction of the planet's motion.

(ii) Candidates had difficulty explaining the concept of retrograde motion and many failed to appreciate that it was due to the Earth overtaking Mars. The best answers were often accompanied with a small sketch showing the paths of the two planets.

2 **(a)** **(i)** Most candidates knew that the angle subtended by a parsec was one arcsecond, but few made a correct reference to a distance of 1AU, or the Earth's orbital diameter.

(ii) Many correct conversions of the parsec into metres were seen. Answers were accepted to just 1 significant figure.

(b) The use of logarithms is a regular part of the examination, but weaker candidates found the manipulation of the equations challenging. Nevertheless, a good number of answers scored 2 or 3 marks and it was certainly an advantage to show working as one error would lose only one mark.

(c) **(i)** The relation between apparent and absolute magnitude was well known, the most common error being to omit the minus sign.

(ii) Most candidates could correctly calculate the distance and an error with the minus sign in part (c)(i) was carried forward.

3 **(a)** **(i)** The axes of the H-R diagram were correctly labelled, with directions included, by the great majority.

(ii) Almost all candidates could identify the main sequence on the diagram.

(iii) The Sun was usually placed on the main sequence, in the correct section. A few candidates risked being penalised by not labelling the position clearly.

(b) **(i)** Labelling the positions of red giants and white dwarves on the H-R diagram was generally done well, although some candidates made white dwarves have a lower temperature than the red giants.

(ii) Candidates were required to trace the path of the Sun after it leaves the main sequence and this produced some good answers. A number of candidates incorrectly moved the Sun along the main sequence, to either the high or low temperature end.

(c) Candidates generally knew that the temperature of the white dwarf decreased but few went on to refer to its subsequent decrease in luminosity.

4 **(a)** The description of the Doppler Effect was well known by the great majority of candidates.

(b) **(i)** Candidates could generally recall the relation for change of wavelength with the speed of the wave source and use this to correctly explain the relative velocities of the two galaxies.

(ii) The data was plotted correctly by nearly all candidates to the required accuracy of half a small division in each direction, although a few candidates surprisingly neglected to draw a line through the points.

(iii) Most candidates knew that Hubble's constant was the ratio of recession velocity to distance. Powers of ten caused some problems in the calculation of *H,* but units which were consistent with the calculation were usually given.

(c) This question was not well answered. Few candidates referred to the possible future of the universe and how this would change the ratio of v/d and thus *H.*

(d) The evidence for a Big Bang has been asked in previous papers and a number of candidates gave full and detailed answers. The majority of candidates chose to cite the CMBR and although arguments using the unusually high abundance of helium compared to hydrogen were given full credit, such answers were not frequently given.

5 **(a)** The degree of transparency of the atmosphere to the four different wavelengths of electromagnetic radiation was recalled by many candidates.

(b) This question turned out to pose few difficulties as a wide range of possible reasons were accepted for full credit.

6 (a) Questions on Relativity have proved to be among the more testing in previous papers and this year the topic continued to be challenging. Candidates could state that the speed of light is constant but many failed to link this to inertial frames of reference.

(b) Candidates who were well prepared often gained full credit for their description of the thought experiment. Those giving less rigorous accounts were in the minority and candidates who did not give a thought experiment, but a practical one, were necessarily penalised. A labelled diagram frequently helped clarify an explanation and could lead to credit being awarded if the explanation was not entirely clearly expressed.

(c) (i) It was evident from candidates' answers that some confusion exists over the meaning of the time dilation relationship.

(ii) The calculation of the time taken to travel 2750m was correctly calculated by many and only a few tried to use the time dilation equation.

Use of the half life to find the number of particles remaining after 2750m proved to be difficult. A few candidates found the decay constant from the half life and then used the exponential decay equation to calculate the number of particles, receiving full credit for a correct answer.

The simple answer of an extended half life due to the high velocity of the particles was rare, but a number of candidates made a good attempt to apply the idea of time dilation.

