Rewarding Learning

CCEA GCE - Physics
(Summer Series) 2011

Chief Examiner's Report

physics

Foreword

This booklet contains the Chief Examiner's Report for CCEA's General Certificate of Education (GCE) in Physics from the Summer Series 2011.

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

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

This report 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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QAN	500/2471/1
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GCE PHYSICS

Chief Examiner's Report

Assessment Unit AS

The **Notes for Guidance** along with papers and mark schemes provide teachers, candidates and examiners with the extent of the specification content.

Please note in particular:

1. **CCEA GCE Specification in Physics** Section 1.2 bullet 4 'The Notes for Guidance, downloadable from our website, support teachers and students'.
2. **CCEA GCE Specification in Physics** Section 6.1 bullet 4. Here the Notes for Guidance are named as a resource to support the specification.
3. **GCSE, GCE, Principal Learning Code of Practice** Section 1.8 (iv) '… over a reasonable number of years, the examination as a whole will address all the specification content'.

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 Candidates generally performed well in this question.

(a) Most candidates obtained full marks in this question. Some candidates did not identify base and/or derived quantities from the paragraph as instructed. In these cases, the units given were often base units as opposed to S.I. units.

(b) Almost all candidates were able to determine the base units of energy. Of those who could not, many used the kinetic energy equation but did not square the units of velocity correctly and sometimes not at all.

Q2 Almost all candidates were able to respond positively to this question. Most correctly identified timing as having the greatest source of uncertainty in the experiment and many went on to suggest a more accurate method. Repeating the experiment at each height and using a range of heights were further improvements that many candidates identified although some responses were unclear as to whether displacement or time or both should be repeated. Most candidates correctly described a graphical method for analysing their results although some were a little vague on the relationship between their gradient and the acceleration of freefall.

QWC - most candidates expressed their ideas clearly and fluently. There were few errors of grammar, punctuation and spelling.

Q3 Many candidates experienced difficulty with parts of this question.

(a) Almost all candidates drew a suitably curved path for the athlete's centre of mass between the 1.0 m take off point to the 0.4 m landing point.

(b) Most candidates successfully calculated the vertical component of the athlete in part (i). In part (ii) many candidates obtained the correct answer despite ignoring the vector nature of the initial velocity, acceleration of freefall and displacement. In part (iii), those candidates who failed to consider the vector nature of the variables were penalised as they obtained an incorrect answer. Another common error was to assume the motion was symmetrical about the maximum height and to double the time taken to reach that height.

Q4 Candidate performance in this question was varied.

(a) In part (i), most candidates appeared familiar with the expression 'directional sense' and responded correctly. A significant number incorrectly stated the directional sense was 'north-east'! In part (ii) some candidates were unable to show clearly the 'perpendicular distance'. Many simply drew a horizontal line between point P and the tail of vector F.

(b) Part (i) was well done. In part (ii) of this question many candidates successfully calculated the distance of the second monkey from the trunk. However, a large number of candidates did not. Some were careless in setting out their calculation and confused the directional sense of the four moments. Others, who labelled their forces 24 g, for example, confused the g for gram and introduced a 'power of ten' error. Part (iii) was poorly answered with only a small number of candidates providing a clear explanation in terms of a reduced perpendicular distance.

Q5 Many candidates found parts of this question difficult.

(a) In part (i) of this question few candidates produced expressions to show that efficiency equalled the ratio of gravitational potential energy at height h_2 to that at height h_1. Part (ii) was generally well answered as most candidates identified h_2 as 1160 mm.

(b) Not all candidates were able to obtain the correct answer to this question. Of those who did, many chose to use equations of motion.

Q6 This question was very well answered.

(a) Most candidates had learnt good statements of Hooke's Law. Those who had not typically omitted to mention that the law holds up to the proportional limit.

(b) The unusual graph question, of part (i), was well handled by the majority of candidates. Calculating the spring constant in part (ii) posed little problem to most candidates. Some stated units that were inconsistent with their calculation.

Q7 Few candidates found this question difficult.

(a) Most candidates were very familiar with p.d. and e.m.f. and responded well to this question.

(b) Where candidates did not receive full credit, in part (i), the most common was an inability to compose a response that 'shows' clearly. In part (ii) of this question, almost all candidates calculated the e.m.f. correctly.

