CCEA GCE - Physics
(Summer Series) 2014

Chief Examiner's Report

Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Physics for this series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) 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

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GCE PHYSICS

Chief Examiner's Report

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 This question was very well answered by many candidates.

In Part (i) of this question, almost all candidates correctly stated the ohm as the SI unit of electrical resistance. Fewer candidates were able to explain what a derived unit is as required in Part (ii). In Part (iii), most candidates were able to determine the base units of resistance and, in Part (iv), most correctly classified resistance as a scalar quantity and were able to explain why.

Q2 This question was generally well answered.

(a) The physics behind this kinematics question was well known but a number of candidate responses were poor. In this 'show that….' type of question it is incumbent upon the candidate to clearly show the logical progression from physical relationship (equation) through substitutions into the relationship (in SI units) to the numerical answer (given to one more significant figure than the 'show that' value).

(b) In Part (i), the calculation of runway length and consequent distance by which it is short were accurately executed. Part (ii) was answered less well. Most candidates indicated the need for greater acceleration but did not relate this, via Newton's second law, to a practical course of action that would lead to a reduction in the mass being accelerated.

Q3 Parts of this projectile motion question challenged many candidates.

Part (i) was well answered by most candidates although a number did not accommodate the direction difference in initial velocity and acceleration of freefall correctly and others did not calculate the vertical component of the shot's velocity. In Part (ii), many candidates correctly calculated the vertical distance risen in the time calculated in Part (i) and most remembered to add on the 2.0 m to obtain the distance of the shot above the ground at its maximum height. In Part (iii), finding a value for the time the shot was in the air challenged most candidates. Many candidates simply doubled the time taken to reach the maximum height – despite Fig 3.1 clearly showing that the motion was asymmetrical. It was encouraging to see that most candidates knew that the horizontal component of the shot's velocity was constant.

Q4 Some candidates were challenged by parts of this question.

(a) In Part (i), not all candidates realised that the work done by the opposing force during the motion must be equal to the kinetic energy with which the stone was launched and so were unable to complete the calculation. Part (ii) introduced an additional component into the motion of the stone. Not very many candidates were able to accommodate the reduced opposing force over the final three metres of the stone's journey correctly and lost the two marks available for this part.

(b) Candidates' responses to this question were not good, with weaknesses in both physics and the quality of written communication in evidence. Many answers stated that the stone will 'speed up' as a result of the sweeping!

Q5 This moments question was well answered.

(a) Most candidates correctly defined the moment of a force.

(b) The calculation of percentage reduction in Part (i) challenged some candidates. The calculation of the moment produced by the woman was generally well answered with most candidates realising that a component of the wrench length (or force) was required.

Q6 Candidates responded positively to most parts of this question.

(a) Definitions of power were usually very good.

(b) This part was very well answered and only a few candidates were discomfited by the mass of the soldier and his backpack being given separately.

(c) Many candidates experienced difficulty in accommodating the 35% of kinetic energy converted to heat and sound. Otherwise, the energy conservation in this context was well handled.

Q7 This question was poorly answered.

(a) This part presented problems to many candidates. Very few candidates appreciated that the gradient would give a mean value for the quotient of force and displacement, which could be used in the Young modulus equation. Most candidates preferred to take the co-ordinates of a single point and substitute these into the relationship for the Young modulus. Many candidates introduced power-of-ten errors in their calculation of cross-sectional area.

(b) Candidates' responses to this question frequently revealed poor answering technique. There were three marks available and responses did not reflect this. Very few candidates attempted an explanation of 'tensile'.

Q8 This question was very well answered.

(a) Part (i), testing the definition of current, was correctly answered by most candidates. Part (ii), testing the definition of the volt, posed problems for some candidates but a large majority performed the calculation correctly.

(b) Most candidates correctly calculated the charge that passed (any point in the wire) in ninety seconds and completed the calculation by dividing by the electronic charge.