(d) Many candidates knew the idea of light being deflected in a gravitational field but gave poor explanations and lost credit. Once again, a labelled sketch diagram could help gain credit and space for this was available. Very few answers explained how two or more images could be formed, or made reference to the General Theory of Relativity.

2825/02 Health Physics

General comments

It must be stressed that the following statements are derived from a small sample, 28 scripts in total. There appeared to be two groups of re-takers – those who missed a top grade last time and felt they had underachieved, and those who did not pass last time but felt they had it in them to do so.

Comments on individual questions

1 **(a)** **(i)** Most were able to calculate the times in μs.

(ii)(iii) A disappointing number were still oblivious to the need for dividing by two in calculating the distance to a boundary and back again.

(b) The purpose of the gel was widely known. The explanation was only scored by top candidates.

2 **(a)** Most got the normal distances for near and far points.

(b) **(i)** Most candidates gained some credit here. There were two marks available which should have indicated to some of the weaker candidates that there were two points to make.

(ii)(iii)(iv) The general standard of the lens calculations was good, so most scored fairly high marks. Everyone realised that distances had to be converted to metres to arrive at a power in dioptres.

(v) Very few candidates failed to score this mark.

3 Those with a sound knowledge of the text book material scored well. Even so, there turned out to be quite a wide spread of scores. One misconception which arose a few times was that MRI generated 3-D images whereas X-rays could not. The main confusions arose in the response of weaker candidates who mixed up the sequence of events, so making no sense of the physics of MRI.

4 **(a)** The width of the graph grid supplied made it rather awkward to choose a good scale for the x-axis, but no candidate appeared to have suffered as a result.

(b) In finding the half-thickness most simply gave the thickness for 0.455 MWm^{-2} without realising that the 4mm at the start had to be subtracted, thereby arriving at an answer of about 1.4 mm. There was no sign of *anyone* taking a second check reading from their graph (e.g. for 0.40 down to 0.20MWm^{-2}) then averaging.

(c) The subsequent calculation, with ecf usually applied, was often competently done.

5 **(a)** Most candidates knew they had to use power over area, but few were able to convert $16cm^2$ into m^2 successfully.

(b) **(i)(ii)** The standard of the calculations relating intensity and intensity level was generally good.

(iii) In making their comment for (b)(ii), not many actually answered the question. Only a few even implied that the increases in intensity were equal, and some were clearly wrong – e.g. 'the intensity increased by the same factor each time'. Rather more marks were scored by comparing the increases in loudness, but several just spoke of the rise in intensity level and never ever mentioned the word 'loudness'.

6 **(a)** **(i)** Many candidates failed at this first hurdle and the calculations provided good discrimination.

(ii)(iii) Most candidates got the correct unit and then fell into one of two groups, those that scored full credit and those that did not know what to do.

(b) In the explanation, there was plenty of material recalled from class notes rather than clear-cut answers to the question. Only a few referred to bone cancer/tumours.

(c) Again, this either scored full marks or zero marks. Where candidates had been well prepared, this did not prove to be difficult.

7 Those who answered the actual question asked, were able to score well. Some (about one third) focused on the ability of the ear to distinguish between two frequencies.

8 **(a)** **(i)** The first part of the question was answered well.

(ii) A small number of candidates played around with the numbers until it gave the required answer.

(iii) Weaker candidates found this part difficult. The most common error was to count the number of cells in each branch of the diagram of Fig.8.2 (i.e. 4) and the number of parallel branches (i.e. 2).

(b) **(i)** This was well answered by most candidates.

(ii) Again, this was well answered by most candidates. The most common error was to add 273 to the change in temperature.

(c) **(i)** This caused a few candidates problems and they were not able to be convincing that the mathematics they performed had meaning, eventually arriving at the required number.

(ii) Most candidates were able to get this correct.

