GCE

Rewarding Learning

Chief Examiner's Report

Physics

Summer Series 2019

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2019 series.

CCEA hopes that the Chief Examiner's 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 section on our website at www.ccea.org.uk.

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GCE PHYSICS

Chief Examiner's Report

Overview

As in previous series, poor handwriting in written responses is a difficulty, more so with online marking than paper marking. Candidates should be aware that they should score out and write fresh answers rather than overwriting numbers as it is very difficult to decipher overwritten numbers when the paper has been scanned. Disorganised layout of working in unstructured calculations continues to create problems. Where the correct answer has not been achieved and examiners are trying to award credit for candidates working it can be difficult on those scripts where the working is unclear. Points on graphs or lines on grids must be clearly marked so that they can be clearly identified after the scanning process.

Candidates should be reminded that while past papers and their mark schemes are useful tools they should not be reliant upon the mark schemes for learning answers. It is obvious in many cases that candidates are learning generic answers but are not applying their knowledge to the specific question asked and are missing subtleties. Evidence of careful reading and interpretation of the question is missing in many candidate's responses. When a definition is required, candidates must ensure that their responses are unambiguous and could not be interpreted in a different way than they intend.

When performing calculations using given data it is expected that candidates should quote their answer to a suitable number of significant figures. While not doing so will not be penalised in every question it is expected as good practice and will, on occasion where relevant be penalised. Answers should also be given on the answer line rather than working out shown leading to an answer and the answer line left blank.

There was a general feeling from candidate's responses to questions on experimental technique and practical skills that candidates do not always have the practical experience necessary for them to have the complete understanding and knowledge that is expected at this level. Centres should be aware that by replacing practical work with videos and simulations they are disadvantaging their candidates. While these may be useful teaching or revision tools they should not replace practical activities.

Assessment Unit AS 1 Forces, Energy and Electricity

Overview

The AS1 unit was well received by candidates with the majority able to access and successfully answer many parts of the paper. The strongest answered questions were the mathematical calculations, particularly the mechanics sections. The weakest answered questions were the definitions and descriptions, with even the very strongest candidates answers at times lacking clarity.

Q1 In Part (a), the question began with a straightforward definition of base units followed by stating some base units and determining the base units for joules. It was surprising how many candidates knew and understood base units but could not express a definition for base units. The majority of candidates could correctly state the missing base units in (ii) but some wrongly gave base quantities instead. Most candidates could correctly state a valid equation, the units of the terms in their equation to obtain the correct base units in (iii). Part (b) tested candidates understanding of prefixes and was quite well done, although in some cases, candidates misinterpreted the question and provided much more calculations than were necessary. The average power of each generator was not as well calculated although candidates could achieve partial credit with generous application of the mark scheme.

Q2 The principle of conservation of energy was very well known by candidates. The calculation of kinetic energy was extremely well done, with very few forgetting to change the g to kg. There were a variety of acceptable equations used for b (ii) such as Fs = ΔE, Wd = Fs or $\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$. In (iii) many candidates did not realise that in the equation P = Fv, v is the average velocity over which the force acts. An alternative method was to use P = Fxs/t with the use of Ft = mv – mu to find t.

Q3 There were a variety of different acceptable ways to state Newton's second law with the most common omissions being not mention of resultant and that both force and acceleration are in the same direction. For those candidates who discusses the proportional relationship between F and a only, they needed to include that the mass was constant for full credit. In (ii) of a, candidates struggled to explain why passengers felt heavier when the lift was accelerating upwards. Many failed to pick up any marks although they had discussed the forces acting on the passengers, they neglected to mention the direction of the forces acting and the fact that there was a resultant force up. Most did not mention a reaction force.

Part b (i) was very challenging, with many candidates wrongly subtracting the counterweight and the lift to get 981N. There was partial credit available for calculating the overall lift weight and correctly stating the direction of the resultant force was down. An ecf was applied in calculating the acceleration in (iii) and a majority of candidates achieved full marks with the ecf applied.