Q9 Aspects of this resistivity question challenged many candidates.

(a) This part was well answered by the majority of candidates. However, some incurred power-of-ten errors and others confused radius and diameter in their calculation of the cross-sectional area of the fuse wire.

(b) Only a handful of candidates received all three marks for their responses. Again, candidate answering technique was often poor. Most candidates did suggest a physical change to the wire used but fewer went on to explain how their physical change would result in the desired outcome.

Q10 The physics tested in this question was well known by most candidates.

(a) This part was well answered by the majority of candidates. However, a number of responses were too general and did not provide the numerical values for internal resistance and electromotive force required for full credit. Some candidates incorrectly stated that the internal resistance was negative (-) 1.8 Ω.

(b) Part (i) of this question was well answered. The most common mistake was to draw a fixed value resistor. Circuit symbols were generally well known but it was not uncommon to see ammeters and voltmeters with lines running through them; these responses lost credit. Part (ii) was well answered although some candidates did not state clearly how the values of voltage and current were to be varied.

Q11 The potential divider circuit continues to challenge many candidates.

(a) Very few candidates answered this question correctly. Many gave an answer of 6 V as they did not appreciate the consequence of placing the voltmeter in parallel with the resistor.

(b) Many candidates scored one out of two marks here as they didn't give enough detail to explain why the output voltage did not change when the voltmeter was in place across R1.

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 Many candidates scored well on this question.

(a) In Part (i), many candidates described a wave as a 'transfer of energy' thus failing to answer the question as to what a wave is; others correctly identified the idea of a 'vibration' which satisfied the requirement of the mark scheme. Candidates' responses to Part (ii) were generally more successful, with many candidates able to describe oscillations/vibrations as being perpendicular and parallel to the wave direction. Some candidates, however, made no reference to the longitudinal wave, and so lost the second mark.

(b) Almost all candidates gained at least one mark for identifying the correct regions of the spectrum in Part (i). A large number of candidates incorrectly identified microwaves as radio waves and there was evidence that candidates recognised picometre as 10-12 m and associated this with the gamma region, rather than converting the 560 pm to standard form and identifying 5.60 x 10-10 m as falling in the x-ray wavelength region. Most candidates gained all three marks in Part (ii); some were awarded only one mark for the standard error of performing the calculation with the highest frequency.

(c) Polarised waves were generally correctly described in Part (i) of this question. A large number of candidates gained only one of two marks in Part (ii) by describing the use of two polaroid filters rather than one, exposing a lack of appreciation that the light was already polarised.

(d) The majority of candidates gave a correct difference between electromagnetic waves and other transverse waves.

Q2 This question was very well answered by most candidates.

(a) The graph axes were correctly labelled by most candidates and a straight line drawn from the origin by most candidates in Part (i) of this question. The gradient of the graph was identified as the refractive index (or the reciprocal of the refractive index, as appropriate) in Part (ii) for all but a small number of candidates.

(b) Nearly all candidates correctly used the equation to calculate the critical angle in Part (i). A large number of candidates achieved full marks in Part (ii) for choosing path 2 and explaining their reason for rejecting paths 1 and 3. A candidate incorrectly choosing path 1 could gain a mark for explaining why there was no total internal reflection at the boundary. For candidates who calculated the critical angle incorrectly, there was the possibility of receiving some credit for responses consistent with their critical angle.

Q3 The majority of candidates found this question accessible and scored highly.

(a) The full definition of principal focus was not always given. Many candidates omitted to state that the incident rays had to be parallel to the principal axis.

(b) The ray diagram was generally well-drawn in Part (i), with almost every candidate drawing two rays correctly. Arrows were quite often omitted from the rays, which incurred a penalty. A small number of candidates incorrectly directed rays from the image to the object. Most candidates responded successfully to Part (ii) by recalling that an object position beyond 2F was required for a diminished image.