(iii) Only a few candidates achieved any marks here. Most responses contained a jumble of numbers with no explanation as to the reasoning.

(d) It was common to find that more than one process was explained and this filled the space available for marking points which all had to be applied to the same process.

2825/03 Materials

General comments

It is reasonable to assume that the 8 candidates who sat this paper were doing so for at least the second time, and therefore had experience of the type of question usually set in this option. Their marks covered a wide range, suggesting that the previous experience had been used with widely varying degrees of effectiveness. Particularly low marks gained by two of the candidates suggested that any improvement shown must have been minimal; the others can be assumed to have performed satisfactorily or better, and may have improved their previous grade.

On the whole, numerical work, some of which was particularly straightforward, was done well, but answers involving description and explanation often showed a range of deficiencies, some of these resulting from insufficient care in the reading of questions. This factor was particularly relevant in the two questions requiring extended writing, where significant issues were often not addressed. In these cases also there was a tendency to make contradictory statements.

Comments on individual questions

1 **(a)** This covered very familiar ground, and few marks were lost.

(b) The diagrams showing elastic behaviour were satisfactory, but some of those showing plastic deformation either failed to include convincing evidence of slip between a pair of layers or exaggerated its extent.

(c) Most of the candidates could satisfactorily explain what a dislocation is, but clear understanding of their effect on behaviour was absent or showed confusion in some answers.

2 **(a)** Values had to be read from the graph. In a few cases wrong units were quoted.

(b) In (i) good attempts to calculate the gradient were the norm. In (ii), sometimes with the benefit of errors carried forward from (a), most of the marks available could be awarded.

(c) **(i)** In several cases the requirement to find the product of the maximum attractive force and the given number of atoms in the cross-section was not realised.

(ii) Two acceptable reasons could usually be given.

3 **(a)** Most of the candidates could write down an expression for resistivity or conductivity and most arrived at the correct current value.

(b) **(i)** Marks varied from 3 to 7 for this explanation. There is general understanding of band theory in relation to semiconductors, but less clarity with regard to a metal.

(ii) The small increase in resistance of the platinum was recognised as a disadvantage, but the non-linearity of the resistance of the semiconductor was less frequently referred to.

4 **(a)** **(i)** Few of the candidates could write a logical step-by-step derivation. A few referred to the number of free electrons in the cross-section rather than a length of the foil. If the starting point of the derivation was I = nAve, only 1 mark could be gained.

(b) **(i)** The requirement to use I = nAve was recognised, but there were some errors in the conversion of mm^2 to m^2.

(ii) Some did not know the expression for the Hall voltage and consequently gained no marks.

(c) Few could start from the fact that semiconductors have a smaller concentration of free electrons and write about its effect on v and thus the value of the Hall voltage.

5 **(a)** The formulae relating primary power to secondary power in a transformer are well known, and the efficiency factor could generally be dealt with, so good marks were achieved by the majority.

(b) The aspects of hysteresis and eddy currents were handled reasonably. The relevance of energy losses in the coils featured rarely. Marks were in general in the upper range of the total available.

6 **(a)** **(i)** There were some errors in the recall of $E = hf$ or $E = hc/\lambda$ and in the conversion of eV to joules.

(ii) The requirement to convert J to eV for the comparison was essential and proved impossible for some. Some error carried forward from (i) allowed some marks to be gained. Few were clear about the theory involved.

(b) Marks varied from very low to the maximum possible, but the lack of clarity seen in (a)(ii) was again evident in most of the explanations.

2825/04 Nuclear and Particle Physics

General Comments

The entry for this paper was, as expected, small. Most centres entered only a single candidate, often no doubt re-sitting in order to improve a grade achieved in July 2009. Consequently the range of marks was greater and more diverse than has been the norm. There were a few excellent scripts which scored highly; equally there were a larger number of candidates who appeared not to have prepared adequately.

