Rewarding Learning

CCEA GCE - Physics
(Summer Series) 2013

Chief Examiner's Report

Foreword

This booklet contains the Chief Examiner's Report's for CCEA's General Certificate of Education (GCE) in Physics from the Summer Series 2013.

CCEA's examining teams produce these detailed reports outlining the performance of candidates in all aspects of the qualification in this series. These reports allow the examining team an opportunity to promote best practice and offer helpful hints whilst also presenting a forum to highlight any areas for improvement.

CCEA hopes that the report will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at www.ccea.org.uk

Contents

Subject Code	1210
QAN	500/2471/1
QAN	500/2438/3

A CCEA Publication © 2013

GCE PHYSICS

Chief Examiner's Report

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 This question was very well answered by many candidates.

(a) A surprising number of candidates were unable to explain why power is a scalar quantity. In addition, some candidates omitted to state explicitly that power is a scalar quantity and forfeited the mark.

(b) In part (i), a sizeable number of candidates could not draw an accurate resultant force on the vector diagram provided. However, the evaluation of the magnitude and direction of the resultant force, in parts (ii) and (iii) respectively, was very well done. The vast majority of candidates opted to calculate these values rather than to use a scale drawing.

(c) Most candidates responded accurately to this question although there were some who mixed up the trigonometric functions and others who confused east and north.

Q2 This question on projectile motion was accessible to most candidates.

(a) In part (i), almost all candidates appreciated that the acceleration due to gravity was equal to the gradient of the velocity-time graph. Calculation of the gradient was usually accurate but lots of candidates omitted the negative sign and lost a mark. In part (ii), many candidates had the correct idea as to how to proceed: however, candidate answer layouts were often difficult to follow. Candidates appeared familiar with extracting displacement information from the motion graphs but not all of them did so with sufficient accuracy. The calculation of percentage difference was less familiar to the candidature.

(b) In part (i), most candidates scaled their displacement axis appropriately and sketched a linear best-fit line starting from zero and of correct gradient. In part (ii), most candidates knew that the horizontal component of the velocity was constant and completed their graphs accordingly.

Q3 Candidates performed well in this question.

(a) Defining work, as required in part (i), was relatively poorly done as many candidates did not make it clear that it is the distance gone in the *direction of the force* that must be considered. The calculations of the frictional force, in part (ii), and the work done, in part (iii), were generally good.

(b) The calculation of the skier's velocity was generally well done. A number of candidates attempted to answer this question using the equations of uniformly accelerated motion; while this can yield the correct answer, it is a more difficult calculation than that using the conservation of energy principle.

Q4 Many candidates found aspects of this question challenging.

(a) Definitions of moment tended to be good.

(b) The identification of the correct distance from which to calculate the moment, in part (i), was poorly done by many candidates. Most indicated the distance from the axle to the footpad. In part (ii), few candidates interpreted the moment – angle graph sufficiently well to attract all four marks. A frequent mistake was to think that the force or angle of the force was changing which missed the point of the question. The calculation of the constant force was generally well done although power-of-ten errors were often introduced.

Q5 The experiment to determine the Young modulus is very well known and consequently, responses to this question were frequently excellent.

(a) The diagrams produced in part (i) tended to be accurate and reasonably well drawn. There was a fairly even split between those candidates using a vertical, two wire arrangement and those who had a single, horizontal wire. Part (ii) of the question was also well answered but many candidates concentrated on how the measurements of force, area, length and extension were taken but did not indicate that a series of values for force and extension had to be obtained. In part (iii) most candidates stated a suitable safety precaution.

(b) This question was well answered with the relevant equation being widely quoted. Many candidates described a graphical analysis – the preferred method - but a large number opted for a calculation. Unfortunately, the importance of finding an average was not appreciated by all those describing the calculation method.

Q6 This straightforward question was very accessible to all candidates, many of whom got full marks.

Parts (i), (ii) and (iii) posed very few problems to the over-whelming majority of the candidature.

Q7 Parts of this question challenged many candidates.

