GCE

Rewarding Learning

Chief Examiner's Report
Physics

Summer Series 2018

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

General Observations

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 clearly rather than overwriting numbers as it is often impossible to decipher overwritten numbers. 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 processing it can be difficult on those scripts where the processing is unclear. Points on graphs or lines on grids should be clearly marked so that they can be easily 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 context of the question asked. Evidence of careful reading and interpretation of the question is missing in many candidates' responses.

When performing calculations using given data it is expected that candidates should quote their answer to a suitable number of significant figures. On occasion, where particularly relevant, there will be a significant figure penalty. Answers should also be written 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 may be disadvantaging their candidates. While these may be useful teaching tools or recap they should not replace practical activities.

Assessment Unit AS 1 Forces, Energy and Electricity

This paper was much more accessible to candidates than the 2017 paper and has allowed all candidates to access a significant number of marks. There was no evidence that candidates did not have adequate time to complete the paper. Errors were spread throughout the paper and there wasn't a particular topic where candidates struggled. For many candidates there is a strong preference and better performance in calculations rather than descriptive answers, typical of physics students.

Q1 **(a)** Most candidates scored full marks in this question. A small minority did not know the relevant equation.

(b) This was well answered. A few candidates did not convert t into seconds but this was a rare omission. Some confused charge with energy and used an incorrect equation.

(c) This question discriminated between candidates at the lower boundary. E candidates were generally able to score at least two out of the three available marks while candidates not achieving an E were unable to apply their knowledge here. Candidates used a variety of approaches to get to the correct answer.

Q2 (a) The majority of candidates could give an adequate explanation of ohmic behaviour.

(b) This question was well answered by most candidates. Some did not include a variable resistor in the circuit, of those who did, the symbol was unknown by a few. The requirement of at least five sets of readings to draw a graph was ignored by some candidates. In Part (iii) A grade candidates had no problem gaining both marks for the graph but B grade and below candidates often sketched the VI shape instead.

(c) This question discriminated well. Candidates at the EN boundary were unable to provide any explanation worthy of credit. Candidates at the AB boundary typically scored 1 or 2 marks out of the 3 available.

Q3 (a) This calculation was well done by many candidates. Some had difficulty identifying the pivot point and only gained part marks.

(b) This question was only answered well by more able candidates. Many incorrectly focused on a lower centre of gravity leading to increased stability and didn't gain credit.

Q4 (a) Candidates did not deal well with the conversion of Tm^3 into m^3. While it was known that this would be unfamiliar, it was expected that more candidates should have been able to relate it to conversion of km^3 to m^3 or similar. The mass conversion was more accessible although some went to g rather than kg. The density equation was well known and most candidates scored for the calculation. Significant figures were usually appropriate to the number given in the question.

(b) This was well answered by most candidates although some did have difficulty manipulating the individual units of v and F into the correct answer.

Q5 (a) The calculations in both Parts (i) and (ii) were well done by most candidates. A few confused Cos and Sin and some others did not convert from N to kg in Part (i).

(b) This question was generally well answered. A few though both quantities were vectors but almost all candidates knew how to distinguish between a vector and scalar.

Q6 (a) This was generally well answered with most candidates achieving part marks. Layout of work was often difficult to follow through and in a 'show that' question this can lead to loss of marks by good candidates. Some had difficulty with unit conversions.

(b) This question discriminated well. A grade candidates were clear in their working and kept horizontal and vertical motion separate, weaker candidates showed a lot of confusion and couldn't distinguish between horizontal and vertical velocities causing loss of marks.

Q7 (a) This question was very well answered.

(b) The majority of candidates managed to gain some marks here.

(i) Some used the 12% incorrectly leading to various answers that resulted in three marks out of the possible four.

(ii) This was well answered by some but many found it difficult to apply their knowledge and gained part marks.

(c) Most candidates scored at least one mark out of the available two here, recognising that carbon gas emissions would be reduced.

Q8 **(a)** Newton's first law was quite well known though commonly the word 'resultant' was either omitted or replaced with 'external'. The quality of the 'compare and contrast' answer varied and discriminated well. There were some excellent answers from more able candidates.