Q4 The description of projectile motion was not well answered, with the majority of candidates providing examples of when projectile motion would be observed. The calculations for horizontal and vertical components of initial velocity were very well done. A few candidates did not actually calculate the components but rather stated them as 12.3sin40 and 12.3cos40 and received only partial credit. Relatively few candidates switched the terms. (ii) was well answered although some candidates used 12.3 rather than 7.91 for u and could only obtain partial credit for their equation. Similarly, in (iii) partial credit for the equation could only be achieved for an incorrect value of initial velocity. In (iv) the most common error was to incorrectly use the time taken to achieve maximum height in (iii) and substitute this as time of flight instead of using 2xt.

Q5 Part (a) was straightforward for most with a substitution into impulse = change of momentum to find and answer to (i) and use of impulse = Ft in (ii). There were alternative methods, but candidates who tried this were not always successful in correctly completing the calculations. The discussion in b was very well done, with a majority of candidates achieving full credit.

Q6 A well sketched graph for a(i) was helpful in answering (ii). Candidates had very little difficulty drawing the graph, but then often ignored it and wrongly used distance = speed x time for (ii). Other mistakes included not working out the total height travelled and using the height of 1 floor instead, or even using 11 or 13 floors. The sketches in Part (b) were extremely well done by strong candidates but poorly completed by weak candidates, with some failing to score any credit. The transitions from acceleration to constant velocity to deceleration in the displacement graph were poor even for the best candidates. Quite a few candidates did not fully complete their acceleration graph by returning to zero and lost a mark.

Q7 Part (a) was a straightforward use of Q = ne and Q = It, although a few candidates substituted me rather than e for the charge on an electron. A large number of candidates were able to successfully find the potential difference in Part (b), however, a significant number of candidates whilst able to add series and parallel resistors, could not determine exactly which bulbs were in series and which were in parallel. Weaker candidates did not achieve credit in Part (c) as they were unable to work out the ratios of the currents in each branch, stating it as 1:2:2 instead of 2:1:1.

Q8 Part (i) was a not overly demanding diagram of all the apparatus used to determine the relationship between the resistance of an ntc thermistor and temperature. The diagrams were often well drawn; however, a significant number had missing apparatus including a method of determining the temperature of the thermistor or had missing labels. Some were drawn unassembled which was disappointing at this level. The description of the experiment in (ii) was quite well done, with most candidates scoring 3 or 4 marks. Some candidates tried to average their results at different temperatures which significantly reduced the amount of credit they could achieve. Some candidates incorrectly tried to measure the temperature of the thermistor by touching it with a thermometer, others tried to change the temperature of the water by passing current through the thermistor. Candidates could choose to use the voltmeter ammeter or ohmmeter method of measuring resistance. Either was acceptable however candidates who used the ohmmeter should not add in a power supply to their circuit. The graph sketch in (iii) was well completed, however the description of the graph shape in (iv) was poor. Very few candidates compared the effects of heating of the wire causing increased vibration of ions to the effect of increasing the number of free charge carriers.

Q9 The definition of EMF was incomplete in most cases, with candidates usually scoring 1 or 0. The most common omissions were the words ‘chemical’ and ‘passing through the battery’. The calculation for Part (b) was challenging although partial credit was available at each stage of the calculation. Weaker candidate wrote almost nothing or provided work which was unfollowable. Although many stronger candidates made mistakes, they were able to show their steps better and achieved significantly more marks. A common error was to disregard the resistance of the voltmeter entirely or to interchange the EMF and circuit pd.

Q10 Part (a) was very well done by most candidates and provided a successful lead into the most challenging part of the paper. Part (b) was very poorly done by even the weakest candidates, with few recalling the symbol for the LDR and most unable to place it correctly into the lighting circuit. Credit could be given to a correct circuit with an incorrect symbol only where the candidates clearly identified their incorrect symbol as an LDR. The explanation in (ii) mostly scored 0 out of 2 since it was impossible to explain correct physics from an incorrect diagram. A large number of candidates were unable to state that the LDRs resistance increased as the light level decreased. A converse argument was not accepted in this case as it did not directly address the question.

Assessment Unit AS 2 Waves, Photons and Astronomy

Overview

Candidates performed reasonably well in this paper and all appeared to be able to successfully answer some parts of most questions. Most areas of the specification were tested, and performance varied across these. Substitution into the lens equation to correct vision would appear to cause some confusion. Other calculations were well done. Explanations were often incomplete and lacking sequence.