(c) Most responses to Parts (i) and (ii) were credited; a negative value on the answer-line was accepted in both cases. A small number gained one mark for evidence of correct substitution into the formula in Part (i) with an incorrect answer. Errors were carried forward from Part (i) to Part (ii) and also from an incorrect calculation of magnification within Part (ii). In Part (iii), candidates were expected to recall the nature of the image formed when the object is placed closer to the lens than the focal length and no errors were carried over from previous parts. In Part (iv) the lens power was required as a decimal fraction to at least two significant figures and the responses of most candidates conformed to these requirements.

Q4 Many candidates found some parts of this question challenging.

(a) Most candidates gained both marks for their labelled sketch, with the second mark awarded for tuning fork(s) in any position relative to the open tube.

(b) Some candidates gave a very concise and accurate response for three marks. However, in many cases the first marking point was missed, as candidates failed to make clear that they were identifying the first position of resonance (by initially having the resonance tube in its lowest position, for example, if that was the method being described).

(c) Some candidates described measuring the length of the resonance tube rather than the air column, which lost them the first mark. Candidates describing a graphical method of dealing with the results were more likely to score all three marks, and very many did, but others missed the third mark for failing to describe repeating the experiment for various frequency values and finding an average value of speed.

(d) This part proved challenging, with many candidates scoring only the mark for naming the principle of superposition. The second mark required that candidates identified the interference between the incident and reflected waves. The third mark was achieved by a very small number of candidates, who described the standing wave as being the result of driving frequency matching natural frequency of the air column.

Q5 Although some parts of this question challenged many candidates, it was accessible overall.

(a) A high degree of accuracy was required to gain three marks for the graph in Part (i). Whilst the vast majority of the candidature sketched a reasonable curve, in many cases candidates either did not choose correct limits on the intensity axis or were careless with the maximum and minimum frequencies. Many candidates explained the ear's logarithmic frequency scale by stating that 'the ear's response is logarithmic' in Part (ii), which was not worthy of credit.

(b) There was a good response to Part (i), where all three substitutions into the equation were necessary. Many candidates offered fully correct solutions to Part (ii) and a smaller number who arrived at the standard error of 0.2 dB by working with an intensity of 95% of the total rather than a reduction of 95%. A number of candidates incorrectly calculated 5% of the intensity level.

(c) Some candidates carefully read the question and correctly identified the four points that were worthy of credit. However, in a number of cases, the frequency of the ultrasound was neglected. Other candidates described the piezoelectric principle rather than the principle of reflection from internal tissue boundaries, and some gave unnecessary descriptions of the use of coupling gel. Most candidates were aware that the A scan gives information on depth/distance, but not many gave the detail of the time-based display.

Q6 Parts of this question proved challenging to many candidates.

(a) Candidates generally did not score well in Part (i) when asked to relate the formation of the line spectrum to the existence of energy levels within hydrogen. Many candidates correctly characterised the energy levels as 'discrete' or 'specific', and a large number of candidates referenced a transition of electrons between levels, but the emission of photons of specific wavelength was not often stated. Candidates were generally more successful at answering the numerical part of this question, and a good number achieved two or three marks for Part (ii). For two marks, some candidates correctly used the equation and calculated energy in joules, but then proceeded to find the difference between two energy values, before correctly making a conversion from joules to electron-volts.

(b) The majority of candidates correctly identified the photoelectric effect in Part (i). Part (ii) contained an error. The word "lower" rather than "longer" was used with respect to the wavelength of the light. At awarding, the 3 marks allocated to this question part were discounted and the remaining 10 marks for Question 6 were scaled up to 13 marks. A comprehensive review of all candidates' scripts confirmed that no candidates were disadvantaged by the error or the subsequent remedial action taken.

(c) Many candidates failed to understand that the de Broglie wavelength was the wavelength of a moving mass or particle – most candidates merely described the equation in terms of Planck's constant and momentum in Part (i). There was a large number of correct answers to Part (ii), but some candidates introduced power-of-ten errors into their calculations.