(b) This was quite poorly answered. While a significant number of candidates reached the correct answer for some it seemed to be by chance rather than a clear understanding of the physics. The direction was often incorrect.

Q9 **(a)** This calculation was well done by most candidates. The negative was often omitted but was not penalised in this case as the error would be picked up in the following part.

(b) Quite poorly done with very few candidates using the area under the graph. Some worked backwards from their answer to Part (c) which was not given credit since it was a 'show that' question and they were using the answer to Part (b) that had been given in the paper.

(c) This question was well done by more able candidates but many EN boundary candidates did not make any progress towards the correct answer.

Q10 **(a)** Many candidates could not explain what was meant by internal resistance, omitting to explain what resistance meant. The calculation in Part (ii) was quite well done by most candidates.

(b) The network of resistors was handled well by most candidates. When candidates made errors it was much easier to award part marks to those who had worked systematically through the network rather than trying to do the whole network in one calculation. In Part (ii) some candidates did not add on the internal resistance of the cell losing one mark. Part (iii) discriminated well at the A boundary. Only more able candidates were able to calculate the current correctly.

Assessment Unit AS 2 Waves, Photons and Astronomy

The new topics on this specification continued to be answered well. As with AS1, performance was better on calculation questions rather than descriptive ones. Understanding and clarity seemed to be an issue in this paper with many candidates giving vague answers and missing key points.

Q1 **(a)** This question was not well answered by many candidates. Those who seemed to understand energy levels failed to interpret the question correctly and missed getting the second mark. Weaker candidates failed to get any marks here. Answers lacked clarity and detail with regard to electrons falling between different energy levels.

(b) This question was well done but some candidates did not convert eV to J and lost a mark in Part (iii). Often weaker candidates did not make the link between photons and visible light.

(c) The question was often answered as a list of definitions rather than a well-structured description of how they went together to explain how the laser worked. Most struggled to obtain the last mark in the mark scheme. Answers did not clearly state that the stimulating photon needed to have the same energy as the difference in the two energy levels if an electron was to be stimulated to fall between these two levels.

Q2 **(a)** This question was generally well done but some candidates used the inappropriate term 'bending' rather than 'spreading' when explaining diffraction.

(b) Few candidates achieved all three marks here in what should have been a familiar question. Candidates did not take enough care when drawing the diagrams.

(c) This question discriminated well.

(i) Many candidates tried to use the diffraction equation to find the angle, rather than by trig. Some candidates used $y=\lambda d/a$ in both parts of (c) and failed to score.

(ii) Weaker candidates did not attempt a calculation for d, and instead used one of the distance values provided in the question. Conversions from m to nm were not always correct.

Q3 (a) Many candidates struggled with a start point of $eV = ½mv^2$. Those who got the first step found it difficult to obtain $K=(2e/m)^{½}$. A significant number of candidates scored full marks and were very clear in their working to the correct answer.

(b) This question was answered quite well. Many candidates were unable to calculate the velocity correctly in Part (i) but almost all were able to use their value correctly to obtain full marks in Part (ii).

(c) The diffraction pattern was well known by most candidates and recalled correctly along with the effect of changing the voltage.

Q4 (a) (i) Few candidates gave enough detail to obtain both marks. Details such as 'lowest' and 'loudest' were usually missing.

(ii) Sketches were well done with a node and an antinode correctly indicated.

(b) Most candidates scored full marks in Part (b)(i) but some candidates gave answers of 140 Hz and 210 Hz in (b)(ii) and lost a mark.

(c) This question discriminated well. Some candidates could not correctly identify the new length. However, they did then use their incorrect value of l correctly throughout the rest of the question and were given credit.

Q5 (a) Many candidates scored two of the available marks. Almost all candidates were able to discuss the change in frequency. Doppler equation well known in general, but only a few applied the sign variation accurately and so the last mark detailing the symbols used and the use of +/- for a source moving away/towards was rarely awarded.

(b) Many candidates simply said light was shifted to the red end of spectrum rather than giving the change in wavelength. Many failed to link distant galaxies to the cosmological red shift In Part (ii) some candidates confused the red shift parameter **z** with the recession speed.

(c) The estimated age of the universe was well calculated by most candidates. Most candidates correctly converted from seconds to years having obtained T from $1/H_0$.