Q8 This question contained parts that challenged many candidates.

(a) Most candidates correctly stated Ohm's Law in part (i) and identified the correct graph in part (ii).

(b) Few candidates, in part (i), identified that the resistance of conductors B and C is equal when their graphs cross. In part (ii), most candidates correctly identified conductor B as an ntc thermistor and explained their choice appropriately.

Q9 This question was quite well answered.

(a) A number of candidates experienced difficulty in calculating the cross-sectional area while some introduced 'power of ten' errors in converting to S.I. units. A significant number of candidates misunderstood the question and determined the base units.

(b) In part (i) of this question almost all candidates correctly calculated the resistance of each length. In part (ii) most candidates plotted points accurately on appropriate scales and drew good best-fit lines. Part (iii) required the candidates to measure the gradient of their best-fit line which most did successfully and then used that value to obtain the resistivity. Many candidates did not give the correct units for resistivity.

Q10 This question proved difficult for many candidates.

(a) Most candidates obtained full credit here. Responses often took the form of a numerical example.

(b) A large number of candidates did not obtain the correct answer for the resistance of R in part (i). However, they frequently picked up some method marks. In part (ii) only a small number of candidates obtained an answer consistent with their resistance of R.

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 Candidates performed well in this question.

(a) Most candidates appreciated that the amplitude in both graphs was the same, although many lost credit because they phrased their response poorly.

(b) The majority of candidates correctly used the information in Fig 1.2 to determine the wavelength, as required in part (i). In part (ii), some candidates had difficulty in establishing that Fig.1.1 represented 4.5 oscillations. Almost all candidates obtained full marks for part (iii).

Q2 Many candidates experienced some difficulty with this traditional refraction question.

(a) A large number of candidates were unable to recall the relationship between the critical angle and refractive index.

(b) In part (i) of this question many candidates did not appreciate the significance of the geometry of the triangle through which the light passed and consequently assumed that the ray would reflect internally. Most candidates appreciated that the ray did not bend at side PR and many went on to show that their ray bent away from the normal on exiting the prism. The third part of this question required the candidates to use Snell's law to calculate the angle of refraction. Most candidates correctly recalled the relationship and many worked through the geometry to establish the incident angle.

Q3 This question was well answered by many candidates.

(a) The majority of candidates demonstrated their understanding of ray diagrams for diverging lenses including the convention to dash virtual rays and obtained full marks.

(b) Most candidates were awarded full marks for their description of an experiment to determine the focal length of a converging lens.

Q4 Many candidates performed very well in this question but there was a sizeable minority who experienced difficulties.

(a) Almost all candidates obtained full marks in this question. There were some who confused nodes and anti-nodes.

(b) Most candidates identified the string length as being half the wavelength of the 1^{st} harmonic. In part (ii), many candidates realised that the frequency and wavelength were in inverse proportion but did not take the additional step of identifying the string length.

(c) Few candidates were able to draw the 3^{rd} harmonic. A common incorrect response was to place nodes at B, F and M.

Q5 Almost all candidates experienced some difficulty with this question.

(a) Very few candidates stated that waves were coherent if there was a constant phase difference. A few candidates defined coherence in optical fibre bundles!

(b) As with (a), only a few candidates offered responses worthy of credit. It was apparent here that candidates understood what 'in phase' means but many missed the significance of the context and answered in terms of interference

(c) Almost all candidates commented on the constructive interference that occurs but very few discussed path difference. Occasionally a candidate stated that phase difference was equal to a whole number of wavelengths!

(d) Most candidates were clearly familiar with this equation and scored heavily. Few candidates calculated the fringe separation correctly. A common error was to divide by seven rather than six, and some divided by twelve while others used the value 24.3 mm. Substitution of the variables into the relationship was well done in general and most candidates obtained a value consistent with their fringe separation. 'Power of ten' errors were common.

Q6 This question was poorly answered.

(a) Many candidates were familiar with using the CRO to determine frequency and obtained full marks. For others, the stages involved in this calculation were elusive. It was not uncommon to see "λ = 4 cm" which illustrates the misconceptions experienced by some of the candidature.

(b) Few candidates produced wavefronts, in part (i), worthy of credit in this GCSE style question. In part (ii), most candidates appreciated that the extent of the spreading would increase as the wavelength increases.