As usual, marks were lost by candidates who wrongly referred to 'atoms' where atoms do not exist e.g. inside the Sun. Others reduced the number of significant figures too soon in their calculations. This was particularly serious in Q3 where two similar masses had to be subtracted to find a mass defect. As stated in previous reports, many candidates made their answers less satisfactory by failing to set them out clearly and in some cases losing marks as a result.

Comments on Individual Questions

1 **(a)** **(i)** Most candidates were able correctly to identify the quantities r, r_0 and A. One or two used the term 'atomic number' instead of 'nucleon number' for A.

(ii) Most were able to sketch a graph from the origin, curving in the right direction. A few drew straight lines and one or two sketched a curve in the wrong direction.

(b) **(i)** Most candidates were able to identify 59 as the nucleon number and substitute into the given equation to find the radius of the cobalt nucleus. One or two had trouble finding the cube root of 59.

(c) **(i)** No candidate failed correctly to state the number of protons and neutrons in the cobalt nucleus.

(ii) Most candidates were able to sum the masses of the protons and neutrons though a few made arithmetic errors.

(d) Many candidates were able to find the mass defect and, using $E = m c^2$, find its energy equivalent. Marks were lost, if at all by failure to apply this equation or failing to square c. Those who prematurely ignored significant figures arrived at very different energy values and lost credit.

2 **(a)** **(i)(ii)(iii)** These nuclear equations prompted a variety of responses. Well prepared candidates scored 4/4 without difficulty but others lost credit, usually by omitting or showing wrongly the neutrinos in (ii) and (iii). A few showed positrons being emitted, rather than electrons. One or two had electrons being absorbed rather than emitted.

(b) **(i)** Nearly all candidates knew the half life of plutonium-239.

(ii) Of those who attempted this, most arrived at the correct value of the decay constant. Those who failed usually did so because they did not convert the half life to seconds correctly. Some gave an answer in years-1 but incorrectly stated it as $s^{-}1$ and so failed to score.

(c) **(i)** In order to find the number of atoms of plutonium in the fuel rod, candidates could either find the number of moles in the fuel rod and multiply this by the Avogadro Constant, or find the mass of a plutonium atom and divide this into the total mass. Both methods were used successfully. A few candidates made powers of ten errors because of gram/kilogram confusion. Some simply failed to use a valid method and did not complete this part. Candidates were expected to give their own answer and not simply copy the approximate answer given in the question.

(ii) This was generally well done by candidates who knew the activity equation. Some used the approximate value for number of atoms, given in (c)(i) but could still score full credit. Most were able to state a correct unit.

3 **(a)** This was not done well by candidates. Many failed to mention that nuclei repel each other and this repulsion has to be overcome in order to get the nuclei close enough to fuse. Only a minority stated that gravity confines the plasma, thus increasing its density and so the rate of collisions among nuclei. There was a misconception among some candidates that the large pressure caused by gravity would alone be sufficient to explain the high temperature and too many candidates referred to atoms rather than nuclei or protons.

(b) **(i)** Only a minority of candidates recognised that the area in question represents the amount of energy needed to overcome the coulomb barrier and bring two nuclei to their critical separation; it is hence the minimum energy needed for fusion to take place. Candidates usually related their answers to the critical separation rather than to the area itself. Only a minority stated that it represented an amount of energy or work, preferring to call it a ‘region’ or simply an area.

(c) Nearly every candidate was able to substitute the value for the solar temperature into the given formula and find a correct value for the mean kinetic energy of the protons in the Sun.

(d) This was less well done. Few stated clearly that the combined k.e. of two protons is much less than the energy needed for fusion. Nor did many make it clear that there is a range of nuclear kinetic energies but that a very small number are greater than the fusion energy. Some stated how unlikely it is that two nuclei will collide head-on, failing to notice that this comment was rendered irrelevant by the form of the question. A few referred to the huge numbers of protons in the Sun as being the reason for fusion taking place, even though the question asked about the *proportion* of nuclei fusing.