Assessment Unit AS 3 Practical Techniques

Q1 Most candidates answered this question very well.

(a) Almost all candidates followed the instructions correctly and produced accurate ray tracings. The most common cause for losing credit was a failure to draw rays with a direction arrow. A number of candidates completed the ray tracing for both incident angles on the same diagram; these candidates were not penalised. Disappointingly, some candidates measured their angles from the edge of the transparent block rather than the normal.

(b) In Part (i) of this question the lateral displacements measured by the majority of candidates were consistent with their diagrams and the mark could be awarded. In a few cases the displacement was measured as the distance parallel to the edge of the transparent block despite the information being given in words and in Fig. 1.4! In Part (ii), the factors suggested by most candidates were sensible and again the mark could be awarded.

Q2 Some parts of this question challenged many candidates.

(a) Most candidates were able to use the micrometer screwgauge and the vernier callipers correctly. However, a significant number of candidates did not record their results to a precision that was consistent with the instrument used and consequently were penalised the mark. In other cases the instruction to obtain 'reliable values' was not observed and these candidates were penalised one mark.

(b) Most candidates received full credit for this question. However, many of these answers were not well set out. It was common to see a principle of moments calculation from which it was usually possible to identify the first two marking points. Candidates should be advised to set their work out logically and also to consider how reasonable their answers are when performing calculations (such as the mass of a metre rule).

Q3 This question was very well answered.

(a) The extension of the spring produced by the addition of the load was, in almost all cases, consistent with the measurements of spring length.

(b) The majority of the candidature is familiar with the requirement to repeat the timing for multiple oscillations from which an average timing can be obtained and the measurement scaled down to find the periodic time. Again, most candidates correctly ensured that their value for periodic time (in seconds) was given to two decimal places to reflect the fact that the timing equipment used measures to one hundredth of a second. Candidates should be advised that the number of oscillations to be timed is dependent upon the experimental arrangement and upon the extent to which the percentage uncertainty in the periodic time is to be reduced.

(c) In most cases candidates calculated a value for the acceleration of freefall that was consistent with their results and lay within the quality range and so could be awarded full marks.

Q4 Most candidates obtained full marks in this question.

(a) Few errors were observed in the recording of the current and voltage. Occasionally values were not recorded to a number of decimal places consistent with the precision of the measuring instrument and a penalty of [-1] was applied. A minority of candidates introduced a power-of-ten error into their values for resistance as they overlooked the milliampere unit for current.

(b) Most candidates correctly deduced the arrangement of the resistors in the two networks. A number of candidates incorrectly deduced that two resistors were in series and this series pair was in parallel with a third for network OC (network OB in Session 2).

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

(a) Sketch graphs of air density against air temperature were generally well done. Most candidates realised that the quantities were indirectly proportional and sketched an appropriate curve. Some responses incorrectly showed an intercept on one axis or both axes.

(b) In Part (i) of this question, almost all candidates appreciated that the data in Table 5.1 were given to three significant figures. In Part (ii), the most common error was to state that the unit of 1/T is the kelvin rather than kelvin-1. In Part (iii), most candidates correctly calculated the values for 1/T but some did not record them corrected to three significant figures. In Part (iv), most graphs were well drawn. Almost all the errors made related to the scaling of the axes; starting from the origin caused the plotted points to bunch and awkward scales often led to inaccurate point plotting. These were the two most common causes of lost marks.

(c) Gradient determination, in Part (i), was generally well done. Most candidates selected widely separated points from their best-fit line, recorded their data accurately, calculated the gradient correctly and stated a unit consistent with the headings in Table 5.1. Using the gradient, in Part (ii), to determine the value of S (B in Session 2) was also well done by most candidates. The most common error here was to introduce a power-of-ten error because atmospheric pressure was given in kilopascal.