However, few realised that the 'shadow zone' is created by the wavefronts and their answers were not credit worthy.

Q7 This question was answered very badly by most candidates from most centres.

(a) Only a few candidates indicated that tomographs are cross-sectional images.

(b) Many candidates attempted a response involving the excitation of target (tungsten) electrons but few identified the ionisation of inner shell electrons while others indicated that it was the excited electron that relaxed. Some candidates were familiar with the idea of braking radiation.

(c) Responses to this question were very poor. A minority of candidates, in part (i), identified that 99% of the incident electron kinetic energy was converted into heat energy and this had serious repercussions on their subsequent responses. A large number of candidates assumed that 99% of the incident electrons passed into the X-ray tube. There were some candidates who correctly identified and explained the role played by the large copper mass and the rotating target. In part (ii), only a few candidates were able to explain that the soft X-rays were dangerous to the patient and that it was necessary to reduce the total X-ray dose received by the patient so filtering out any unnecessary (low energy) X-rays was important.

Q8 Most candidates found this question straight forward.

(a) This was very well answered as almost all candidates identified the two marking points.

(b) The overwhelming majority of candidates received full marks for this part. Common errors were to state that the gradient was equal to the Planck constant or that it was equal to 1.

(c) Again, most candidates answered this question very well.

Q9 Many candidates experienced some difficulty with this question.

(a) Most candidates realised that the electron would be excited to $n=\infty$ but fewer stated that the electron would have kinetic energy. Often elements of the photoelectric effect were included and where those mentioned "work function" the candidate lost credit.

(b) Most candidates responded correctly but a large number stated the electron would be promoted to between $n=4$ and $n=\infty$ indicating their lack of appreciation of the central tenet of the quantum theory.

(c) This part was generally very well answered with most candidates correctly working out the photon energy in electron-volt and then describing the transition from $n=2$ to $n=1$.

Q10 This question was answered well by the majority of candidates.

(a) Almost all candidates obtained full credit in part (i) but few could name a phenomenon that could be described by both the wave model and the particle model as required in part (ii).

(b) The majority of candidates obtained full marks in this calculation but there was a sizeable minority who were distracted by the inclusion of the alpha particle's charge.

Assessment Unit AS 3 Practical Techniques

Q1 Candidates performed well in this question.

(a) The majority of candidates recorded their readings in appropriately headed columns, timed a minimum of five oscillations and repeated and averaged before stating the periodic time for each spring combination.

(b) Most candidates were able to identify the equation that described the trend of their results. Of those, many provided compelling explanations. However, a large number incorrectly stated that the periodic time was proportional to the number of springs (Session 1). Those who chose to perform calculations to establish the relationship were expected to perform the calculation on at least two of their three sets of data, a number did not.

Q2 Not all candidates performed well in this question.

(a) While the majority of candidates correctly measured and recorded values for the image distance, a sizeable minority recorded the object to screen distance ($u + v$).

(b) The first part of this question was well answered as most candidates demonstrated their proficiency with this calculation. In part (ii) a number of candidates missed the significance of the phrase 'using the results from Table 2.1' and incorrectly stated that the experiment should be repeated. Judgement of sharpest image position as the major source of uncertainty was almost universal, in part (iii); unfortunately not all candidates expressed that idea clearly.

Q3 This question was well answered.

(a) Candidates generally identified the most suitable measuring instrument, explained why it was most suitable and correctly stated its uncertainty. There were occasional 'power of ten' errors in stating the uncertainty.

(b) Most candidates demonstrated their competence in using the measuring instrument.

(c) Most candidates demonstrated their competence in using the measuring instrument.

(d) Most candidates received the mark for the calculation of ratio. However, ratios were seldom given as (dimensionless) quotients and not necessarily an integer, as expected. Those candidates who did lose the mark usually calculated the inverse ratio to that requested.

Q4 This question was very well answered by almost all candidates.

(a) Almost all candidates obtained three valid sets of voltage and current readings.

(b) Values of resistance consistent with the candidate's voltage and current values were calculated.

(c) Almost all candidates in Session 1 correctly identified the lengths of the wires and in Session 2 correctly identified the thickness of the wires from their resistances. Convincing explanations generally accompanied identifications.