Q1 Most candidates were able to correctly calculate the red shift parameter in Part (a) but in Part (b) there were a significant number who incorrectly calculated a shorter wavelength or used the unknown wavelength as the denominator in the equation.

Q2 Snell's law was known by some candidates, but many gave a definition of refractive index in Part (a) and some did not refer to the boundary between two media. Part (b) was well answered by the majority of candidates. A few omitted the angles in (i) and some description were vague or showed no subsequential approach to the method in Part (ii). Part (c) was correctly answered in adequate detail by the top candidates. Some weaker candidates described how to obtain the refractive index and did not answer what was asked in the question achieving only part marks.

Q3 Part (a) was well answered by most candidates. All gained some credit in (i) and many correctly identified all 4 statements. The calculation in (ii) was also well done with the majority of candidates scoring full marks. A few weaker candidates did not know how to progress from reading the points. As expected at AS level, only a few chose to work in radians. In Part (b)(i) most candidates were able to relate the sound wave to the definition of a longitudinal wave and the calculation in Part (ii) was quite well done although some candidates did not correctly identify that there were eight wave cycles.

Q4 In Part (a) most candidates were able to correctly use the equation to calculate the wavelength. A loss of 1 mark was common with 10n errors or an incorrect division of 15 to get the fringe spacing. Part (b) was answered well by some candidates but many repeated the use of the double slit equation from Part (a) rather than using the diffraction grating equation. 'd' and 'a' were often confused.

Q5 Part (a) of this question was answered very well with many candidates achieving full marks. Weaker candidates tended to leave out some of the key points that they were cued into in the stem of the question and only a few candidates gave very poor responses or confused short and long sight. The calculations in Part (b) were not well answered and there appeared to be a lot of confusion as to what u and v represented. At times candidates reached the correct answer using wrong physics which was not given credit.

Q6 The explanation in Part (a) allowed most candidates to achieve some marks and top grade candidates had no problem stating the facts concisely to be awarded full marks. Refraction was sometimes incorrectly given as an example that could be explained using standard particle theory. The calculation in Part (b) proved difficult for weaker candidates who often used the velocity in place of momentum in the equation.

Q7 Part (a) was answered well by some candidates though many did not give complete answers and only scored 1 mark for the idea of transfer of energy in a progressive wave. In Part (b) the wave pattern was well drawn by most candidates but the calculation was often incorrect with many candidates working from the lowest frequency creating a full wavelength on the string.

Q8 The explanation in Part (a) was well done by top candidates but most left out detail, not linking colour, wavelength and n, to score part marks. In Part (b) the calculation was well done and many candidates achieved full marks. Some ignored the instruction to give the answer to one decimal place. The calculation in (c) was again well answered by most candidates.

Q9 In Part (a) few candidates scored both marks. Many described ultrasound and discussed reflection of x-rays. A common answer was that x-rays passed through soft tissue but not bone without any detail. Part (b) was rarely answered fully. Many candidates ignored the stem of the question and did not continue from the point of thermionic emission. Part marks were achieved by most candidates although some could not give any relevant information.

Q10 The photoelectric effect in Part (a) was explained well by top grade candidates but it was common among others to leave out essential key points. The calculations in Part (b) were well done by many although weaker candidates could not find the correct numbers to use in Part (ii) and those candidates tended also to have difficulty understanding how to reach the answer in Part (iii). Part (iv) was well done by many but it was a common mistake not to calculate the difference in the energies and just use the work function in the equation. In Part (c) many candidates achieved part marks, knowing the answer to one or the other. Top candidates had no problem with this part.

Assessment Unit AS 3A Practical Techniques

Overview

Candidates performed generally well in this paper. As last year, there were a number of issues in centres where apparatus lists/set-up instructions had not been followed and this resulted in candidates having answers outside the range given in the mark scheme. Where possible centres should set up as instructed to ensure that their candidates are not disadvantaged.

Q1 In Part (a) most candidates correctly measured the length of the spring although some did not give their answer to the nearest mm. In Part (ii) many lost marks for an incorrect conversion to force and the quality of their extension values was sometimes out of tolerance. Parts (iii) and (iv) were quite poorly answered by many and the doubling of the uncertainty was often not done. While the calculation in Part (b) was well done, only a few candidates correctly converted the extension to metres and Part (ii) was only correctly answered by top grade candidates.