(d) A surprising number of candidates did not identify the need to draw an extreme fit line in order to complete this question. Some of the extreme fit lines drawn appeared random, bearing little relation to the spread of the plotted points. Most candidates appreciated that when calculating the percentage the value for S (B in Session 2) obtained from the best-fit line should be the denominator.

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

Q1 This question was generally well answered.

(a) Almost all candidates correctly calculated the momentum of the alpha particle.

(b) The majority of candidates appreciated that the solution to this question required the application of momentum conservation and many went on to correctly determine the magnitude of the velocity. Of those who failed to do so, most experienced problems in obtaining a value for the mass of the polonium nucleus. Almost all candidates correctly identified that the velocity direction must be opposite that of the alpha particle. A number of candidates merely answered 'left'!

(c) This question was generally well answered although there were some candidates who appeared not to know that the descriptions 'elastic' and 'inelastic', in this context, referred to the conservation of kinetic energy.

Q2 This question was well answered.

(a) Almost all candidates obtained full credit for both parts of this question. Some candidates, in Part (ii) suggested using a heat sink to counteract the increase in mean molecular kinetic energy but this was a change to the apparatus rather than the procedure and did not receive any credit.

(b) Part (i) of this question was very well answered; responses to Part (ii) were much more varied. Most candidates approached Part (ii) correctly but the vast majority failed to obtain a correct value for the length of the gas column. Many candidates also introduced power-of-ten errors.

Q3 Candidates' responses to this 'stretch and challenge' question were mixed.

Many candidates correctly calculated the energy loss from the 500g water sample. Most candidates incorrectly assumed that the same amount of energy would be extracted from the 350g sample after its 30 minutes cooling. A sizeable minority of candidates correctly determined the mean power loss and many of these candidates used the value to determine the final temperature of the water. A large number of candidates did not appreciate that a temperature difference of 6.9°C is also a temperature difference of 6.9K.

Q4 This question was very well answered.

(a) Very few candidates were unable to correctly determine the angular velocity.

(b) Most candidates successfully calculated the centripetal force on the racing car. However, a large number of candidates experienced difficulty in determining the radius of the racing car's circular path and consequently forfeited a mark.

Q5 Answers to this question were generally very good.

(a) Almost all candidates correctly identified the motion as simple harmonic. Most went on to demonstrate that the straight line through the origin represented proportionality between acceleration and displacement and that the negative gradient indicated that the displacement and acceleration acted in opposite directions.

(b) Part (i) of this question was well answered; however, a few candidates were unable to determine the periodic time from the acceleration – displacement graph.

(c) Most candidates correctly identified the amplitude as additional evidence to support the assertion that both graphs described the same motion.

Q6 Parts of this question challenged many candidates.

(a) Part (i) of this question required candidates to consider the 'fair test' concept and many realised that, in order to isolate the scattering due to the gold that the scattering from the glass by itself has to be subtracted from the total scattering at each angle. Part (ii) required candidates to engage closely with the information provided and realise that a person counting the number of flashes per minute would find it impossible to accurately count the large number of alpha particles scattered through an angle less than 60°. Part (iii) required the candidates to realise that the alpha particles were coming from a radioactive source and that during the 51 hours of the experiment the decay of the radioactive source would mean emission of fewer alphas by the source. Consequently, the making of a fair test relied on data being adjusted up.

(b) This question was well answered. Most candidates were able to link the experimental results of large numbers of alpha particles passing through at small scattering angles and a small number being back scattered with the idea of a small, positively charged nucleus.

Q7 This question challenged many candidates.

(a) In Part (i), many candidates were unable to adequately explain the random nature of radioactive decay. A common mistake was to rephrase, rather than explain the statement. In Part (ii) very few candidates appreciated that exponential decay means the quantity being considered decreases by a fixed fraction in a fixed time interval.