(e) Most candidates realised that they needed to find a mass defect and deduce the binding energy from it. However some failed to convert the unified atomic mass units into kilogram and a few did not use the Einstein equation to find the energy in joule. Others simply made arithmetic errors, usually because they converted the u to kg too soon which much increased the scope for error. A small number of candidates failed to find a mass defect at all and used instead one of the masses given. Nevertheless, better candidates did score fully.

(e) A sizable minority did realise that a positron will meet an electron, annihilating and emitting energy. Others thought that the positron might trigger some other reaction or simply contribute its own k.e.

4 **(a)** Many candidates did realise that because the mass of a proton increases with its speed, its period inside the cyclotron would change and it would get out of synchronisation with the alternating electric field which accelerates it. However a significant minority either cited the speed of light as a limit to the amount of energy which it can acquire or stated that the proton would fly off out of the cyclotron because of its high speed.

(b) **(i)** Better candidates were able to equate the maximum k.e. of the protons to the energy gained during their acceleration and hence to find their maximum speed. However, some lost credit by either leaving the energy in keV or omitting the factor of 1000 in the conversion.

(ii) Many candidates were able to calculate the time a proton takes to travel half a revolution and so to demonstrate that they cross the gaps in the dees every tenth of a microsecond. However, the question asked the candidate to *show that* this was the case so full working and preferably some explanation was required. Some candidates calculated the whole period and then, presumably realising that their answer was twice the one they wanted, simply divided it by 2 without explanation. These answers did not get full credit. Some candidates used an equation for circular motion in a magnetic field but failed to score.

(iii) This proved surprisingly poorly done. All candidates needed to do was to find how many times the 10 keV of energy gained at each crossing went into the total energy, 800 keV.

(iv) There was a poor understanding of the way the energy of a proton inside a cyclotron varies with time. Many failed to realise that the energy increases in steps, doing so only as it crosses the gap between the dees. Many graphs showed straight lines, implying a steady energy increase. Even those who did show a stepped graph often showed the wrong energy gain per step (usually 20 keV instead of 10 keV) or had the time interval wrong, usually 0.2 instead of 0.1 microsecond.

5 **(a)** Most candidates had a general idea of the fixed target and colliding beam experiments but many were weak on the detail. A common misconception was that *single* particles are used as projectiles and/or as targets. Some referred to a beam but failed to mention that it is a beam of particles. Not all stated that the particles are *accelerated* or that they must have high energy or speed. The statement that the particles are 'fired at' the target was commonly stated but this was not given full credit. Many referred to the target without pointing out that it consists of *nuclei*. Some candidates failed to mention either that the collision must be head-on or that the colliding particles must be travelling in opposite directions when they collide.

Some candidates thought that many collisions occur in the fixed target method because the particles are aimed at a large target rather than one in which there is a high density of nuclei, making the probability of collision much greater. There were many incomplete explanations of the advantages of the colliding beam method. A common statement was that because the colliding particles were travelling in opposite directions the initial momentum was zero. Then, without any mention of the final momentum it was stated that therefore all the initial k.e. is available to create new particles. As usual, some candidates were confused as to the distinction between momentum and k.e.

(b) (i) Candidates were expected to equate momenta for the incoming electron and the outgoing Z particle and to realise that, since their speeds are the same (i.e. the speed of light) their masses are also the same. A common mistake was to state that since there are two particles reacting, the Z particle must have a mass equal to twice the electron mass. Some candidates simply failed to distinguish the electron and the Z particle in their equation. Others seemed to have no understanding that as particles approach the speed of light, small differences of speed make a large difference to the mass.

(c) This was not well done. Few were able to state that the reason why the reaction is inefficient is that much of the input energy is taken as k.e. of the product Z particle. A commoner answer was that it is because many particles do not make any collision.