Q5 This question was well answered by the majority of candidates.

(a) Most candidates were able to quote the general equation for a linear graph but not all clearly identified the term within Equation 5.1 that corresponded to the gradient.

(b) The first part of this question was to head the columns (Session 1), column (Session 2), in Table 5.1. Some candidates omitted the unit completely while others did not use the established protocol (quantity-solidus-unit) for including it and sometimes the unit was not raised to the correct power. In part (ii), most candidates calculated consistent numerical values but not all gave them to two significant figures. In part (iii) most candidates demonstrated sound graph drawing skills. A surprising number of candidates did not maintain a regular scale along a single axis and did not realise their mistake when it came to drawing the best-fit line.

(c) In part (i), the majority of candidates read off a correct value for their intercept and inverted it to get V_{in}. Most values of V_{in} fell within the quality range. The extreme fit lines drawn in part (ii) were very varied. It was not necessary to calculate the centroid but the extreme-fit lines drawn by some candidates bore little relevance to the plotted points. Many candidates incorrectly calculated the experimental uncertainty by taking the difference of the intercepts and inversing that. In Session 2 most candidates calculated a consistent percentage uncertainty. There were some candidates who incorrectly divided the difference in V_{in} by the extreme-fit $V_{in.}$ In part (iii), almost all candidates used widely separated points, from their best-fit line, to calculate the gradient. Most were able to use that value to find a consistent value for the resistance. Most resistance values fell within the quality range.

Assessment Unit A2

The **Notes for Guidance** along with papers and mark schemes provide teachers, candidates and examiners with the extent of the specification content.

Please note in particular:

1. ***CCEA GCE Specification in Physics*** Section 1.2 bullet 4 'The Notes for Guidance, downloadable from our website, support teachers and students'.
2. ***CCEA GCE Specification in Physics*** Section 6.1 bullet 4. Here the Notes for Guidance are named as a resource to support the specification
3. ***GCSE, GCE, Principal Learning Code of Practice*** Section 1.8 (iv) '… over a reasonable number of years, the examination as a whole will address all the specification content'.

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

Q1 Most candidates were able to respond positively to all parts of this question.

(a) The conservation of momentum was very well known by almost all candidates.

(b) In part (i), most candidates successfully calculated the velocity of the trolleys after impact and most established, correctly, that the trolleys moved to the right. Most candidates, in part (ii), were able to state that the collision was inelastic but few attempted an explanation in terms of kinetic energy.

Q2 This question was well answered.

(a) Almost all candidates identified that a fixed mass of gas had to be considered at constant temperature in part (i). In describing an investigation into Boyle's Law, as required in part (ii), most candidates demonstrated their familiarity with the experiment and scored heavily.

QWC - most candidates responded appropriately to this question and expressed their ideas clearly and fluently with few errors in spelling, punctuation or grammar.

(b) Most candidates successfully calculated the new air temperature in the tyre. However, a large number attempted the calculation without converting temperatures to their S.I. unit!

Q3 This question was very well answered.

(a) In part (i) of this question almost all candidates correctly calculated the angular velocity of a point on the equator of the Earth. Most went on, in part (ii), to use their answer and calculate the linear velocity. Only a small number of candidates were unable to determine a consistent centripetal force.

(b) This part was not well answered. Few candidates appeared to appreciate that the reaction force of the ground is reduced as a result of some of the gravitational attraction force being used to provide the centripetal force.

Q4 Many candidates experienced difficulty with this question.

(a) Few candidates, in part (i), were able to draw the correct velocity-time graph. A common error was to draw a positive sine curve. In part (ii), the phase difference was usually correct.

(b) Very few candidates were able to correctly explain the meaning of 'free vibration' and 'forced vibration'.

(c) In part (i), most candidates correctly stated that the frequency of the forced vibration must equal the natural vibration frequency of the system. However, in part (ii) lots of candidates provided examples in which there was oscillation but for which there was no obvious driving force. The graphs drawn by most candidates in response to part (iii) were very good. A common mistake was to have the peak of the damped graph sharper than that of the undamped - this was generally a reflection of poor drawing rather than poor physics.

Q5 Candidates were able to respond positively to most parts of this question.

(a) Candidates responded very well to this question.