Q2 This question discriminated well. Some weaker candidates ignored the instructions in Part (a) and the table was completed poorly. Grade A candidates had no problem. The calculation in Part (b) was very well done by some and there was a range of marks here, with some able to formulate the equations but not reach the correct solutions.

Q3 The usual errors associated with timing oscillations arose in Part (a) with a few candidates having times that were less that 5 seconds, not repeating or not calculating period. These mistakes are getting less common as candidates are better prepared. In the table headings most correctly use the solidus before the unit. Part (b) was well done by many candidates. Some only used one value of m to calculate the constant. Some weaker candidates could not formulate the initial equation.

Q4 Candidates who followed the instructions carefully scored well in this question. In Part (a) most correctly drew around the block and the mirror line but some diagrams were poor and incomplete. The rays reflected the quality of the initial set up with many getting full marks in Part (ii). In Part (iii) some did not give their measurements to the nearest mm and others measured incorrect distances. In Part (b) some answers were outside quality and others were quoted to an incorrect number of significant figures.

Assessment Unit AS 3B Data Analysis

Overview

This paper tested a wide variety of the practical techniques and data handling skills associated with the specification. The paper was reasonably successful in allowing candidates of differing abilities to respond to the questions with varying degrees of success. The focus on significant figures and decimal places in the marking of specific relevant question parts is evident in the scheme. These were marked along the lines of the advice given in the chief's report, information days and webinar.

Q1 Graphs were generally well drawn with only some candidates getting confused with the labelling of the E axis and the unit. Points were sometimes carelessly plotted causing marks to be lost. Best fit lines were generally good. Poor scales are often still an issue with candidates using, for example, multiples of three.

Q2 In (a) most candidates were able to work out the correct unit although some inverted it. Part (b) was well answered by most although some candidates failed to complete the last step by making v the subject of the equation in Part (i). Weaker candidates sometimes doubled the value of the gradient rather than halving it to get the speed in Part (ii).

Q3 Many candidates correctly extrapolated the best fit line and read the intercept but many failed to complete the last step of the calculation to get velocity. In Part (b) most candidates chose the correct equation of motion but many then ignored the initial velocity. The gradient in Part (ii) was well done and most candidates were able to calculate the acceleration from this. Part (iv) was not well answered by many candidates. Some worked from the equation and described adding percentage uncertainties. Of those that did begin correctly with an extreme fit line, rather than a vague statement of a steepest line or extreme best fit, most did not go on with the required detail to get both of the other marking points.

Q4 In Part (a), most candidates were able to correctly state the uncertainty and gain some marks in Part (ii). Commonly the idea of discarding anomalies was omitted when candidates did not achieve full credit. In Part (b) a number of candidates ignored the figures in the value and gave the answer as 'ruler'. Part (c) was answered quite poorly by many candidates. More able candidates tended to score 4 or 5 out of 6, losing marks by quoting answers to an incorrect number of significant figures. Some weaker candidates just added absolute uncertainties and could not calculate volume.

Q5 They type of lens was usually correctly answered with very few getting Part (a) incorrect. Part (b) was not well answered. Almost all candidates calculated the mean correctly but disappointingly few got the other marks, ignoring the information they had been given in the stem of the question. Part (c) was also not very well answered with only the very best candidates getting full marks for the required explanation.

Q6 Part (a) was well answered by most candidates who appeared to have been exposed to similar apparatus. In Part (b) most got at least one position correct. Some had gate 1 too close to B, after the collision would have taken place. Part (ii) was well answered, better than when asked in a previous paper. Part (c) was not very well done. Many candidates omitted detail and only a few candidates got to the final step.

Assessment Unit A2 1 Deformation of Solids, Thermal Physics, Circular Motion, Oscillations and Atomic and Nuclear Physics

Overview

In general, candidates performed very well in this paper. There was no evidence to suggest that candidates had insufficient time to complete the paper. Candidates performed particularly well in structured questions and those of a quantitative nature. Qualitative answers were also well attempted in this paper. The level of language used in the examination appeared to be appropriate for all candidates. The paper was successful in allowing candidates of differing abilities to respond positively to the all of the questions posed.

