Rewarding Learning

CCEA GCE - Physics
(Summer Series) 2012

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 2012.

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's Report 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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GCE PHYSICS

Chief Examiner's Report

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 Candidate performance in this question was generally poor.

(a) Most candidates correctly identified power as the physical quantity measured in part (i) although a large minority thought it was energy. In part (ii), the majority of candidates knew the process by which the base units could be found but not all were able to execute the process accurately and failed to obtain the base units consistent with their quantity.

(b) This part was very poorly answered. Only a very small number of candidates worked out that machine two was the most powerful. The 'Error Carried Forward' protocol allowed the possibility of gaining the mark for working out the magnitude of their chosen machine – very few took this opportunity. Surprisingly, the naming of the derived S.I. unit of power was poorly answered with many candidates restating the base units. The fact that many of these candidates added the correct unit for power in their calculation in question 6(b)(ii) indicates that their confusion is with the names of these units rather than the units themselves.

Q2 This straightforward question was very well answered.

(a) Almost all candidates correctly calculated the magnitude of the acceleration. The most common error was to omit the negative sign.

(b) Again, the overwhelming majority of candidates were able to calculate the distance travelled by the remote controlled car. Of those who could not, most indicated their appreciation of the technique to be employed.

Q3 This question provided some differentiation among candidates.

(a) The difference between distance and displacement was well known. A minority of candidates implied that displacement is the straight line distance between two points for which they received no credit.

(b) Some candidates struggled with this part. Common mistakes were in not identifying a correct angle, confusing sine and cosine and not stating the direction as either a bearing or a point of the compass.

(c) The simple calculation of journey time, in part (i), was not successfully accomplished by all candidates. The three most common errors were to divide speed by distance and obtain an answer of 1.5 hours, to round off their answer incorrectly and state 0.6 and giving the correct answer of 40 minutes as 0.4 hours! Part (ii) of this question was tricky and many candidates did not correctly visualise the velocity vector required as the resultant of the two given in Fig. 3.2. Often candidates would attempt a Pythagoras type calculation but combined velocity and displacement vectors. An unfortunate mistake made in stating the direction was to give it as a bearing rather than an angle from the displacement vector s.

Q4 Many candidates found this question challenging.

(a) This part was poorly answered. Few candidates explained that there was uniformly accelerated motion in one direction and a constant velocity in the perpendicular direction.

(b) In part (i) of this question many candidates produced good responses showing clearly that the initial vertical component of velocity is 31.6 m s^{-1}. Although other methods exist, and were credited, the best 'show that' technique involves performing all significant stages in the calculation to find the value of the quantity involved. It is important that the equation is stated, the substitutions are carefully made into the equation and the answer shown to a greater number of significant figures then rounded off to that required. In this particular question, examiners were looking for the substitution of the negative acceleration. In part (ii), a large number of candidates successfully calculated the horizontal component of velocity, some calculated the time to reach maximum height and used that while others had no clear idea of how to answer the question. The 'Error Carried Forward' protocol allowed candidates to use whatever value they calculated for the horizontal velocity component to calculate the launch angle and many candidates benefitted from this. Unfortunately, a large number of candidates had no real idea as to how to tackle this question.

Q5 Most candidates found this question accessible.

(a) A large percentage of the candidature provided a concise and accurate statement of Newton's Second Law of motion.

(b) The simple calculation required in part (i) was well done by most candidates. Only the weaker candidates were distracted by the superfluous information. Part (ii) was well answered.

Q6 Many candidates found parts of this question challenging.

(a) Most candidates accurately defined power but fewer offered accurate definitions of efficiency. Many responses here were vague, candidates attempted to explain what efficiency is rather offering definitions.

(b) Many candidates produced excellent answers to part (i); they stated the work equation, showing clearly the substitutions into it and the resulting answer. Of some concern here is the confusion between work and moments; lots of candidates used sin 35°, some by error, but others made clear they were using the equation 'force times perpendicular distance'. Only the most careful candidates scored full marks in part (ii). The most common mistake was to consider the work done calculated in part (i) as the input energy rather that the output. The majority of candidates added the correct S.I. unit to the answer but were unable to do the same in Q1(b)(ii).

Q7 Almost all candidates were able to engage positively with this question.

(a) It was obvious to most candidates, in part (i), that the stretching force was altered by adding more slotted masses. Unfortunately, in part (ii) many candidates did not make it clear that extension is measured on the millimetre scale relative to the position when no stretching force acts.