(b) Almost all candidates were familiar with the equation and correctly identified the mass number as required in part (i). They were equally confident, in part (ii), in describing the atomic structure of lithium-7 and in part (iii) in determining the radius of the lithium-7 nucleus. Some candidates made a 'power of ten' error when converting from femtometre to metre. When asked to calculate the density, in part (iv), many candidates used the value for r_0 (1.2 fm) rather than that calculated in part (iii).

Q6 The material tested in this question was familiar to most candidates.

(a) Descriptions of the half-life experiment were generally disappointing. Many candidates included unnecessary detail (on the preparation of the radioactive sample, for example).

(b) Many candidates struggled with this 'stretch and challenge' calculation. A common mistake was to use inconsistent units for the decay constant and the activity in the $A=\lambda N$ equation. Also, a large number of candidates were unable to obtain the mass of cobalt-60 given the number of cobalt-60 atoms and the mass of one cobalt-60 atom!

Q7 Responses to this 'stretch and challenge' question were generally good.

(a) Many candidates did not recall that electrical energy $E=ItV$ and so were unable to use the mass-energy relationship to complete the calculation.

(b) In part (i) of this question, most candidates calculated a mass defect in atomic mass units, attempted the conversion to kilogram and then used the mass-energy relation to obtain a quantity of released energy. However, many candidates were careless in one or more stages with the result that few obtained full marks. Commonly, candidates missed that three neutrons were emitted in the fission reaction described. In part (ii), a large number of candidates experienced difficulty in determining the number of uranium-235 atoms in a kilogram.

Q8 This question was poorly answered by a minority of candidates.

(a) Most candidates were familiar with the D-T reaction and wrote the correct equation for it, in part (i) of this question. In part (ii), most candidates were able to provide two reasons why the D-T reaction is the most suitable for terrestrial fusion.

(b) Responses to part (i) of this question often evinced a sound appreciation of the basic operating principles of the JET fusion reactor. In part (ii) of this question, most candidates appreciated why fusion was difficult to achieve in JET.

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

(a) Part (i) of this question was well done with the majority of candidates correctly calculating the values in the three columns. There were some candidates who used natural logarithms rather than logarithms to base 10 as required. The graph work in parts (ii) and (iii) indicated the skill which most candidates brought to this type of analysis. Generally, graphs were well scaled with correctly plotted points and good best-fit lines. Most axes were correctly labelled but some candidates, despite the headings in the table, omitted them or labelled the axes wrongly. In part (iv), almost all candidates were able to show that the mass per unit length was equal to the product of density and cross-sectional area. Only a few candidates correctly calculated the radius of the wire in part (v).

(b) Despite being given the terms to be used in describing the wave on the wire and that in the air, many candidates' answers were very confused.

Assessment Unit A2 2 Fields and Their Applications

Q1 Most candidates scored well in this question.

(a) The overwhelming majority of candidates demonstrated sound understanding of the concept of a gravitational field.

(b) Most candidates were familiar with this calculation although a large number failed to convert the Earth's radius to the S.I. unit.

(c) Almost all candidates, in part (i), appreciated that geostationary satellites have an orbital period the same as the Earth's and went on to calculate it correctly. In part (ii), most candidates were aware of Newton's law of gravitation. Two common mistakes on substituting into the equation were, firstly, to fail to include the radius of the Earth in determining the separation of the (centres of mass of the) Earth and satellite and, secondly, to not using S.I. units for distance. Part (iii) of this question was poorly done with only a few candidates demonstrating an awareness of Kepler's third law.

Q2 This question was quite well answered, although many candidates found some parts of it challenging.

(a) Most candidates wrote excellent definitions of electric field strength. Some misinterpreted the question and defined 'unitary' field strength while others failed to specify a charge of 1 C.

(b) The straightforward calculation in part (i) elicited very good responses from a large number of candidates. A common mistake was to fail to square the radius during the calculation. In part (ii)(1) few candidates used the simple method of multiplying their value for the electric field strength by the charge of the electron preferring instead to use the force-charge relationship, effectively duplicating the calculation in part (i). Some candidates substituted values for the proton and electron 'mass' into the force-charge relationship; others divided the product of the charges by the value 8.99×10^9 F^{-1} m rather than multiplying and another group used the Boltzmann constant (k)! Part (ii)(2) was well answered with many candidates drawing on their precise use of the force-charge relationship to obtain a negative value for the force and correctly interpreting it here.