Q6 (a) Diagrams were not often of a good quality and labelling lacked detail. Candidates generally scored one or two marks out of the three.

(b) This was well answered but a few candidates did not clearly explain that the experiment should be repeated for different values of u.

(c) The axes were usually correctly labelled but the sketch of the line was often incorrect. There were a variety of acceptable answers, the majority of candidates used 1/u against 1/v.

(d) Many candidates incorrectly gave their answer in terms of the gradient of the graph no matter how their axes had been labelled. For those candidates who identified the intercept, very few gave the detail of averaging both intercept values.

Q7 **(a)** The ray diagram was well drawn by many candidates. A significant number failed to put an arrow on either ray. In some cases the eye was not indicated at all. Some candidates treated the lens as a converging rather than diverging lens. The table in Part (a)(ii) was usually correctly completed.

(b) Only more able candidates scored full marks in this question. The majority were able to correctly calculate the image height but either forgot to identify f and/or v as negative. The algebra of dealing with reciprocals still causes problems to some candidates. In Part (ii), many candidates did not appreciate that the image and object were on the same side of the lens.

Q8 **(a)** Definitions of longitudinal and transverse waves were quite poor. Many candidates did not reference particle vibrations. Polarisation was well understood although definitions were not always correct. The majority of candidates were able to state that only transverse wave could be polarised.

(b) This question was answered well by most candidates.

(c) Most candidates scored part marks in this question. There were some power errors in Part (i). A few candidates did not correctly obtain a value of T=0.24ms from the graph. The sketch of the wave was usually well understood and completed but the phase change was correctly managed by only a few candidates.

Q9 **(a)** Part (i) was well known but many candidates failed to score 3/3 in Part (ii) as they incorrectly used $i=52^{o}$.

(b) Candidates found this question challenging, missing the concept that the light was travelling at a different speed inside the fibre. Many of those candidates who scored 4/4 in Part (i) went on to score 3/3 in Part (ii), however, a great many students were unable to pick up any marks in this part.

Assessment Unit AS 3A Practical Techniques

Candidates performed generally well in this paper. As with last year, there were a number of issues in a minority of 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 by incorrect centre set-ups.

Q1 **(a)** The majority of candidates were able to measure the diameter of the container although there were some power errors and some answers that did not reflect the measuring instrument used. Most candidates could correctly calculate the cross section area from their diameter measurement. A few confused diameter and radius.

(b) Answers for the height were usually quoted to 0.1 cm as required. Outlining the difficulties in Part (ii) provided some discrimination. Weaker candidates gave vague answers not relevant or applied to the gas jar as asked. Only the top candidates considered both aspects to score both marks.

(c) Almost all candidates correctly found the mass of the liquid.

(d) Most candidates used the equation correctly to determine density. Those who did not measure h accurately will have been penalised here for a value outside the accepted range for density.

Q2 (a) The circuit diagram was generally well drawn although a significant number of candidates did not know the symbol for a thermistor. A number did not include the switch in their drawing.

(b) The table was well completed by most candidates. Some did not have the required temperature change and there were a number of candidates with values of current and voltage that seemed unlikely. The resistance was usually calculated correctly although many had power errors and quoted their answers to an inappropriate number of significant figures.

(c) This was well answered by most candidates.

Q3 (a) This question discriminated well. Weaker candidates struggled to give the correct range of object distances.

(b) Diagrams were often untidy and labels vague, in particular for the illuminated object. The metre rule was often omitted.

(c) A significant number of candidates had incorrect values of u and v. Some recorded u+v and other values seemed not to be possible with the lens provided. Many others had provided theoretical answers rather than practical ones.

(d) This question was quite well answered by most candidates, but a significant number considered the uncertainty only in the metre rule scale or expressed a difference between different experimenters' eyesight.

(e) This was very well done by almost all candidates.

Q4 (a) Tables were generally well laid out and headed correctly. A few candidates did not measure multiple oscillations or repeat readings. Some did not quote times to 0.01 s.

(b) (i) The T^2 values were usually calculated correctly.

(ii) Only some candidates gave adequate explanation of their choice of n value.

(iii) Most candidates scored at least one mark. A significant number only calculated a single k value.