In part (i), the circuits drawn by many candidates often omitted a variable resistor, and sometimes any resistance! The labelling of the axes, in part (ii), often failed to attract any credit because the unit was absent or not indicated using the established protocol. A large number of candidates labelled the axes with the correct quantities but incorrectly sketched linear graphs that passed through the origin. In part (iii), most candidates knew that the gradient was necessary but many did not give a sufficiently detailed explanation of how to use the gradient to obtain a value for the internal resistance of the cell.

Q8 Responses to this question were not good, evincing a number of candidate misconceptions.

In part (i), it was not obvious to all candidates that the potential difference across R_m was the difference between the supply voltage and the potential difference across the single resistor. In addition, many candidates' answering technique was ineffective in attracting all the marks for this 'show that' question. Candidates should be reminded that they ought to perform the calculation and write down the answer to a greater number of significant figures than the answer they have to 'show' and then explain that their answer rounds to the 'show' value. Part (ii) was a challenge to many candidates. The most common method of obtaining the resistance R_m was that of determining the resistance of the parallel section and working from that using the equation for resistors in parallel. Some candidates who were using this method stopped after determining the resistance of the parallel section.

The calculation of resistivity in part (iii) was generally well answered. Error Carried Forward (ECF) provision from parts (i) and (ii) allowed most candidates to demonstrate their knowledge and understanding of resistivity. Power-of-ten errors were common.

Q9 Some candidates successfully met the challenges posed by this question.

(a) Very few candidates commented on the increase in the number of collisions between the conduction electrons and the lattice molecules and so forfeited the second mark.

(b) Most candidates quoted the Potential divider equation from the Data and Formulae Sheet and proceeded to substitute in the appropriate values to show the value for R_1. As with Q8(i), some candidates' answering technique for this was poor; teachers should remind them of the guidance in Q8 in this report. In part (ii), the determination of the new value for the variable resistance posed significant problems to many candidates. It appeared as if many candidates could not visualise this scenario and so were unable to make any headway. In addition, candidate responses to this question tended to be poorly set out and lacked any discernible logic.

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 A majority of candidates scored highly in this question.

(a) Very few candidates accurately explained a transverse wave as many failed to comment adequately on particle movement and the direction of wave travel.

(b) Part (i) was well answered with few candidates experiencing difficulty in extracting the wavelength from the displacement-distance graph. Part (ii) was also answered correctly by most candidates.

(c) Most candidates were able to identify the point oscillating 180° out of phase with the reference point. Of those that were unable to do so, point E was the most common incorrect option. Part (ii) of this question was more challenging; only a relatively small number of candidates gained this mark.

(d) In part (i), many candidates found difficulty in showing the relationship between the frequency and the periodic time. The necessary understanding may have been present but a lack of clarity in the presentation meant that credit could not be awarded. In part (ii), some candidates' failure to recognise that the displacement-time graph was a cosine plot caused them to forfeit the first mark. Others sketched cosine plots but of fewer than two cycles and were penalised, while another group of candidates lost marks through a failure to draw an accurate representation of the graph.

(e) Few candidates were able to phrase their responses in such a way as to attract the mark.

Q2 Most candidates found this question accessible.

(a) To be awarded this mark candidates had to state that the critical angle is an angle of incidence and that it is the angle of incidence at which the angle of refraction is 90°; many candidates were unable to do this.

(b) The diagrams, in part (i), tended to be completed accurately. In part (ii), most candidates correctly identified the phenomenon as total internal reflection (TIR). The descriptions, in part (iii), were generally good but a significant number of candidates failed to describe how the refractive index could be obtained from the critical angle.

(c) Most candidates were able to determine the correct value for the critical angle of glass. However, the responses from a number of candidates indicated a degree of confusion as to whether the refractive index they had calculated was correct for light passing from air to glass or from glass to air.

Q3 Many candidates found parts of this question challenging.

(a) In part (i), many candidates when explaining what the principal focus of a converging lens is failed to mention that the incident rays had to be parallel to the principal axis. In part (ii), many image descriptions were incomplete.