Q3 Almost all candidates were very familiar with an experiment to determine the time constant of a capacitor.

(a) Most candidates produced circuit diagrams that allowed the time constant to be determined. Often, however, the standard of these diagrams was poor – candidates should be warned of the consequences of careless drawing.

(b) Most candidates obtained full marks in part (i). There was sometimes an inconsistency in that a charging circuit was drawn and a discharging experiment was described. In part (ii), most candidates provided a correct explanation as to how the results should be analysed.

Q4 Most candidates found this question relatively straightforward.

(a) In part (i), almost all candidates were able to identify that the force on the wire acted up. Unfortunately, fewer were able to use Newton's 3rd law to precisely explain that the force on the scales would increase, as required in part (ii). Some candidates simply stated the law and made no attempt to apply it to the situation, others thought the reaction force acted directly on the scales.

(b) Part (i) was well answered, and most candidates were able to find an accurate value for the average force as required in part (ii).

(c) Almost all candidates answered part (i) correctly; part (ii) was more problematic. Overall a large scored full marks.

Q5 Almost all candidates experienced some difficulty with this question.

(a) Very few candidates obtained full credit in this part of the question. Many candidates failed to link the energy loss with the design feature aimed at minimising that loss. A large number of candidates cited the insulation on the copper wires as minimising energy losses!

QWC - most candidates responded appropriately to this question and expressed their ideas clearly and fluently with few errors in spelling, punctuation or grammar.

(b) The Turns Ratio calculation of part (i) was well done. It was pleasing to see that many candidates calculated the secondary voltage to four significant figures and rounded to three to 'show' the value. Part (ii) was a 'stretch and challenge' question which many candidates found very challenging.

Q6 Very few candidates achieved full marks in this question.

(a) The majority of candidates, in part (i), identified the correct relationship between the electric field strength and the voltage between, and separation of, the parallel plates and went on to calculate the correct value of E. In part (ii), a sizeable minority did not realise the application of Newton's 2nd Law here. Of those who did, some used the mass of the electron to calculate the acceleration of the proton.

(b) Many candidates struggled with this 'stretch and challenge' question. A large number of candidates did not recognise the necessity of finding the vertical and horizontal components of velocity on leaving the field. Among those who did was a large group which used horizontal velocities and vertical accelerations in equations of uniform acceleration. There were others who made invalid assumptions such as those who assumed that the proton entered mid-way between the plates and had a vertical displacement of 40 mm on exiting.

Q7 Almost all candidates were able to respond positively to all parts of this question.

(a) Almost all candidates, in part (i), realised that the vacuum was necessary to prevent a loss of energy from the particles being accelerated. In part (ii) candidates were very familiar with the function of the electrodes. Part (iii) had an element of 'stretch and challenge' and many candidates successfully calculated the flux density of the dipole magnets.

(b) In part (i), a minority of candidates responded that antimatter is composed of antiparticles. The majority of candidates explained what antiparticles are. Most candidates successfully calculated the energy released in the annihilation of the antimatter. A number of candidates failed to consider the equal mass of matter required. Some candidates used the equation $E=\frac{1}{2}mc^2$.

Q8 This question was generally well answered.

(a) The overwhelming majority of candidates identified mesons as comprising a quark-antiquark doublet.

(b) The table, in part (i), was often completed accurately with the exception of the proton and electron charges; only the most perceptive candidates gave these values in coulomb. Most candidates realised that charge, baryon number and lepton number must be conserved for a reaction to be possible.

(c) The quark structure of the proton was very well known.

(d) Many candidates were familiar with the conversion of a down quark to an up quark mediated by a W^- boson.

Q9 Most candidates were able to respond positively to all parts of this synoptic question.

(a) While most candidates were able to successfully complete this calculation, there was a minority who could not. Often candidates were unable to recall the relationship between critical angle and refractive index.

(b) Almost all candidates were able to establish that the mirror moved through 45°, in part (i) and in part (ii) most were able to determine the angular velocity.

(c) This relatively straightforward calculation saw candidates introduce a number of errors. A large number of candidates took the square root before dividing by twelve million and many candidates made 'power of ten' errors converting from square centimetre to square metre and/or to micrometre.