Q1 In Part (a) Hooke's law was accurately stated by many in Part (i) although a few candidates discussed the 'elastic limit' rather than the 'limit of proportionality'. Part (ii) was generally well done but some candidates read incorrect values from the graph. This was particularly so when reading F = 14 N. A significant number of candidates read this as 13 N. A few candidates gave the value of the gradient instead of the inverse value and many answers had 10^n errors within them. Diagrams in Part (iii) ranged in quality. Both vertical and horizontal arrangements were known. Some candidates forgot to fully label diagrams and lost marks. A few candidates drew a spring with a mass attached. A maximum of 2/5 was awarded for this set up.

In Part (b)(i) many candidates scored 4/4 in the calculation. Some correctly stated the correct equation to calculate area but forgot to square d when carrying out the calculation. There were also some 10^n errors in this part. In Part (ii) the majority of candidates gave detailed answers and scored 4/4. Some gave contradictory answers despite correctly stating $R = \rho L/A$. A few candidates discussed the diameter of the wire changing but did not link this into the area and lost one mark.

Q2 Parts (a) (i), (ii) & (iii) were very well done by the majority of candidates. Part (b) was very well by the majority with many scoring 4/4. Most candidates determined the angle of the string to the horizontal or vertical and used an appropriate equation to calculate T. Only a few candidates used $T^2 = (Fc^2 + W^2)$.

Q3 Most candidates were able to determine that the periodic time in Part (a) (i) and used this to calculate ω. Substitution of values from the graph into $x = A\cos(\omega t)$ was well done but errors occurred if they used values of t greater than or equal to 2.0 seconds. In Part (ii) tangents were poorly drawn and as a result answers were not within the accepted range. There were also 10^n errors where candidates forgot to convert cm to m. Many candidates used the equation instead of drawing the tangent and scored full marks. In Part (b) (i), most drew the correct negative sine graph. Some gave a sine graph and scored 1/2. Part (ii) discriminated well. Few candidates drew correct graphs. Some did appreciate that only positive values could be obtained and could obtain 1/2 here.

Q4 In Part (a) most candidates were able to state the name to describe the condition as 'resonance'. Graphs in Part (b) were generally well drawn although some candidates drew linear graphs and lost the mark in this part.

Graphs in Part (c) to represent damping were not well drawn. Only the best candidates scored 3/3 by showing a clear, broader, correctly shifted, lower amplitude in this part. Those that drew a linear graph in Part (b) could obtain the first mark in the scheme for showing reduced amplitude of oscillation. This question discriminated well.

Q5 Most candidates were able to score 6/6 in Part (a). Some weaker candidates scored 3/6 by obtaining ΔE = 20160 J but were not able to use this value to determine Δm Most candidates correctly stated that the mass would increase.

Q6 In Part (a) (i) some candidates were not able to correctly describe the plasma state. The majority of candidates gave the correct equation representing nuclear fusion of deuterium and tritium in Part (ii). Some symbols were incorrect with N instead of n for the neutron. Descriptions of the function of the blanket in Part (iii) were good in many cases. However, a significant but did not mention absorption of neutrons. Part (iv) was poorly answered by many candidates and was a good discriminator. Many discussed inertial confinement here. Some candidates were able to obtain the first mark on the scheme but very few scored 2/2 by referencing the matching of the frequencies of radiation used to the resonant frequencies of the ions and electrons within the plasma. Part (b) was well answered by the majority. Some answers did have a 10^n error despite a correct substitution of values into the equation $E_k = 3/2kT$. Some candidates were not able to recognise a million as 10^6.

Q7 Most candidates scored 2/2 in Part (a) (i). Part (ii) was also well answered with most candidates giving good detail to reinforce their explanation. Graphs in Part (iii) were generally well drawn with an appropriately labelled axis to obtain both marks. Only very occasionally did the graph drawn not match the unit on the temperature axis. Part (b) (i) was not always well done with many candidates not showing Nm being the total mass of the gas. Most candidates scored 2/2 in Part (ii) although some took the square root of the correct value and ended up with an answer of 1334 ms^{-1}. Part (iii) was well done by most candidates.