(b) The overall standard of response to this ray diagram question was surprisingly poor. It is clear that the majority of candidates know the rules for tracing the rays. However, some candidates incorrectly positioned their object; many omitted to show the direction of their rays and/or forgot to follow the convention to draw virtual rays and images using dashed lines.

(c) This calculation was not well done. Many candidates only gained the mark for recalling the magnification relationship.

Q4 Almost all candidates experienced some difficulty with parts of this question.

(a) Candidates were challenged by the explanations required in part (i). Few candidates were able to satisfactorily state the meaning of diffraction and many found 'coherent' difficult to explain. In part (ii), a sizeable minority was unable to describe the interference pattern produced by the Young's double slit experiment.

(b) Most candidates performed this calculation accurately but only some were able to identify the colour of the light used in the experiment.

Q5 Most candidates were able to respond positively to all parts of this question.

(a) Candidate responses to this question hinted at a sound appreciation of the technique involved but frequently evinced a writing style incapable of describing it. Almost all candidates received the mark for the relationship between periodic time and frequency but for many this was the only credit their response attracted. A flaw common to many candidates was in not using the term 'cycle'; candidates chose instead to refer to 'the wave' or 'wavelength' - terms that were not considered worthy of credit.

(b) In parts (i) and (ii), the majority of candidates produced good diagrams of the standing wave patterns obtained. Many however, did not. The two most common mistakes were: drawing the correct pattern below the water's surface and inverting the correct pattern. In part (iii), most candidates correctly calculated the wavelength of the sound but few were able to use these, in part (iv), to calculate the resonant lengths.

Q6 Most candidates were familiar with this material and responses tended to be very good.

(a) Most candidates recognised the advantage of imaging over exploratory surgery, but many failed to give a reason and so forfeited the second mark.

(b) In part (i), many candidates omitted to state that a non-coherent bundle of optical fibres is used in the illumination process. In part (ii), almost all candidates mentioned the coherent bundle of fibres for imaging but only a few offered additional detail to attract the second mark. Some candidates mistakenly referred to "incoherent" bundles of fibres.

(c) In part (i), candidates' explanations generally failed to offer the detail required on energy conversion during the ultrasonic scan. In part (ii), candidates demonstrated a high level of knowledge of the differences between A and B scans. Candidate responses tended to lack structure and many failed to contrast both types of scan. In part (iii), candidates were familiar with the use of gel in this context but very few could compose a response to attract the mark. Some candidates incorrectly referred to the gel as a "bonding agent".

(d) Almost all candidates appreciated that x-rays are used in CT scans but surprisingly few know that MRI scans make use of radio waves.

Q7 Aspects of this question challenged many candidates.

Part (i) of this question was poorly answered with many candidates focussing on the negative charge of the electrons to explain the negative energy levels. Part (ii) was well answered – most candidates correctly described the allowed energy levels and understood that a downward electron transition results in the emission of a photon with wavelength proportional to the difference in allowed energy levels. Many candidates correctly answered part (iii) of this question. Part (iv) was generally accurately done but a significant number of candidates incorrectly found the difference between a higher energy state and the ground state. There were many correct answers to part (v) of this question. Most sources of error arose from the identification of the transition energy.

Q8 Many candidates responded positively to parts of this question.

Part (i) of this question was frequently well answered. Many candidates incorrectly offered electron diffraction and some stated the photoelectric effect – suggesting that they had read the question inaccurately. Responses to part (ii) tended to be accurate. Explanations of de Broglie wavelength in part (iii) were not good with many candidates omitting the fact that the particles must be moving. Graphs, in part (iv), were well sketched, although some candidates carelessly allowed the curve to intersect an axis.

Once again many candidates' responses hinted at the correct idea but credit could not always be awarded. For example, some candidates omitted to state the concentric nature of the fringes. Very few candidates correctly described how the pattern would change with increasing energy.

The calculation to determine the momentum of the electrons, in part (i), was well executed. In part (ii), many candidates went on to determine the correct electron kinetic energy.