Assessment Unit AS 3B Data Analysis

Candidates performed well in this paper. The 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 discrimination. This is not easy in this area of the specification.

The focus on significant figures and decimal places in the marking of specific relevant question parts is evident in the scheme. These were marked in line with the advice given in the previous chief's report and information days.

Q1 The scale and labelling of the axes was correctly done by most candidates. Drawing of a best fit curve proved problematic to only a few. Most candidates found this question straight forward. Plotted points are sometimes difficult to spot if they are not marked with a cross or circled and a thick best fit line is drawn.

Q2 **(a)** Most candidates correctly extrapolated the line and read the intercept correctly.

(b) The extreme fit line was generally well drawn and the use of its intercept understood. A few inexplicably tried to use the gradient to calculate the uncertainty. The presentation of absolute uncertainty to one or two significant figures at most was often done correctly here.

Q3 **(a)** The gradient evaluation was done well by most candidates. Some missed the negative. The correct unit was stated by most. The mapping of the equation in Part (ii) proved a good discriminator. The internal resistance could still be answered correctly, even with the most common mapping error. A mis-use of the 'false' y intercept was given by most in Question 1 Part (iv) and the explanation of why the x intercept was correct was seldom given.

(b) Most candidates were awarded for the idea that the current was low but the practical benefit of low current being drawn at the start was seldom appreciated.

Q4 **(a)** This question was often answered without focus on the piece of apparatus used, this approach would have made the second marks more accessible and relevant.

(b) As Part (a), this question was often answered without focus on the piece of apparatus used. Most candidates did record the correct time.

(c) A significant number of candidates incorrectly used equation 4.1 and values from a single row from table 4.1 to evaluate the speed rather than the distance of 5.00 m.

(d) This question discriminated well. More able candidates had no problem getting the correct unit. Weaker candidates usually scored the first mark for the unit of wavelength and speed but could not deal with the squaring of the speed unit.

Q5 **(a)** Most candidates failed to 'finish' the explanation and achieved only two of the available three marks.

(b) The absolute uncertainty calculation in Part (ii) discriminated. Many provided a final answer with an excessive irrelevant number of figures.

(c) Most candidates calculated the percentage difference correctly although some did not use the 9.81 m s^{-2} as a reference. In Part (ii) closer to the accepted value is a clear reference to accuracy. This is achieved by repetition and averaging, but needed to be qualified. Many candidates gave vague statements and it was unclear what was being repeated. The use of electronic timing is the most significant change to the procedure that would ensure an answer closer to the true value.

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

Candidates generally performed well in this paper and there was no evidence that time was an issue, all candidates reached the final question with few gaps.

Q1 **(a)** Most candidates were able to correctly label the y-axis of the graph but labelling the x-axis discriminated. Weaker candidates often labelled it from 0 to 240 showing they did not appreciate the peak coincided with a nucleon number of 56

(b) The principles of fission and fusion were well described by the majority of candidates. Many did not refer to the graph and a lot omitted reference to the binding energy per nucleon.

(c) This question was generally well answered although often poorly set out and it was difficult to follow candidates' working if they made an error within the part.

Q2 **(a)** This was very well answered by the majority of candidates. Some did not go into the required detail of the operation so there was some discrimination in this question.

(b) This question was well answered by many but a significant number did not read the question carefully enough and compared nuclear power to fossil fuels.

Q3 **(a)** The calculation of the radius was well done by most candidates. Some candidates at the lower grade boundaries were unfamiliar with the 'f' prefix and others used the incorrect value for A.

(b) The position of the screen caused some problems here and the microscope was on occasions labelled incorrectly. Most candidates had the correct positioning of P and were able to explain the increase in range as a result of the vacuum.

(c) Many candidates had the correct curve but started it in the same position as the original.

Q4 **(a)** Only more able candidates scored all three marks in the explanation with many weaker candidates omitting the definition of acceleration or the link between velocity and direction. The calculation was usually very well done.

(b) **(i)** The calculation was very well answered by most candidates.

(ii) The explanation was not well answered with many candidates getting confused with the speed needed to reach the top of the circle and the speed that would cause weightlessness.

(iii) Was answered well by candidates other than those at the lower grade boundaries.