Q8 Most candidates scored 2/2 in Part (a) (i). Some weaker candidates stated that A was atomic number and others could not define r_0. Part (ii) was well done by the majority of candidates. However, some stated that $r_0 = e^{intercept}$ having correctly used log_{10} in their mapping. Some used loose terms such as 'reverse log' in their descriptions. Part (b) was well answered and the majority of candidates scored 4/4. Some answers were either 14 times too big or too small but candidates were able to score 3/4 in this case.

Q9 In Part (a) descriptions of the nature of α particles were generally well written. Responses were well structured, of appropriate form and style and contained good detail with regard to the indicative content. Most candidates were able to score 4 or 5 out of 6 in this part. Few stated that α particles lost energy by ionization for the sixth mark. Weaker candidates struggled with the indicative content and answers were repetitive. Part (b) (i) was well answered by most candidates. Most candidates scored 2/2 in Part (ii) although some did not correctly convert days into seconds but could score 1/2 in this case. Part (iii) was well done by most candidates. Some realised that 256 days equated to two half-lives but many candidates used the exponential equation to determine N. Most candidates were able to obtain the mark in Part (iv) for the correct answer and others from an ecf for their value of N. Part (c) (i) was poorly answered by many candidates and was a good discriminator. Most used their value of N and multiplied it by 1.41×10^{-13} to obtain an incorrect energy value. Only a few candidates realised that the difference in N_0 and N was required in the calculation. Many candidates scored 4/4 in Part (ii) although some did not correctly convert MeV into J. It was evident that some candidates did not know or had forgotten the equation to use. These candidates could score one mark for a correct value of energy in J. Part (iii) was poorly answered by many candidates and was a good discriminator. Many candidates used the value of velocity of the beta minus particle instead of the momentum and a significant number used the mass of a proton instead of the mass of an electron.

Assessment Unit A2 2 Fields, Capacitors and Particle Physics

Overview

Almost all areas of the APH21 specification were covered in this paper. It was successful overall in discriminating between candidates of differing abilities and a good range of marks was obtained. There were question parts accessible to all in which full marks were generally obtained, and other parts where only the more able candidates scored highly. Generally, responses are better on the mathematical questions than the descriptive, and laws/definitions are not particularly well-known or recalled accurately.

Q1 In Part (a) the definition of the farad was not well known, many neglected to give the detail of 1 coulomb of charge and said "the charge per volt" or gave the definition of capacitance.

In Part (b) (i) most candidates gave sufficient detail to qualify their choice of 330 micro-coulombs, as requested, and Part (ii) was very well done overall.

Q2 Part (a) was generally well answered, most correctly referring to a 'region' within which.., although a number of candidates did not manage to use the correct wording to describe a generic field. In Part (b) (i) the label on Fig. 2.1 was usually correct, a good number also identified Fig. 2.2 as the mass, candidates did not all recognize the significance of the relative number of field lines in the diagrams; In Part (ii) a generous mark-scheme allowed for various differences between the fields, benefitting many – there were some who compared the diagrams of Fig 2.1 and Fig. 2.2 rather than fields in general.

Q3 Part (a) discriminated between candidates, as marks ranged from 1 to 5 - most gave the formula for force (F) and completed two calculations, many then subtracted the magnitudes rather than adding them to get 3 of the 4 calculation marks. The direction was mainly correct for the final mark. Some candidates worked from the field strength (E) equation to reach the correct answer, a small proportion failed to multiply field strength by the 4 micro-coulomb charge and could get a maximum of 2 marks. A very small number used the Boltzmann constant, k, in a correct equation. Some candidates confused the equations for F and E. In Part (b) candidates struggled to achieve all 3 marks – only the best candidates could express the logic required to explain the correct position.

Q4 In Part (a) most candidates scored all 3 marks here, responding to the 'show that' instruction by substituting fully into correct equations. A few omitted steps or did not show substitution of values used and lost marks. Common errors in Part (b) included using the speed of 3.0×10^{7} m s^{-1} from the previous part rather than 6.20×10^{7} m s^{-1} as required, failing to either square or square root as required in the calculation, incorrectly calculating the percentage increase in the mass. Candidates' knowledge in Part (c) was not sufficient to gain all marks in many cases – the detail of acceleration of the charged particles by electrodes was usually omitted and often scientific language was lacking. Candidates had not followed the sequence suggested by the bulleted points in the question.