(d) While most candidates, in part (i), realised that photon energy must be greater than or equal to the band gap for electron excitation, fewer were able to calculate the maximum photon wavelength. Many candidates were able to successfully calculate the number of photons that were incident on the pixel in part (ii).

Assessment Unit A2 3 Practical Techniques

Q1 **(a)** Almost all candidates followed the instructions correctly to obtain valid results for image distance and image diameter. Some candidates mistakenly recorded the object to image distance for *v* while some misinterpreted the 2 mm square graph paper taking it to be 1 mm. Others lost marks because they did not quote image distances to the nearest millimetre as dictated by the uncertainty in the ruler.

(b) Graphs were generally well drawn with most candidates employing a sensible scale that allowed the plotted points to extend across at least half of each axis. Some candidates were penalised for using awkward scales to spread their points across all the available graph grid. Most axes were labelled correctly, although a small but significant number of candidates failed to label the graph axes using the established convention of quantity-solidus-unit; points were plotted accurately and a good best-fit line drawn. A small number of candidates were penalised as their points were so poorly or thickly indicated that the exact co-ordinates of the point was unclear. Teachers may wish to instruct candidates to use a dot with a circle or an x, carefully plotted with a fine pencil to reduce ambiguity about position.

(c) Almost all candidates were able to identify constants *A* and *F* with the gradient and intercept respectively. Most candidates went on to correctly determine the gradient from two, widely separated, points on the best-fit line and realised that there were no units for *A*. Of those candidates who had a false origin for *d* most correctly calculated a value for the intercept using their gradient and the co-ordinates of a point on the best-fit line. However, there was a large number who simply quoted the value where their best-fit line crossed the y-axis.

(d) The first part of this question was well answered with almost all candidates citing the location of sharpest image position and measurement of distance with metre rule as the experimental factors. Other, more general, suggestions were offered by candidates (parallax error, for example) but they were not considered correct in the context of this experiment. Part (ii) was well answered. In part (iii) most candidates knew to draw an extreme-fit line. Some extreme-fit lines however, bore little relation to the plotted points, often passing through a single plotted point at a random angle. Candidates who drew lines of maximum and minimum gradient usually remembered that the uncertainty in *F* equalled half the difference in their intercepts. The calculation of percentage uncertainty, in part (iv), was very well done.

Q2 **(a)** Almost all candidates recorded accurate values of the current flowing during the capacitor discharge. There were some who had 'power of ten' errors in their recorded values.

(b) Most candidates were familiar with this type of manipulation and produced a correct logarithmic form of Equation 2.1. and stated y=mx+c. Not all, however, clearly mapped the variables in the logarithmic equation to those in the linear graph equation.

(c) In part (i) of this question a large number of candidates did not label the column in a manner consistent with the established protocol. Most went on to calculate values consistent with their results. Some incorrectly calculated logarithms to base ten and others converted the current in microampere to ampere before taking the logarithm; some introduced 'power of ten' errors in the process. In part (ii), the graphs produced were usually of a high standard. In part (iii) of this analysis, most candidates identified the gradient as being significant in determining the time constant and went on to calculate a consistent value for this.

(d) This question was answered very well in Session 1 and Session 2 with most candidates showing a valid calculation that led to their correct choice of capacitor arrangement.

Q3 **(a)** The experimental description of this oscillatory motion, required in part (i), was well answered by most. In part (ii), many candidates had difficulties in identifying another difficulty to accompany that of determining the curved length. In part (iii) many candidates offered responses that failed to attract credit because they were too general and lacked obvious application to this specific experiment.

(b) In part (i) almost all candidates correctly identified variables to be plotted that would result in a linear graph. Most went on to explain, in part (ii), how the gradient was related to the acceleration of free fall.

(c) In part (i) of this question, a large majority of candidates correctly calculated the density of the liquid and included the correct unit. Some candidates used the solidus in the unit for density and were penalised as this does not conform to the established protocol. The calculation of percentage uncertainty in part (ii) of this question was generally well answered. Many candidates, however, had difficulty in identifying the diameter as having the largest percentage uncertainty. In part (iii) most candidates were familiar with the base unit technique of identifying homogeneity. Not all candidates clearly determined the base units of pressure from Equation 3.2 and compared it to those from force/area.

Contact details

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