Assessment Unit AS 3 Practical Techniques

Q1 Most candidates responded very positively to this question.

(a) This question was well answered. Occasional errors arose when candidates omitted to calculate the periodic time from their multiple oscillation measurements. Almost all candidates repeated readings. The most common error resulting in a penalty was to record the distance in incorrect units.

(b) In part (i), most candidates realised that the period of the oscillation increased as the depth of the loop increased. Part (ii) was generally well answered although some candidates omitted to support their answer with an appropriate calculation. Candidates are advised that the Senior Examining Team considers the terms 'proportional' and 'directly proportional' to convey the same mathematical relationship.

Q2 Many candidates found aspects of this question challenging.

(a) Measurements were usually correct with appropriate uncertainties.

(b) The calculation of absolute uncertainty proved difficult for some candidates who incorrectly added the two uncertainties. A number of candidates correctly and appropriately used the 'maximum/minimum' method.

(c) Responses to this question were rarely correct as most candidates failed to suggest using more than one sheet of paper. The micrometer screw-gauge was most often chosen as the measuring instrument.

Q3 Almost all candidates engaged positively with all parts of this question.

(a) Reading the meters and recording the corresponding values of voltage and current caused candidates no problems.

(b) The calculation of power was well done; while P=IV was used most often equations incorporating R were also used.

(c) This part discriminated well between candidates. Most candidates gained credit for identifying the resistance closest to the internal resistance. Unfortunately, the descriptions of a method to find a more accurate value for the internal resistance seldom attracted further credit. Candidates suggested a spread of methods that were awarded marks, the use of the negative gradient of a potential difference – current graph was most popular.

Q4 The majority of candidates found all parts of this question accessible.

(a) Most candidates populated the table accurately. Some candidates incorrectly recorded the values of the wire diameter to 0.001 mm, while others misread the micrometer screw-gauge as 0.77 mm instead of 0.27 mm, for example.

(b) Most candidates determined a value for the resistivity that was consistent with the values in their table, however, calculations were often poorly laid out. Cross-sectional area was often mis-calculated - very often because the candidate had confused diameter and radius. Other candidates attempted to calculate volume by multiplying length by diameter. Power-of-ten errors were common.

Q5 Many candidates experienced difficulties with parts of this question.

(a) It was very rare for a candidate to receive both the marks for this part as so many candidates failed to record all their values to three significant figures. Many candidates incorrectly calculated speed by using values of wavelength and time from the table. Candidates should be advised to engage closely with the context of the question.

(b) In part (i), few candidates experienced any difficulty in squaring both sides of Equation 5.1and subsequent mapping to y=mx+c was usually excellent. Part (ii) was also very well answered.

(c) In part (i), the unit for the heading was often incorrect but the values for speed squared, in part (ii), were generally credited. In part (iii), the graphs were well drawn with just a few candidates exhibited poor scales but most labelled their axes consistently with the table.

(d) In part (i), almost all candidates were able to find a consistent gradient from a large triangle. However, a number of candidates' responses contained unit errors. The calculation of constant P, in part (ii), proved difficult for some candidates and many answers were not within the range to receive the quality mark.

(e) This question was answered very well by some candidates but it was clear that others had just randomly drawn a line on the grid. Those with an incorrect P value rarely went on to score here.

Assessment Unit A2 1 Momentum, Thermal Physics, Circular Motion, Oscillations and Nuclear Physics

Q1 This question was generally well answered.

(a) Almost all candidates successfully applied the conservation of momentum principle to this scenario and obtained a correct value for the velocity of the trolley.

(b) Many candidates gave the answer to the loss in kinetic energy as 60% which was incorrect. The correct answer was 40%. The error indicates that a degree of confusion existed in the minds of candidates in applying the physics to the specific context of the question. Other candidates who answered 60% had not read the question carefully enough.

Q2 The majority of the candidature responded positively to this question.