Q5 Most used the examples of electron and proton in Part (a) and gave the difference that leptons are fundamental whereas hadrons have substructure, but for a second difference the detail of the strong 'nuclear' force sometimes missing. In Part (b) the four independent marks here, proved challenging to many and in Part (c) (i) many gave the equation in two stages, Part (ii) was mostly correct, some lacked detail of weak 'nuclear' force or 'interaction'.

Q6 For Part (a) careful reading of the information in the stem of the question was required, which was accessed by a good proportion of the candidates. Most identified the direction correctly in (b) (i) as being out of the page; Part (ii) was not well expressed, and very few candidates gained the second mark for identifying how ‘m’ relates to ‘r’ the position at which it strikes the detector; Few candidates scored full marks in Part (iii) - there were many standard errors such as using the mass of the larger ion (7u) or a combined mass of 13u, or 4.0 mm rather than 2.0 mm as the radius, however part marks were accessed by the majority.

Q7 In Part (a) (i) many candidates scored 2 out of 3, the direction of orbit was often omitted; in Part (ii) a significant number of candidates achieved full marks here, there were careless errors with the calculation in some cases such as dropping squares and cubes. Others did not correctly subtract the planetary radius for the final mark; In Part (iii) the equation was well-known but many used the satellite height rather than orbital radius in their calculation. In Part (b) many candidates got 2 marks for correct equations and made an error calculating ‘g’, usually by substituting the height of the satellite above the surface rather than the orbital radius.

Q8 In Part (a) many diagrams were correct and labelled, however the quality of the drawings was disappointing - 2 of the 3 marks were allowed for a correctly labelled circuit symbol, although this was not what was requested. In Part (b) (iii) candidates’ answers often lacked necessary detail, such as mentioning a common core rather than winding coils on top of each other as a means of reducing flux leakage. A number of candidates referenced energy loss in the transmission lines rather than the transformer.

Q9 Faraday’s Law was generally well-defined but Lenz’ Law was less well expressed in Part (a). In Part (b) (i) detail of inaccuracy due to the short time-scale was required here, not all candidates made a specific reference to time; In Part (ii) an explanation of the graph was required here, and many candidates gave descriptions of the changing emf, referencing the motion of the magnet and not explaining by application of the Laws of electromagnetic induction – very few scored full marks in this part; There was a better response in Part (iii), with candidates generally recognising the effect of greater number of turns and greater velocity on magnitude of emf, some lost the third mark for the detail of the time it would take for the peak(s) to occur.

Assessment Unit A2 3A Practical Techniques and Data Analysis

Overview

The average mark in this paper was high with the majority of candidates performing well. The maturity of the development of practical skills from A2 candidates was evident. Candidates did not appear to have any issue completing both experiments within the one hour time limit and it did not seem to matter which practical question they started on.

In the Capacitor experiment some examination centers appeared to have voltage values set higher than specified in the Confidential Instructions, whilst this made scaling the graph more difficult for some candidates their overall performance was unaffected.

Q1 In Part (a) data collection was usually very good although a few candidates gave nT and/or T values to an incorrect number of decimal places. In some cases, average values of nT were incorrectly calculated. A few candidates recorded the length to the nearest cm not mm.

In Part (b) several candidates could not correctly show that a graph of T^2 against L would result in a straight line from which P and L_o could be determined. The mathematics of the expansion proved demanding for these candidates.

In (c) (i) values of T^2 were calculated accurately by the majority of candidates. The standard of graph plotting in Part (ii) was generally very good although a few candidates lost a mark by choosing a poor scale. Gradients were accurately calculated with only a minor number of candidates falling outside the specified tolerance in Part (iii). In Part (iv) the majority of candidates were able to calculate a consistent P value but some failed to correctly state the units.

In Part (d) a significant number of candidates incorrectly stated that the intercept of the graph with the L-axis represented $(4\pi^2 L_o/P)$ and not the original length of the spring system.