(b) In part (i), most candidates appreciated that the mean value could not be to a greater degree of precision than the raw data and so had to be rounded to one decimal place. Responses to part (ii) tended to be vague; only a few candidates explicitly identified reliability as the explanation. Strain was well defined in part (iii). The number of candidates who scored all three of these marks was small. Most only received the mark for knowing the equation (equations) to calculate the Young modulus as they missed the subtlety of making multiple calculations (and averaging) to obtain a reliable value for the modulus. Many candidates overlooked the significant figure requirement.

Q8 Most candidates found this question accessible.

(a) In part (i) of this question many candidates produced good responses showing clearly that the total charge is 466 C. As in Q4(b)(i), the best 'show that' technique involves performing all significant stages in the calculation to find the value of the quantity involved. It is important that the equation is stated, the substitutions are carefully made into the equation and the answer shown to a greater number of significant figures then rounded off to that required. Few candidates were unable to deduce the current flowing in the circuit as required in part (ii).

(b) The majority of the candidature was able to calculate the potential difference across the kettle.

Q9 This question was generally well answered.

(a) In part (i) of this question, most candidates attempted a voltmeter, ammeter description. The most common reason for not obtaining full marks was because the positioning (parallel or series) of at least one of the meters was not given in the description. In part (ii), most candidates described the use of a micrometer screw gauge to obtain a mean diameter and provided an equation to calculate the cross-sectional area that was consistent with the mean diameter (or radius, if the candidate went down that route).

The quality of written communication was generally good. Candidates should be made aware that these marks can only be awarded if the response is relevant.

(b) Most candidates correctly completed the resistance-temperature graph, required in part (i), and identified 'superconduction' as the name required in part (ii). In part (iii), the majority of candidates realised that there would not be any heat energy generated by the circulating current, however, a sizeable number were less definite and in their responses indicated that there would hardly be any heat energy generated. This latter group did not receive credit.

Q10 This question was generally well answered.

(a) In part (i), candidates often only identified one equation for current and the suffix from the voltage symbol was commonly omitted. A small number of candidates misinterpreted the question and wrote two sentences about current. The manipulation required in part (ii) to determine the magnitude of resistance R_2 was handled well by most candidates.

(b) The majority of the candidature handled this question well. Almost all candidates scored two out of the three marks available. Frequently the last mark was forfeited as the current split was reversed.

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 This question was well answered.

(a) Very few candidates were able to state the range of wavelengths for visible light, in the majority of cases the nanometre requirement was ignored.

(b) Most candidates completed Fig. 1.1 accurately.

(c) Part (i) of this question was well answered although some candidates confused period with wavelength and others amplitude and displacement. A large number of candidates were unable to deduce the phase difference from the displacement - time graph.

Q2 Many candidates found parts of this question challenging.

(a) A large number of candidates demonstrated poor answering technique here as they tended to answer this question, about a general wave phenomenon, in terms of visible electromagnetic waves only. Part (i) was answered using a specific example (more optically dense to less optically dense). In part (ii), many candidates omitted to mention that the waves must be travelling towards a medium in which they will have a larger speed.

(b) The calculation in part (i) was a challenge to many candidates. Most correctly determined the distance travelled by the sound waves but few could progress beyond this stage. Common mistakes were to use the wrong trigonometric function and/or failing to deal with the reflected distance calculated. Part (ii) was very poorly answered with most candidates calculating the refractive index of the wave travelling from Layer B to Layer A and confusing it with its inverse.

Q3 This question was accessible to many candidates.

(a) Part (i) was well answered. Almost all candidates knew that ***u*** was the lamp – lens distance and that ***v*** was the screen – lens distance. Most candidates answered part (ii) in terms of the $^1/_u$ against $^1/_v$ graph. Of those who described a calculation and average method some described the incorrect method of averaging all the ***u*** values then averaging all the ***v*** values and performing a $^1/_u + {}^1/_v = {}^1/_f$ calculation once.

(b) Many responses to part (i) of this question evinced poor answering technique. The correct technique to employ is to re-interpret the "show that" requirement as "calculate". Perform the calculation writing out significant steps and state the answer to one more significant figure than that asked for. The calculation in part (ii) to find the lens – slide distance was well answered by some candidates but many did not give their answer to three significant figures and so forfeited the mark.

Q4 This question was not well answered.

(a) In part (i), candidate responses frequently omitted any reference to superposition (or interference) of the incident and reflected waves. Better candidates had few problems in drawing the second mode of vibration required in part (ii).

(b) In part (i), most candidates correctly calculated the wavelength of the sound waves but a large number were unable to relate that to the distance between the transducer and reflector given the standing waves mode of oscillation. As a further consequence, few candidates correctly answered part (ii).

Q5 This question was generally well answered with all candidates who attempted an answer gaining some credit.