(a) Candidate statements of Boyle's law generally contained all the required information and received full marks. However, many responses (that received full marks) were poorly expressed. Candidates should be advised to learn text book statements of laws, principles etc.

(b) In part (i), the overall quality of the diagrams was good, however, some candidates produced diagrams of such poor quality that it was not possible to reward their effort. In part (ii), very few candidates obtained full marks as many overlooked the steer for "accurate" results. In part (iii) almost all candidates correctly identified the axes of the graph and sketched a suitable best-fit line. Candidates should be advised to use a ruler to sketch linear best-fit lines as it removes any doubt as to the candidate's intention.

(c) Many candidates' responses failed to adequately explain why the tube should have a constant diameter and scored only one mark.

(d) There was a good general appreciation of the physics in this question. Most candidates realised that the kinetic energy of the racing car was converted into heat energy in the brakes. A sizeable minority, however, became confused over the mass to use in the equations. It was particularly common for candidates to overlook the fact that the racing car had four disc brakes and consequently these candidates' value for the specific heat capacity was four times too large.

Q3 Aspects of this question stretched some candidates and challenged others.

(a) Parts (i) and (ii) of this question were straight-forward calculations which were well answered by candidates. Some mistakenly used the diameter rather than the radius in their calculation of force. Part (iii) was less well answered with many candidates omitting to specify that the horizontal component of the string tension provides the centripetal force.

(b) Almost all candidates appreciated the connection between the circular motion of the conical pendulum bob and the harmonic oscillation of its shadow and received the mark for stating the periodic time in part (i). However, part (ii) proved difficult for many candidates. A large number of candidates worked out the displacement correctly and gave it as the answer rather than using the displacement to obtain the answer.

Q4 Parts of this question were accessible to only the most able candidates.

(a) Answers to parts (i) and (ii) of this question were good. The physics was well known but some candidates omitted to provide an explanation and lost the second mark in each part. Part (iii) was less well answered.

(b) The sketching of the curve in part (i) often failed to attract both marks. The most common fault was for the curve not to show the radius varying as the third root of the mass number. Pleasingly, the calculation in part (ii) was successfully completed by the majority of candidates.

Q5 Elements of this 'stretch and challenge' question posed significant challenges for almost all candidates.

(a) In part (i), many candidates omitted some form of timer from their diagram and consequently forfeited the mark. In part (ii), only those responses that synchronised the starting of the timer with the measurement of the initial activity and linked the taking of subsequent activities at suitable time intervals received credit: few candidates were awarded both marks. A significant number of responses contained unnecessary information about the preparation of the isotope. However, in part (iii), while most candidates appreciated that the half-life of the isotope was the salient feature, only some candidates were able to express so satisfactorily.

The quality of written communication was generally good. Relevant ideas were usually expressed clearly through well-linked sentences and there were few errors in grammar, punctuation and spelling.

(b) Candidates generally used these decay graphs well. In part (i), the most common reason candidates lost marks was for not repeating and averaging the half-life calculation. In part (ii), most candidates successfully followed the conventional route of measuring the gradient to obtain the decay constant, converting that to the half-life and quoting the half-life in minutes. However, some candidates took the antilog of a value for ln(A./Bq), found the log of half that activity and determined the time from the horizontal axis.

(c) This unstructured calculation was very poorly answered. Many candidates picked up a mark or two but very few successfully completed it.

Q6 Candidates found this question accessible.

(a) The only significant issue to arise from this question was that Δm was frequently identified as mass rather than change in mass.

(b) The majority of candidates performed this calculation accurately. A large number of candidates elected to convert the mass defect into the binding energy using 1u = 931 MeV – which is, of course, acceptable. Some candidates omitted to divide their binding energy by twenty-four and forfeited the fourth mark.

Q7 The quality of responses to this question varied considerably.

(a) A surprising number of candidates missed the point of part (i) of this question and based their response on binding energy. In part (ii), some candidates indicated a degree of misconception by considering the kinetic energy of the fission fragments and heat energy generation as different. In part (iii), poor answering technique was in evidence as many candidates implied the correct response rather than stating explicitly that the melted fuel rods could form a super-critical mass within which a runaway chain reaction could occur unchecked. Part (iv) was generally well answered.