Q5 **(a)** Almost all candidates could correctly explain half- life but fewer scored the remaining two marks. Weaker candidates confused activity and half-life and only a few candidates gave both considerations. The calculation of half-life discriminated, better candidates had no problem with the calculation and used a variety of methods. Layout of the calculation was a problem when trying to award part marks to weaker candidates.

(b) This question discriminated with some candidates struggling with the time units and also using the Ln equation correctly.

Q6 **(a)** Most candidates were able to correctly link the Young modulus value to flexibility.

(b) This was generally well done although common errors were the omission of the negative and power errors.

(ii) The table was very well done by many candidates but others struggled and often mixed up the entries in the table.

(iii) The calculation was very well done. A common error arose in the final step when a significant number of candidates confused CSA and volume.

Q7 **(a)** Candidates scored highly in this question, most gaining at least six out of the eight marks available. Quality of diagrams was often poor and descriptions did not often flow well.

(b) This was well answered by the majority of candidates. As with other unstructured calculations, layout was often poor and difficult to follow.

Q8 **(a)** The explanation of simple harmonic motion was known well by the majority of candidates.

(ii) Most handled the calculation very well, variations in reading the period from the graph leading to some variation in the answer. Some candidates did not get the final mark for the correct position but most scored well.

(iii) The calculation is new to this specification and was very poorly answered. Very few candidates scored full marks. A significant number got part marks for only considering the extra energy stored at the extreme ends of the motion but many did not get any credit in this part.

(b) This question was well answered by candidates at the A Grade boundary boundary although many omitted the drawing of a tangent.

(c) This question was quite well answered although some candidates did not appear to understand resonance or driven oscillations.

Q9 **(a)** Most candidates scored well in this question.

(b) **(i)** The calculation was generally very well done.

(ii) Caused more problems with many candidates using the incorrect mass in the equation. Some candidates left their answer as the mean square speed.

Assessment Unit A2 2 Fields, Capacitors and Particle Physics

In general, candidates performed reasonably well in this paper. The paper was successful in allowing candidates of differing abilities to respond positively to the all of the questions posed.

Q1 **(a)** The majority of students answered this well. The definition of the time constant was well known although some did state it as 'the product RC'. Descriptions in Part (ii) were well written with most scoring 3/3. However, a number of students incorrectly discussed in terms of charging a capacitor and did not understand that this would not be possible with the circuit given.

(b) The graph was well known with only few giving a non-finite intercept on the V axis and a finite intercept on the t axis. Descriptions in Part (ii) lacked appropriate detail and it was not always clear how values of 2τ, 3τ etc. could be obtained and thus used to determine the average value of τ.

Q2 **(a)** Newton's law of universal gravitation was well known by the majority. A significant number failed to include that the force between two masses was attractive and lost 1 mark.

(b) **(i)** Many students were able to score almost full marks but some either forgot to subtract the radius of the earth from their calculated value of 'r' or forgot to convert the radius of the earth from km to m and therefore lost the last mark.

(ii) This was either very well done or very poorly done. Those who struggled usually started with an incorrect equation. Most candidates were able to obtain at least one mark for their conversion from s to hours.

(iii) Some candidates failed to mention the value of the orbital period of the earth being 24 hours and lost the mark here.

Q3 (a) (i) Most candidates knew the four fundamental forces and their corresponding exchange particles but a significant number did not include detail for the strong and weak force. The terms 'nuclear' or 'interaction' were frequently missing. Many candidates described the 'gravitational' force as 'gravity'.

(ii) (iii) Were well done but few scored 2/2 in Part (iv). Many gave only one equation and did not seem to understand the significance of the w- boson.

(b) This was well done by the majority of candidates.

Q4 (a) Most scored both marks in this part. Some candidates drew what resembled the field pattern for a bar magnet and did not score marks.

(b) A significant number of candidates indicated the force to be in an upward direction suggesting they did not know or could not correctly use FLHR.

(c) (i) Only the more able candidates scored full marks. 10^n errors were evident and some failed to calculate Δm obtaining values of 0.745N or 749N.

(ii) Was well answered with most scoring 3/3 in this part obtaining marks due to ecf from Part (c)(i).

(iii) Was also well done in the majority of cases showing knowledge of the AS specification.