(b) Specification Section 4.6.4 requires students to be able to *model with a constant probability of decay* and this question addressed that requirement. In Part (i), many candidates indicated familiarity with a model (dice being the most common) but some, contrary to the demands of the question, described an experiment using radioactive material. Part (ii) required analysis of the results obtained from the experiment in Part (i). Very few candidates obtained full marks here. Often candidates' sketch graphs did not have intercepts and frequently no explanation was provided as to how the graph shows exponential decay.

(c) Many candidates struggled with this calculation. Responses indicated inconsistency between the activity in becquerel and the decay constant in 'per day'. Additionally, many candidates mistakenly took the product of the decay constant and the initial number of atoms as the activity after one day.

Q8 This question was well answered by the majority of candidates.

(a) Almost all candidates were able to successfully complete this familiar type of calculation. A few candidates incorrectly used mass measured in unified atomic mass units in Einstein's mass-energy equation.

(b) A sizeable minority of candidates struggled to determine the number of uranium-235 nuclei (atoms) in 1 kilogram and so lost the first mark. Responses that merely substituted 1kg into the mass-energy relationship were common.

Q9 Most candidates were able to respond positively to this question.

(a) Almost all candidates named the function of the boron rods but not all went on to explain that the rods have to be able to move up and down in order to sustain criticality.

(b) Most candidates realised that this question was about the critical size/mass of the fissile material and responded accordingly.

(c) In Part (i), most candidates knew that the moderator had to slow neutrons but not all went on to explain that this was because uranium - 235 could only absorb the neutrons at lower speeds. In Part (ii), lots of candidates lost a mark through failure either to name the second function or to explain why it is necessary.

Q10 There were a number of very good responses to this question.

(a) In Part (i) of this question almost all candidates appreciated the need for high temperature (molecular kinetic energy) but only a few responses indicated the requirement that the reactants had to be in close proximity for a sufficient length of time to increase the opportunity for two reactants to meet and fuse. Part (ii) was well answered, although unfortunately some candidates simply named the plasma confinement methods and lost all three marks.

(b) This calculation was very well answered.

Q11 This question challenged many candidates.

(a) This multistage, unstructured calculation was completed correctly by a large number of candidates. The use of 'error-carried-forward' (ECF) within this question allows many candidates to pick up credit. A small number of candidates did not read the question carefully and used the wrong isotope.

(b) Drawing the best fit curve was not well done in Part (i). In Part (ii), only a few candidates interpreted the description correctly to find a range that lay within the mark scheme tolerance. In Part (iii), only a few candidates appreciated that the alpha particle slowed as it got further from the source. Few candidates received this mark.

(c) In Part (i), most candidates realised that it was necessary to map the equation to $y=mx+c$. Not all candidates went on to prove that the gradient was 1.4 and even fewer proved that the intercept was -45. The unstructured nature of Part (ii) left many candidates not knowing how to respond. Regardless of the method chosen, there were two marks for obtaining a value for one quantity using the data for the other quantities. The second two marks were for finding the percentage difference between the calculated quantity and that given.

Assessment Unit A2 2 Fields and their Applications

Q1 This question was generally well answered.

(a) The definition of gravitational field strength was well known, though some candidates confused definition with a simple statement of what was meant by a gravitational field.

(b) Part (i) was well answered with most candidates scoring full marks. In Part (ii), most candidates knew the equation and substituted correctly to obtain full marks but others had incorrect values for the radius and/or forgot to square the radius value even though they had it correct in the equation. In Part (iii), some candidates calculated the value for the Earth-Moon force rather than using the value given in Part (ii)! Many candidates substituted incorrect values for the separation and/or the mass into the equation thereby revealing only a superficial understanding of the Physics.

(c) Many answers lacked full explanations, with reference to direction and equatorial orbit being frequently omitted.

Q2 The majority of candidates responded positively to this question.

(a) Part (i) was well answered by most candidates although some ignored the words 'in the force' from the stem of the question and gave answers referring to the field instead. Part (ii) was also well answered with most candidates scoring at least two marks. Some did not know the name of the law and others inexcusably confused k with the Boltzmann constant.