(b) In part (i) of this question almost all candidates provided a sound description of nuclear fusion. Part (ii) was less well done. It appears that very few candidates understand the role confinement plays in keeping the highly energetic, charged particles close enough together and for long enough to increase the chances of a fusion event occurring.

(c) In part (i), the deuterium-tritium reaction was generally well known by candidates as were the reasons, in part (ii), for making it the most suitable reaction for terrestrial fusion.

Q8 The standard of responses to this data-analysis question was generally very good.

(a) The majority of candidates were able to show mastery of converting equations into logarithm form and then mapping to y=mx+c.

(b) In part (i), it was not evident to a sizeable number of candidates that the reason for the increased variation was because the oscillations were too rapid and consequent timing periods were short. Failure to identify the answer to part (i) made it almost impossible to respond appropriately to part (ii) and suggest a practical step to improve reliability.

(c) Most candidates correctly manipulated the data in the table. However, a number of candidates did not calculate the periodic time from the data but took log (t_{av}/s). Unfortunately, some candidates did not engage closely enough with the question and used natural logarithms, while others failed to head their columns following the established protocol.

(d) Most candidates were able to complete graphs that were well scaled, with accurately plotted points and suitable best-fit lines.

(e) Most candidates were accurate in their determination of the gradient and the intercept and obtained values for the constants A and n consistent with their graphs.

(f) Many candidates did not obtain the correct answer to this calculation. Responses indicated a degree of carelessness in substituting; in particular, indices were often omitted when they had correctly featured at an earlier stage.

Assessment Unit A2 2 Fields and Their Applications

Q1 Most candidates found this question accessible.

(a) In part (i), the definitions of electric field strength were good with most candidates opting for the preferred word description as opposed to quoting the equation and explaining the terms. In part (ii), a number of candidates did not know that the direction of electric field strength is that followed by a positive charge. Part (iii) was generally well answered. Part (iv) was less well done; while almost all responses indicated that candidates were familiar with base unit manipulation, many candidates failed to complete the task successfully.

(b) Candidates are very familiar with the similarities and differences between electric and gravitational fields but some candidates lost marks because they did not customise their knowledge and understanding to answer this question which was specifically about the forces in the fields.

Q2 Candidate responses to this question tended to be positive.

(a) Part (i) was answered well by the majority of candidates. In part (ii), a large number of candidates successfully completed this calculation. Errors arose through the incorrect conversion between units.

(b) Statements of Newton's law of universal gravitation, in part (i), were generally very good. In part (ii), most candidates demonstrated the necessary skills to show that the square of the period is proportional to the cube of the radius. Many omitted to comment that $4\pi^2/GM$ is a constant and forfeited the last mark.

Q3 This question on capacitors was very well answered by most candidates.

(a) It was very rare for any candidate to drop the mark for part (i); the positions of the ammeter and the voltmeter in the charging circuit are very well known. Part (ii) provided a more challenging task for many. A common mistake was to show the current increasing with time to a maximum. The other main source of lost marks was the quality of the candidates' trend lines. In part (iii), most candidates responded appropriately – the number of candidates suggesting the inclusion of a larger resistance was much greater than the number opting for an increase in capacitance.

(b) Many candidates experienced problems with this unstructured calculation. It was particularly common for candidates to incorrectly take 76% of the energy of the flash.

Q4 Aspects of this question challenged many candidates.

(a) Part (i) was well answered with most candidates appreciating that there has to be a component of the current carrying wire perpendicular to the field. Part (ii) was also well answered, although there were some mistakes by candidates in marking the direction of the current through the vertical wire. Most candidates coped well with the calculation of magnetic flux density.

(b) Part (i) of this question revealed weaknesses in answering technique as some candidates described the function and not the structure, while others described the structure and not the function. The most common reason for a lost mark was failure to state that the two coils were linked by a core. The calculations in parts (ii) and (iii) were well answered by most candidates.