Q5 (a) (i) Was well done by most candidates. Most managed to correctly state the type of transformer used and how one was constructed.

(ii) Candidates struggled to give adequate detail to obtain full marks in this part. Many did not include that both the input to the primary coil and output from the secondary coil were alternating. Descriptions of the changing magnetic flux in the primary coil and how this produced a changing magnetic flux in the secondary coil were poor in many cases. Some candidates appeared to misunderstand the diagram and mistook transformer T1 for the primary coil and T2 for the secondary coil. There were, however a very small number of candidates who answered this extremely well and scored 6/6.

(b) Most candidates were able to access both marks in this part giving concise answers in terms of current and energy/power loss. Some did discuss the resistance of the transmission lines decreasing due to the high voltage and did not score.

Q6 (a) This definition was recalled well by most candidates.

(b) (i) The majority of candidates were able to correctly calculate the force but struggled to accurately describe the direction. Some candidates confused electric field strength with force but could access the last mark for direction.

(ii) Part (ii) challenged candidates and was a good discriminator. Many were able to score the first two marks by equating a correct electric field strength at Z due to each charge. Some candidates correctly solved the resulting quadratic or took the square root of each side of the equation to obtain x=1.13m. However, some struggled to gain the last two marks and seemed to find the mathematics involved difficult.

Q7 (a) (i) This was poorly answered by many candidates. Very few candidates included detail of the centripetal force provided by the magnetic field.

(ii) Few candidates scored full marks. The required detail was missing in many answers. Many students discussed cooling with liquid nitrogen instead of liquid helium.

(iii) Only more able candidates scored the mark in Part (iii). Most gave answers in terms of 'the speed of particle increases and therefore time in the cavity decreases'. Half of this statement was given in the stem of the question and more detail was required to gain the mark. The few that did gain this mark gave excellent answers describing 'synchronous acceleration' or used the expression itself.

(iv) Was very well answered by most candidates.

(b) Most candidates found this question difficult, but most were able to access some marks within it, often for conversion of eV to J. It provided good discrimination.

Q8 (a) Faraday's law was generally well learnt with most candidates gaining the mark in Part (i). The graph caused problems for many students. Some did score 4/4 here but many scored only 2/4. Usually this was due to the inversion of the correct graph and detail of the magnitude of E being incorrect. A good discriminator.

(b) (i) This was a good discriminating question; very few candidates obtained 3/3 in this question. The majority of students stated the coil should be parallel to the field but then went on to state that the rate of change of flux was zero. This implies a certain amount of confusion around this topic. Rarely did candidates include enough detail to obtain the second mark on the scheme.

(ii) The frequency was generally calculated correctly. However, a surprising number of candidates gave an answer of 0.12Hz having calculated the time period of the output.

(iii) This was poorly answered by many candidates. The relevant equation was given on the data sheet, which some candidates had not realised. Those that had, struggled to convert cm^2 to m^2 and ended up with a power error.

Q9 (a) The structured nature of this question meant that it was answered very well by most candidates.

(b) In part many candidates correctly calculated the time spent by the beam in the electric field. However, some calculated t=6.31x10-9s having used s=175mm instead of 15mm. In Part (ii) most candidates were able to obtain this mark either from their correct value of t in Part (i) or form an ecf for their value.

Assessment Unit A2 3A Practical Techniques

The average mark in this paper, as expected, was high with the majority of candidates performing well. Marks were comparable to Questions 1 and 2 on the legacy Unit 3 paper. Candidates did not appear to have any issue with timing and it did not seem to matter which practical question they started on.

1 **(a)** In the heading, candidates sometimes omitted /s. Most values of D were ≥36.0cm which was the minimum required in the mark scheme. Most candidates timed ten oscillations but a significant number timed too few resulting in overall times less than five seconds, which was the minimum time accepted. Some candidates gave times to an incorrect number of decimal places, recording the periodic time to a greater precision than the original measurement.

(b) Mapping was well done and the majority identified b as the gradient.

(c) Headings were at times incorrect. Values were not always recorded to two decimal places as requested in the stem of the question. This part differentiated well between candidates.