(b) In Part (i), most candidates knew the shape of the graph although some incorrectly showed intercepts and were penalised. Few candidates scored full marks in Part (ii). Weaker candidates tended to calculate the force between the charges. Of those who correctly calculated values of electric field strength for each charge at the midpoint, many then got the addition incorrect and lost the final mark. The direction of the electric field strength was generally correctly identified.

Q3 Many candidates were challenged by parts of this question.

(a) Part (i) was very well answered. Part (ii) was also well answered by most candidates, although some did not know the relationship for capacitor energy.

(b) Almost all candidates correctly calculated the capacitance across the capacitor network.

(c) Part (i) was poorly answered. Most candidates discussed the transfer of charge but gave no detail as to how the polarity of the charging capacitor is linked to the polarity of the charging battery. Most candidates correctly sketched the variation in capacitor p.d. with time in Part (ii). Part (iii) was well answered although some candidates merely stated that the rate of discharge would change without providing detail as to how it would change. In Part (iv), the definition of capacitor time constant was well known by some candidates but others just provided the equation as their answer.

(d) This question was answered well by most candidates. Very few realised that 12 seconds was the time constant from the values given and used $V = V_0 e^{-\frac{t}{RC}}$!

Q4 Many candidates experienced problems when answering parts of this question.

(a) This question was very poorly answered but most candidates were awarded one mark for identifying that the weber was the S.I. unit of magnetic flux.

(b) Parts (i) and (ii) were well answered by most candidates although some candidates introduced power-of-ten errors into their answers.

(c) In Part (i) of this question, Lenz's Law was well known although some candidates carelessly omitted some details. A few candidates confused Lenz's with Faraday's Law. In Part (ii), almost all candidates recognised that a current would be induced in the coil of wire. Some candidates then described how the direction would change if the magnet was turned around but failed to mention the N pole produced or the resulting repulsion.

The quality of written communication in the answering of Part (c)(ii) was generally of a high standard allowing both marks to be awarded to most candidates.

(d) In Part (i), power-of-ten errors were common; many candidates could not convert from square centimetre (cm^2) to square metre (m^2). The calculation of induced e.m.f, in Part (ii), was completed accurately by most candidates, as was the calculation of the induced current in Part (iii).

Q5 Most candidates responded positively to this question.

(a) The responses of most candidates were good but only a few candidates mentioned the need for a vacuum, consequently the final mark was seldom awarded.

(b) Candidates tended to score full marks or one or two out of five. Quite a few tried to use F = BIl or mv^2/r. F=Bqv was often written down without any further development of the answer and received partial credit.

Q6 This question was well answered by the majority of the candidature.

(a) Most candidates knew that the accelerator required a vacuum to prevent energy losses through collisions with air molecules.

(b) Most candidates were able to access at least some of the marks in this part. A lot of candidates discussed the attraction of the particle to the next electrode but neglected the repulsion from the electrode the particle had just exited. A second common omission from many candidates' responses was the necessity for a high frequency a.c. supply to the electrodes.

(c) Part (i) was well answered by most candidates. A few candidates mistakenly gave 'not fundamental' and 'hadrons are composed of quarks' as two separate differences. In Part (ii), most candidates knew about baryons and mesons but fewer were able to give a specific example of each type.

Q7 Many candidates were challenged by some parts of this question.

(a) Part (i) was well answered by most candidates. However, some stated that the forces were balanced without providing the detail required for the credit. Part (ii) of this question was also well answered although many candidates introduced errors and were duly penalised. Many candidates omitted the acceleration of freefall from their calculation in Part (iii), despite 'weight' being in bold print in the stem of the question. In the sketch graphs in Part (iv), most candidates scored for explaining how the object's velocity would vary with time when falling in a vacuum but only a few candidates correctly sketched a graph to show the ball bearing falling through a fluid. Part (v) was answered well by some candidates but others omitted parts of the equation and only scored part marks.