Q5 This question on electromagnetic induction was well answered by the majority of the candidature.

(a) Candidate statements of Lenz's law and Faraday's law were generally accurate and the descriptions as to how each is demonstrated with a bar magnet and a coil appropriate.

The quality of written communication was generally good. The correct definitions and descriptions were expressed clearly through well linked sentences that contained few errors in grammar, punctuation and spelling.

(b) Many candidates exhibited carelessness in their response to this calculation. Often the area of the coil was incorrectly calculated or a power-of-ten error introduced.

Q6 This question was well answered by candidates.

(a) Those candidates who responded to each element within part (i) of the question tended to score well. In part (ii), a number of candidates omitted to mention the polarity of the plates and forfeited a mark.

(b) Few candidates experienced any difficulty in correctly answering part (i). In part (ii), most candidates used the data to correctly determine the time-base setting.

Q7 Lots of high quality answers were in evidence for this question on particle accelerators.

(a) This was very well answered. Some candidates lost marks because they didn't specify that the circular path followed by a particle in the cyclotron had an increasing radius.

(b) Almost every candidate responded to this question in such a way as to be awarded the mark.

(c) This question challenged some candidates and a number of them did not attempt an answer.

Q8 This question on particle physics was generally well answered.

(a) Parts (i) and (ii) are frequently asked questions and responses to them were excellent overall. Candidates tended to be awarded either all four marks or zero.

(b) Most candidates were able to identify the category of hadron each of the quark structures represented in parts (i) and (ii). Many candidates found it much more challenging to determine the charge of those hadrons.

Q9 In general, candidates found all parts of this synoptic question accessible.

(a) This part of the question was well answered. In part (i) the responses of only very few candidates could not be credited. Often this was because the direction was omitted or wrong; sometimes poor or careless drawing of the field lines was the reason. There was little challenge posed for most candidates in calculating of the height of the cloud in part (ii) and the energy of the lightning strike in part (iii).

(b) The physics required for part (i) was well known; however, the poor answering technique of many candidates as exhibited in their responses to this "show that" question meant that marks could not be awarded. Part (ii) of this question was more challenging and a number of candidates did not identify the relevance of the momentum conservation principle to it.

(c) In part (i), the use of the general wave equation in determining the wave speed was correctly done by almost all candidates. The description in part (ii) was less well answered. Again there were issues with answering technique as not all candidates described and explained the impact on amplitude and wavelength.

Assessment Unit A2 3 Practical Techniques

Q1 The majority of candidates answered this question very well.

(a) In part (i), an over whelming number of candidates arranged the apparatus correctly and recorded accurate values for 'b' in centimetre. Given the nature of this experiment, it was considered inappropriate to expect measurements of the image distance to be given to 1 millimetre precision but no mark penalty was levied for those who did. Some candidates mistakenly recorded 'a'+'b' values in the column for image distance. In part (ii), almost all candidates correctly calculated a reliable value for the focal length of the converging lens. However, two issues were apparent. First, many candidates presented their working out in a random structure. Given that this is a test of "Practical Techniques", it is a cause for concern that so few of the candidates will attempt to generate tabulated/systematic results unless so directed. Secondly, a minority of candidates found the mean of the object distances and the mean of the image distances and used them in the lens equation. Given that the means calculated are of limited physical value, this technique was considered invalid and these candidates were penalised one mark. In part (iii), almost all candidates failed to compare their value for the focal length of the converging lens quoted to one significant figure with the value quoted to one significant figure given in the paper.

(b) Almost all candidates correctly followed the instructions to re-position the metre rule and place the diverging lens at the distances 'c' given in Table 1.2. Most went on to record accurate values for distance 'd' but some recorded the 'c' + 'd' distance by mistake and forfeited the last mark.

(c) In part (i), few candidates were unable to identify f_2 as the gradient and 33 as the intercept (17 session 2). Some candidates lost the mark for not quoting y=mx+c; revealing a weakness in their answering technique rather than in their knowledge and understanding of practical physics techniques. Part (ii) was responded to successfully by most candidates: values calculated allowed graphs to be drawn with an appropriate horizontal scale, accurately plotted points and a considered best-fit line in part (iii).