6 (a) This question was generally well done and most candidates were able to score. The quark composition of the proton and neutron, the list of known quarks and the charge, baryon number and strangeness of the up or down quark were well known. Some, though fewer, candidates went on to make general points about quarks such as that they are fundamental particles or that for every quark there is an antiquark etc.

(b) (i) Most candidates were able at least to score in finding the charge, baryon number and strangeness of the particle X and many scored full credit. The working was not asked for but, if given, it enabled the examiner to award partial credit for an incomplete answer.

(c) Some candidates were able to state that X is a π^+ particle.

7 This question on general physics enabled well prepared candidates to score highly. Others reached their own level, resulting in a wide range of marks.

(a) (i) Most candidates were able to calculate the area of photoelectric cells needed though a minority failed to allow for the 10% efficiency and so got an area of one tenth of the required answer.

(ii) Those who had arrived at a correct area in (i) usually divided the total area by the surface area of a single P.E. cell and confirmed that there must be 25000 cells. Candidates who had wrong answers in (i) but who stated their answer to (ii) consistently, even though it was not 25000 could still score. However, most of these candidates manipulated their answer to make it 25000 and so lost this mark.

(iii) Candidates were expected to divide the 0.50 V output voltage of a single P.E. cell into the 125 V provided by a series branch in order to find the number of cells in the branch. Some did this but many failed and simply guessed, or counted the number shown in the sketch. The number of branches should have been deduced from the total number divided by the number of cells in each branch. However, a common answer was 4 – presumably arrived at by counting the number shown in the schematic diagram.

(a) (iv) Candidates needed to use the power equation to find the total current and divide this by the number of branches. This was not well done, but the reasoning which led to wrong answers was not always clear.

(b) **(i)** This was similar to the answer in (a)(i) and the same omission was made by some candidates i.e. they failed to allow for the 70% efficiency of the solar panel.

(ii) This was well done and many candidates were able to apply the equation $Q = m c \theta$ in order to arrive at the correct water flow rate.

(c) **(i)** Most candidates were able to show that if 1000 J is 40% of the energy of the cylinder of air, the whole amount must have been 2500 J.

(ii) This was less well done. Candidates needed to use the k.e. equation in order to find the mass of the cylinder of air. Some were at a loss as to how to approach this. Others confused themselves by using the same symbol, V for both volume and speed.

(iii) This also caused some candidates to go astray. Usually the problem was to know the volume of a cylinder; surprisingly many candidates were not able to do this, the expression for the volume of a sphere or the surface area of a cylinder appearing on several scripts.

(d) Candidates were asked to choose one of the possible methods and to comment on its appropriateness. All three options were chosen by different candidates and comments were made. The solar panel was the most popular because of its high efficiency. Some candidates also stated that it produces hot water which households need. A few pointed out correctly that heat is a less versatile form of energy than, say, electricity. Credit was also occasionally won by stating that the output varies with cloud cover etc. and day or night exposure.
Those choosing the P.E. cells usually referred to the versatility of its electrical output but noted the large area or roof which they would occupy. Again cloud cover etc. was alluded to.
The aerogenerator was chosen by only a few, one or two of whom realised that the radius of the fan makes it unsuitable for mounting on a house roof.

2826/01 Unifying Concepts in Physics

General Comments

The number taking this paper this year has fallen considerably with many now working on the new syllabus. As a result, almost all of the candidates were repeating the exam and the entry pattern was very different. There were the usual examples of careless working costing grades and many candidates working by rote, without much thinking being apparent. There was no evidence at all that candidates did not have time to complete the paper in the allotted time.

Comments on Individual Questions

1 This question was very revealing about the candidates' feeling for size. The speed of passengers in a plane varied from slower than a car to above the speed of light. It was also apparent that there are quite a number of candidates who really do not understand the difference between area and volume. Certainly some thought that the magnetic field of a bar magnet was no greater than that of the Earth.