(d) The graph was well plotted, usually with appropriate scales chosen. There was evidence from some centres of inappropriate scales, such as the x-scale beginning at zero. Sometimes plotting errors were evident. Best fit lines were well drawn here.

(e) Most candidates were able to determine the magnitude of the gradient from a large triangle but some failed to identify it as being a negative value.

Q2 **(a)** Values of x to indicate the lens position were obtained by the majority of candidates. A very small number were finding repeats of one of the lens positions and therefore consistent small x values. Some candidates did not use the full range of y values, losing one mark if their greatest value did not equal or exceed y=780mm.

(b) **(i)** The mapping caused some candidates difficulty and was a discriminator. This was usually either very well done or poorly done. Many candidates who scored 2/2 in Part (i) correctly identified that the intercept = 4f but did not develop this to state f= intercept/4 and so lost a mark.

(iii) In this part x2/y values were generally correctly calculated to either two or three sf. Calculation errors were evident in some cases. The unit was usually correctly stated.

(c) **(i)** The graph was generally well plotted with appropriate scales chosen. Some candidates chose inappropriate scales making it difficult to plot points correctly.

(ii) Almost all candidates scored the quality mark for their intercept of the best fit line and were able to correctly calculate the value of f based on their answer to Part (b)(ii). The majority of intercepts were >600mm and <640.

(iii) Best fit lines were not always well drawn leading to differentiation between candidates. A number of candidates incorrectly considered the gradient in this part.

Assessment Unit A2 3B Data Analysis Theory

There was a good range of marks, with few students obtaining either very high or very low marks showing that the paper was successful in allowing candidates of differing abilities to respond positively. Few parts were left unanswered, and candidates provided evidence of calculations and working out. In some parts, candidates had to apply their knowledge to a greater degree, and there was discrimination between candidates of differing abilities in many parts.

Q1 (a) (i) Most candidates responded with 5V for 1 mark, though not many referred to the actual reading shown.

(ii) (iii) Were generally well answered although a significant number went to half a division in their uncertainty.

(b) (i) Was well answered by the majority of candidates.

(ii) Nearly all candidates used the percentage uncertainty method, many did this correctly but with errors in the number of significant figures for both the quantity R and the uncertainty in R.

(iii) Error and 'mistake' were often linked for one mark, but few candidates gained both marks, many focused on equipment issues here and did not access marks, often just repeating the word given in the question.

(c) The majority of candidates referenced repeating and averaging results and obtained 2/3 but failed either to mention anomalous results or that they had to be discarded.

Q2 (a) (i) There were many good answers and tangents well drawn, those drawing poor tangents could access the gradient mark, most recognised the maximum occurred at 0.5s, 1.5s etc.

(ii) The majority of candidates got Part (ii) correct from an understanding of SHM.

(b) (i) Was generally well done, particularly the smaller displacement, several candidates did not recognise the same time period and some lost a quality mark for an inaccurate sketch.

(ii) Candidates generally commented that velocity would be less/smaller and many added an explanation connecting it to the smaller displacement.

Q3 (i) Candidates had difficulty with correctly counting the number of waves and thus calculating correct time period. A significant number of candidates did not use the time base or forgot to convert it into seconds. There were some power errors with f value.

(ii) Was accurately done in most cases.

(iii) Decreasing frequency was often given as an answer here, with or without correct reference to amplitude.

(iv) Was usually well-answered with accurately drawn vertical lines. Lines, when they had been drawn in light pencil, were difficult to distinguish on-line on the grid, some candidates drew two dots rather than a vertical line.

Q4 (a) (i) Was well answered by the majority of candidates.

(ii) Discriminated well, only better candidates correctly identified the units, seconds were often included for both A and B.

(b) **(i)** The majority of candidates knew that the values should be recorded to three sf but only more able candidates referenced the raw data for E in their reason.

(ii) The main problem for some candidates was choice of inappropriate scales, particularly on the x-axis. Otherwise the graphs were generally well-drawn. Not all axes were fully labelled.

(c) **(i)** Was generally well answered though at times the answer was quoted to an incorrect no of sig fig.

(ii) (iii) Were well done by most candidates.

(d) The gradient was well calculated and most values were within the required range, indicating quality of line drawn.

(ii) The percentage difference was generally well-answered.

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