Q2 In Part (a) (i) completion of Table 2.1 usually scored full marks apart from a small number of 10^n errors. Graphs in Part (ii) were very well plotted with the quality of smooth curves excellent. Only a small number of candidates chose an inappropriate scale for current. In Part (iii) a significant number of candidates did not repeat the calculation for 37% of I_0 to obtain a reliable value for the time constant. Some candidates could not use the graph to get a correct corresponding value of time from their current value. Calculations to determine the value of capacitance C in Part (iv) were well done with only a few outside of specified quality range. Some candidates did not convert F to μF.

Parts (b) (i), (ii) and (iii) were well answered. In Part (iv) a significant number of candidates struggled with this part by incorrectly substituting their correct value of C_{Total} as C_1 in equation 2.1.

Assessment Unit A2 3B Physics Unit

Overview

While there was a reasonable degree of challenge on this paper, the standard of candidate's responses were generally good. The more difficult skills of calculating uncertainties, data analysis in calculating and interpreting gradient and managing logs were tested, which some candidates found demanding. There was a synoptic element, drawing on AS2 theory. Weaker candidates found a number of aspects of the paper challenging. There was no evidence that candidates did not have sufficient time to finish the paper.

Q1 In Part (a) the majority of candidates drew the line of best fit correctly. A small number of candidates did not identify the trend and forced the line of best fit through the origin. Most candidates answered Part (b) (i) correctly using a large triangle to calculate their gradient. Some candidates were unable to give the correct unit with their answer. In Part (ii) most candidates were able to identify that R = 1/gradient, however some candidates incorrectly used V=IR. The vast majority of candidates were able to identify +/- 10% and give a consistent conclusion. In Part (c) (i) the majority of candidates did not give a full enough explanation of a zero error to award the mark for this question. Part (ii) was well answered by the majority of candidates. In Part (iii) most candidates were able to identify that the y-intercept was equal to the zero error and perform a suitable calculation to correctly determine its value. A few candidates extended the line of best fit beyond the grid of the graph and this response was not rewarded full marks.

Q2 Most candidates were able to correctly rearrange the equation in Part (a) as required, however some candidates were unclear what variables were included within a square root symbol. The mapping portion was completed well by the vast majority of candidates. In Part (b) the majority of candidates were able to identify what the gradient represents but many candidates did not go on to make q the subject of the formula, which was required to award the mark.

Q3 Part (a) was completed well by the vast majority of candidates. Some candidates did not show the canceling of the units for A and B as m^2/m^2 and dropped a mark as a consequence.

In Part (b) some candidates were able to achieve full marks in this question either by combining percentage uncertainty or using the max-min method. A number of candidates were unable to calculate the cross-sectional area correctly, either failing to use the correct equation for the area of a circle or not converting to metres correctly. Candidates using the percentage uncertainty method often failed to halve the uncertainty of h or double the uncertainty for A. Candidates using both max and min method often neglected to halve the range when calculating the absolute uncertainty.

Q4 Part (a) was completed well by the vast majority of candidates. Some candidates did not give their answers to the required 3dp or failed to round their numbers correctly. The majority of candidate completed Part (b) (i) well. Some candidates lost a mark for failing to use a false axis for L/db to ensure the data set took up more than half the graph. In Part (ii) most candidates were able to identify the meaning of the y-intercept, however, a few candidates were unable to read the intercept from the graph correctly. A number of candidates were unable to rearrange the logarithmic equation correctly to obtain the correct answer. A significant number of candidates were unable to answer Part (iii) correctly. Some candidates omitted the use of the term 'fit' when describing drawing the extreme fit line. A large number of candidates suggested finding the difference in either the gradient or the intercept rather than finding the new P value then calculating the difference.

Q5 A significant number of candidates were unable to answer Part (a) correctly, either not recalling the principle of superposition from AS or not applying it correctly to the content. In Part (b) (i) only a small proportion of candidates achieved full marks in this question. While a large number of candidates correctly calculated the time period a number of candidates found it difficult to link this to the time-base setting. A number of candidates dropped marks for giving their final answer to an unrealistic number of significant figures for a time base setting or by stating an inconsistent unit. A significant number of candidates found Part (ii) difficult. Despite error carried forward being applied for their wave drawn in Part (a) a number of candidates were unable to extract a time period from their graph.

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