2 Energy was seldom defined as the (stored) ability to do work so few regarded the kinetic energy as the work the object could do against drag forces while slowing down. Part (c) was too often attempted without quantitative facts. It was surprising how many candidates could not relate a ratio of 16/9 as an increase of 7/9, which is an increase of 78%.

3 The answers to this question were generally good. Where candidates did make mistakes it was often in treating the distance up on the steepest part of the journey as 500m rather than 400m. There were many candidates who seemed to think that the motor would have to do work on the cable car when it was descending. Very few candidates were aware that there is no need for variable resistors in a motor circuit in order to vary its power output. Even fewer mentioned the back emf of the motor changing and hence acting as a self control system.

4 This question was done very badly, even by the good candidates. Few realised that the p.d. across the three branches of the circuit must always be 12 V. Most candidates just put numbers into inappropriate equations. Few realised that the parallel resistor formula can only apply with the same p.d. across all the resistors. The thoughtful work required for a successful outcome was seldom found.

5 This question worked well. Many of the able candidates could work their way right through to the end, and even weaker candidates made a good deal of progress on it. Part (c)(iii) proved a stumbling block for some.

2826/02 Unifying Concepts in Physics / Experimental Skills 2 – Coursework

General Comments

There is little new to say about this legacy examination. The number taking the A2 coursework option was very small indeed. I have given a full report so that centres will not need to look at archive material to get any help they may require on re-sit candidates next session.

The comments on the individual descriptors are the same as in previous awards and my reports from earlier years remain relevant.

Briefly the main features of each skill are as follows.

Planning

A preliminary experiment should be carried out to guide the final investigation, rather than be an early run of exactly the same work. The range, scales, safety and equipment choice should be influenced by this preliminary work. One or two detailed references to books or internet sites are needed at level 7, it would be good if these were taken into account in the body of the work, rather than just used as a means of securing the mark.

Equipment should be chosen taking into account precision and reliability rather than just offering a list of the equipment used, with little justification as to why these particular instruments or methods have been chosen.

Some good science should be shown, to allow the higher descriptors to be met.

Reference must be made to other areas of the specification. There should be an appreciation that Physics is about simple ideas applied to differing areas of study and that similarities occur based on theses simple rules. Annotation to show where other areas of the specification are brought into the work would greatly aid the moderation process.

The use of the 8 mark should be reserved for really excellent work making the investigation a truly first class study, the mark should be awarded very sparingly. Where given the top mark should be supported by annotation showing exactly why the marker felt if was worthy of full marks.

Implementing

It is important to watch for consistency of observations carried out. They must be to the precision of the measuring device e.g. 10cm. in a table of results is not to the same precision as 14.1cm. The readings should always be to the maximum precision available with the apparatus used.

The “a” descriptors can only be judged by the centre. A good table of results with consistent readings, repeats and correct units is all that is needed to score up to I7b.

Analysing

Good graphical work is needed with gradients and intercepts taken and used for the award of A5a and A5b. Science of a high level and the correct use of significant figures in the final quoted result are needed for the level 7 descriptors. Again linkage to other parts of the specification is required for A2.

It is difficult to gain high marks here if the investigation does not lead to a straight-line relationship. The careful use of statistics and IT should be encouraged bearing in mind that the final answer should be given with significant figures correctly based on the experimental observations.

Again the award of 8 marks should be viewed very carefully and annotated in detail where the centre feels it is valid.

Evaluating

An objective discussion is needed with identification of where uncertainties lie and how they might be overcome. The identified sources of uncertainty need to be looked at in terms of the numerical effect that they have on the final result. That final result should be given in the form a +/- b, with correct significant figures for both the result and the uncertainty and with the correct units. Improvements should be offered to the procedures to increase the reliability of the results, with the maximum effort being expended on the data with highest uncertainty. A treatment similar to that found in the appendix of “Physics 1” will yield all the “b” descriptors here.

The idea that error is the difference between the observed result and a book value must be avoided.