(b) Parts (i) and (ii) were well answered by some candidates. However, the responses of many candidates indicated that the concept of wave-particle duality is not well understood. Candidate responses to Part (iii) were varied. Most candidates were credited for stating Einstein's mass-energy relationship but only some candidates were able to apply it successfully to get to the correct answer.

Assessment Unit A2 3 Practical Techniques

In general, candidates performed well although the planning and design exercise proved testing to many candidates.

A large number of candidates used pencils for their written answers which, in some cases, were very difficult to read; candidates should be advised to use black pen.

Owing to settings on some calculators, many candidates are stating numerical answers as fractions; this practice should be discouraged and candidates advised to use decimals.

The use of correction fluid was apparent on a number of scripts; this practice should also be discouraged.

Q1 This question was very well answered by the majority of candidates.

(a) Part (i) of this question was well done with the majority of candidates obtaining reliable data. The heading for the column in Table 1.1 was not always adequate – the unit and number of oscillations were sometimes missing. There are some candidates who think that the period is the time for half an oscillation. A number of candidates quoted the period, in seconds, to 3 decimal places. Part (ii) was well answered by most in Session 1. In Session 2, some candidates did not appreciate that the value of *d* that was to be inserted in the table had to be in metres.

(b) In Part (i), some candidates rearranged the equation incorrectly and obtained a negative intercept. The error was usually carried forward correctly in Part (b)(iv). Part (ii) was well done by most candidates. Some candidates incorrectly calculated T^2d in Session 1. In Part (iii), many candidates lost the first mark for a suitable scale for the T^2d axis; otherwise the graph was well plotted. Part (iv) was well done by the majority, although some candidates had difficulty obtaining the units for A and for B.

Q2 Almost all candidates were able to respond positively to all parts of this question.

(a) In Part (i), nearly all candidates obtained full marks, although some did not record all data for voltage and current to two decimal places and were penalised. In Part (ii), most candidates correctly calculated power from their values of current and voltage but not all candidates were able to give a correct unit for power.

(b) In Parts (i) and (ii) the mapping of Equation 2.1 to y=mx+c was well done and the logarithms were calculated correctly by the majority of the candidates. In Part (iii), the points were well plotted and the best fit line drawn accurately by most candidates. Few candidates experienced problems with it being a log-log graph; they were helped by being given the scales. In Part (iv), the gradient was calculated accurately, and most candidates showed how it was obtained from widely separated points on the best-fit line. Only a few candidates were confused by the negative values for $\log_{10}P$. Many of the extreme-fit lines were poorly drawn in Part (v); but most candidates demonstrated the correct technique for obtaining uncertainty using an extreme-fit trend line. A number of candidates attempted to determine the percentage uncertainty without using the graph and scored zero.

Q3 Parts of this question challenged many candidates.

(a) Part (i) was well answered by many candidates. The stem of the question gave fairly detailed instructions as to what their method should include and high marks were obtained by those candidates who systematically went through the instructions. The calculation of the cylinder's mass and its absolute uncertainty, in Part (ii), were poorly answered by many candidates; only a few scored full marks. Many candidates incorrectly considered the uncertainty in the radius rather than the diameter and many omitted to double the percentage uncertainty in the diameter.

(b) In Part (i), candidates who answered in terms of measuring the slope length and height and then used trigonometry scored full marks. Those candidates who discussed using a protractor did not give enough detail to score the second mark here. In Part (ii), most candidates correctly identified another factor that would affect the average velocity of the cylinder.

(c) Very few candidates scored well here. Those using $v=u + at$ failed to state that they had measured the average velocity on the slope and not the final velocity. Most candidates scoring either one or both marks used $s = ut + \frac{1}{2}at^2$ as a starting point. Some candidates tried to resolve forces and met with varying success.

(d) In Parts (i) and (ii), the majority of candidates were able to correctly filter the data provided in the stem to obtain the correct answers.

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