(d) Most candidates followed the accepted procedure of using points from the best-fit line that are sufficiently distant to calculate the gradient. A number of candidates lost the final mark because they ignored the fact that the gradient (and diverging lens focal length) was negative.

Q2 It is clear that the candidature is very familiar with this experiment and the responses from most candidates were excellent.

(a) A large number of candidates obtained an accurate value for the resistance but not all did so in a systematic manner. A large number of candidates introduced power-of-ten errors; some because they incorrectly read or recorded the value from their microammeter others because they didn't know the 'micro' prefix. In an analogous calculation to that commented on in Q1(a), a large number of candidates calculated the mean p.d. and the mean current and used these values to calculate resistance. As in Q1(a), this is considered to be an invalid technique and such candidates were penalised a mark. However, candidates who made this mistake in both experiments were penalised only once.

(b) The measuring and recording of the voltage variation over the 90 second duration posed few problems to any of the candidates. Some candidates recorded discharge voltages that were atypical but yet conformed to the marking points and so received full credit.

(c) In part (i), a large number of candidates failed to apply the accepted protocol of "ln(quantity/unit)" and so lost the first mark. Most however, correctly took the natural logarithm of their discharge voltage and received the second mark. Only a small number of candidates used logarithms to base ten. In part (ii), the graphs produced by the majority of candidates were of excellent quality and illustrated the accuracy of the measurements taken in (b). Some candidates introduced axes labelling that was wrong and not consistent with their label in Table 2.1; they were duly penalised.

(d) Many candidates exhibited poor answering technique in part (i). This question asked the candidate to explain how the gradient equals -1/CR which means the candidate has to show the examiner ALL stages of the explanation clearly – many did not do so. The generous mark allocation in part (ii) was exploited by almost all candidates. In part (iii), most candidates found the intercept accurately and manipulated that to get a value for the initial voltage. Some candidates realised that the answer should be what they recorded for the discharge voltage at time zero in Table 2.1; this response was considered worthy of full credit only if that point was the actual intercept of their best-fit line.

Q3 Parts of this question challenged many candidates.

(a) In part (i), most candidates stated a suitable value for the absolute uncertainty in measuring the length of the string. However, a large number of those candidates failed to make clear that the measuring uncertainty had to be applied at each end of the string. In part (ii), almost all candidates identified the correct balance and most correctly based their explanation on the precision of the instrument. However, not all of these candidates were awarded the mark because their answer did not make explicit that the precision of the measurement and the precision to which the balance recorded were the same. In part (iii), most candidates were able to accurately calculate a value for the mass per unit length and state it to three significant figures. A large number of candidates were unable to manipulate the uncertainties correctly.

(b) In part (i), almost all candidates appreciated that the weight of the slotted masses provided the tension in the string and explained how weight is determined from mass, receiving full credit. The essentials of the derivation in part (ii) were evident in many responses but often the derivations lacked structure. It was as if many candidates were proving Equation 3.3 correct to their own satisfaction rather than explaining to the examiner how the equation is obtained. Only a handful of candidates failed to identify the correct length of string to measure in part (iii). Part (iv) was poorly answered as many candidates ignored the instruction to "Describe how you would use the apparatus ...". Part (v) was generally well known but poorly described. It was very common to read about measuring the 'length of a wave' or the 'wavelength'; these phrases were not considered credit worthy. In part (vi), most candidates correctly identified a graph to draw and showed how the gradient was linked to the mass per unit length.

Contact details

The following information provides contact details for key staff members:

- Specification Support Officer: Nuala Braniff
  (telephone: (028) 9026 1200, extension 2292, email: nbraniff@ccea.org.uk)
- Officer with Subject Responsibility: Kevin Henderson
  (telephone: (028) 9026 1200, extension 2270, email: khenderson@ccea.org.uk)