Many candidates lost a mark for not labelling their diagram; others lost a mark because the quality of their diagram was so poor that it was not possible to identify the salient features. Most candidates quoted a value for the slit-screen separation accurately but an appropriate value for the slit separation was known by only some candidates. The interference pattern obtained from the experiment was well described by most candidates. Unfortunately, a number of candidates did not provide sufficient detail in their explanation of how the interference pattern was formed.

Q6 Most candidates found this question accessible.

(a) Part (i) of this question was poorly answered. In part (ii), the majority of candidates appreciated that the amount of diffraction spreading is greatest when the aperture size is comparable to the wavelength. Some candidates mistakenly thought that the sound frequency is influenced by the opening.

(b) The meaning of 'the intensity of a sound', in part (i), was not accurately answered; many candidates gave vague statements about loudness. The calculation of intensity level difference in part (ii) was fairly well done but some took the difference in the intensities values and used that in the equation.

Q7 Most candidates managed to gain some marks throughout this question but vague, non-specific answers caused many candidates to lose marks.

(a) In part (i) of this question almost all candidates correctly identified Fig. 7.1 as being produced by a B-scan. Very few candidates could state a typical frequency of the ultrasound used in medical diagnosis as required in part (ii). Many candidates quoted 20 kHz!

(b) Reasons for using a B-scan for the human knee application were generally well known.

(c) A large number of candidates were unable to name a suitable 'coupling medium' but almost all candidates had a good appreciation of why one was necessary.

Q8 Candidate performance in this question was very mixed.

(a) Almost all candidates correctly identified the description of photoelectric emission.

(b) Most candidates knew that it is the frequency of the light that should be increased. However, some went on to include 'and intensity' and were not then awarded the mark.

(c) This part was poorly answered with the majority of candidates revealing a misconception by referring to electron energy levels.

Q9 This question provided for some discrimination among candidates.

(a) The majority of candidates accurately calculated the photon energy.

(b) Only the most careful candidates received full credit here. Some were careless in drawing their energy levels on to Fig. 9.1, while others were careless in using, or didn't know how to use, the photon energies and the lowest energy level to calculate the three other energy levels.

(c) Laser action is well known by some candidates but poorly known by others.

The quality of written communication was generally good. Candidates should be made aware that these marks can only be awarded if the response is relevant.

Q10 This question was generally well answered.

(a) Some candidates gave a general statement about wave-particle duality without answering the question asked in terms of the observations made from the Davisson-Germer experiment; specifically that particles are behaving like waves.

(b) Most candidates made an attempt to find a mass but many did not appreciate the labelling of the x-axis on Fig 10.1 and so used the incorrect velocity in the de Broglie equation.

Assessment Unit AS 3 Practical Techniques

Q1 This question was very well answered.

(a) In part (i), the diameter of the golf ball (table tennis ball in session 2) was measured accurately with the wooden blocks and metre rule. The mark was commonly lost for not stating the diameter to the nearest millimetre as befitting the precision of the measuring instrument. In part (ii), almost all candidates used the micrometer screw gauge to obtain three values for the diameter, recorded them to a number of decimal places consistent with the precision of the instrument and obtained a diameter within the quality range.

(b) Very few candidates failed to pick up the marks for this part of the question.

Q2 Most candidates were able to respond positively to this question.

(a) Almost all candidates demonstrated their ability to insert a milliammeter and a voltmeter into a circuit to measure the current and p.d. respectively. In most cases answers were recorded to a number of decimal places consistent with the precision of the instruments.

(b) In part (i), most candidates successfully adapted their circuit and took a current reading to prove they had done it correctly. Part (ii), assessed the candidates appreciation of polarity and again almost all candidates demonstrated their mastery of this concept. Some candidates inserted the milliammeter into the circuit at a location where it read the same value regardless of the polarity of component Q; these candidates were penalised. In most cases answers were recorded to a number of decimal places consistent with the precision of the instrument or consistent with that used in part (a).

(c) The vast majority of the candidature demonstrated their practical understanding of this quantity and obtained a value between 1.30 V and 1.80 V. Again, most candidates maintained their decimal place consistency.

Q3 Good experimental technique was clearly evident in the responses to this question.

(a) Although most candidates scored the mark for the table, many tables were very untidy and poorly constructed. A large number of candidates did not label their columns (rows) appropriately: some candidates omitted the number of oscillations they timed whilst others did not follow the established protocol of using the solidus to indicate the unit in which the quantity is measured. It was expected that all times would be recorded to two decimal places and in most cases it was. Almost all candidates received the mark for processing their results to obtain a periodic time consistent with the measurements they took. However, some periods fell outside the quality range and candidates were penalised a mark.

Q4 This question was very accessible to all candidates.