2826/03 Physics Practical

General Comments

This January 46 candidates sat the practical exam; the paper was perhaps slightly easier than last January and the mean mark a little higher. There were no difficulties reported from centres with apparatus. No candidate appeared to be short of time.

Comments on Individual Questions

Question 1

The candidates were given three 47kΩ resistors and asked to make 7 different resistances from different combinations. Most managed this but it was a challenge for weaker candidates. A capacitor was then charged, and then discharged through the resistance combination, and the "half-life" time for the discharge current measured. This half-life was then plotted against resistance to obtain a straight line graph.

All candidates constructed the circuit and carried out the experiment without help, although not all could think of all 7 combinations. Tables of results were well presented, but many failed to repeat readings. Graphs were good, with scales well chosen, and most got a decent straight line. Gradients and intercepts also caused few problems.

However parts (f) and (g), as intended, were more difficult. Weaker candidates found it tricky manipulating logs, and not many remembered that the resistances were in kΩ and not Ω, and so either got the capacitance wrong, or the unit wrong. Credit was only given if the capacitance was obtained from the measured gradient (= C ln 2).

Question 2

In this experiment candidates measured the period T of a bifilar pendulum with two different string separations d, and were asked to show that $T \propto 1/d$. Some only measured a single oscillation and many did not repeat readings, but most knew how to show the proportionality. The experiment generally worked well.

In the evaluation section they had to discuss problems with the experiment and possible solutions. The standard answer of "two sets of readings are not enough, take more sets of readings and plot a graph, of T against 1/d to get a straight line through the origin", would have earned three marks; less than half the candidates put this. Other difficulties were swinging or swaying of the suspended ruler, and difficulty in accurately counting and timing oscillations. Light gates were only credited if details of positioning were indicated. Slow motion replay of cameras or videos was credited if a timer was incorporated or in view.

Planning Exercise

Candidates were asked to plan an investigation of how the calibration of a Hall probe would vary with the temperature of the probe.

Marks were given for diagrams of the apparatus layout involving a solenoid or Helmholtz coils, and the correct formula for the magnetic field. Practical details of the method for altering the probe temperature and how to measure it were required, as well as a sensible procedure. The Hall probe temperature had to be measured while it was actually in the magnetic field, so a rapid transfer of probe from oven or beaker of warm water to the field was not accepted, unless accompanied by a suitable thermometer. Also the Hall voltage had to be measured in an identical magnetic field at each temperature.

Setting all this out and presenting the information properly required clear thinking, and as always it proved a good discriminator. Extra detail marks (maximum 3) were given for evidence of preliminary work, discussion of Hall effect, correct circuitry for coils, among other things.

Several candidates omitted all references, thus losing two easy marks.

Grade Thresholds

Advanced GCE Physics A (3883/7883)
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2824	Raw	90	62	56	50	44	39	0
	UMS	90	72	63	54	45	36	0
2825A	Raw	90	64	58	52	47	42	0
	UMS	90	72	63	54	45	36	0
2825B	Raw	90	71	63	55	48	41	0
	UMS	90	72	63	54	45	36	0
2825C	Raw	90	65	58	51	44	38	0
	UMS	90	72	63	54	45	36	0
2825D	Raw	90	60	54	49	44	39	0
	UMS	90	72	63	54	45	36	0
2825E	Raw	90	64	57	50	44	38	0
	UMS	90	72	63	54	45	36	0
2826A	Raw	120	87	78	69	60	51	0
	UMS	120	96	84	72	60	48	0
2826B	Raw	120	87	78	69	60	51	0
	UMS	120	96	84	72	60	48	0
2826C	Raw	120	85	78	71	64	58	0
	UMS	120	96	84	72	60	48	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
3883	300	240	210	180	150	120	0
7883	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
3883	9.1	27.3	63.6	77.3	100.0	100.0	25
7883	13.4	38.4	68.1	86.1	96.3	100.0	226

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums/index.html

Statistics are correct at the time of publication.

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