(a) Very few candidates did not know how to adjust the spring balance reading in response to the 0.5 N zero error.

(b) The volume of the immersed mass was generally calculated correctly in part (i), although it was incumbent upon the candidate to show their subtraction in order to be awarded the mark. In part (ii) the reading for a reduced weight was credited if the candidate maintained decimal place consistency with their previous answer for weight in part (a).

(c) Few candidates were unable to calculate a value for R consistent with their values.

Q5 This question provided for some discrimination among candidates.

(a) In part (i), almost all candidates appreciated that the table data was given to three significant figures. This led most candidates to quote their mean electrical power output to three significant figures and consequently obtain the mark for part (ii). Part (iii) was more difficult. Here the candidate had to identify that the value in trial one was 'rogue' and should be discounted from the averaging process and state that no mistake was made in the calculation of the average. It is quite sensible to conclude that there had been a mistake in either reading or recording the output power for trial one but that was not the question asked. Few candidates were assertive enough to gain full marks but most achieved one out of two. In part (iv), most candidates correctly stated that log P and log v were not directly proportional because the best-fit line did not pass through the origin. Some candidates stated that P and log v were not directly proportional but were proportional because the best-fit line was linear. It should be noted that the terms proportional and directly proportional are synonymous. In part (v), the overwhelming majority of the candidature determined the gradient of the graph accurately although many did not use points that were sufficiently far apart and in part (vi) determined the intercept and most went on to find a value for k consistent with their intercept.

(b) In part (i), the calculation of ratio continues to be a problem to candidates. Despite the steer given in the question to divide the values, many candidates did not do so and of those a large number inverted the ratio. Furthermore, by not stating the ratio as a number, many candidates hampered their ability to answer part (ii), which was either done very well or not at all. Part (iii) was very poorly done although a sizeable minority of candidates correctly calculated the missing turbine power.

(c) In part (i), most, but not all, candidates calculated the percentage uncertainty for P_{max} and the absolute uncertainty for ρ. In part (ii), most candidates correctly rearranged equation 5.4, substituted in the values from the table and obtained a value for the Betz coefficient. Most went on to successfully demonstrate their ability to combine uncertainties.

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

Q1 Most candidates were able to respond positively to this question.

(a) In part (i), a significant number of candidates failed to accurately interpret the statement of specific heat capacity. In part (ii), some candidates were unable to apply understanding of specific heat capacity to the context of the question. Many candidates explained that the temperature did not rise significantly, but did not relate this to a given heat input to allow the comparison with other substances.

(b) Part (i) of this question was well answered but some responses lacked precision as candidates did not identify the object for which the mass was required. Some candidates incorrectly stated voltage and current. In part (ii), many candidates lost credit because they did not make specific heat capacity the subject of the equation or failed to explicitly state that the temperature change was required.

(c) In part (i), the calculation was well answered. Only a few candidates lost marks for an incorrect identification of the specific heat capacity of copper. While some candidates incorrectly converted temperature rise to Kelvin. In part (ii), most candidates used the correct equation with only a few failing to convert watt to kilowatt.

Q2 Some parts of this question challenged many candidates.

(a) In part (i) of this question, the vast majority of candidates accurately quoted the principle of conservation of momentum and almost all went on to accurately quote the principle of conservation of energy in part (ii). In part (iii), very few candidates were able to synthesise the conservation laws to gain all the marks in this question. Many failed to separately analyse total energy and kinetic energy.

(b) The vast majority of candidates gained a mark for the direction. However, only the most able candidates were awarded marks for velocity.

Q3 Overall performance in this question was poor.

(a) Most candidates identified the change in direction leading to a change in velocity, but few related this to the rate of change in velocity and hence acceleration.

(b) Part (i) of this question was poorly answered with many candidates unable to identify the sine component of the tension as balancing the weight of the stone and in part (ii) few realised the cosine component of the tension was the centripetal force.

(c) This question was well answered with many candidates gaining full marks.

Q4 Candidates responded well to this question.

(a) Accurate definitions of simple harmonic motion were given by the majority of candidates.

(b) In part (i), some candidates were unable to determine the angular frequency and hence could not progress to the calculation of acceleration. Those same candidates were unable to complete the calculation to determine distance in part (ii).

(c) Part (i) was poorly answered with a number of candidates focussing on the friction between the coils of the spring and neglecting air resistance. Part (ii) was characterised by poorly drawn diagrams. The period was rarely drawn constant and many attempts failed to show decreasing amplitude.

Q5 This question was accessible to most candidates.

(a) Part (i) was well answered with most candidates correctly stating that the screen was to detect alpha particles. Part (ii) was less well answered as many candidates failed to state that the moveable microscope was to detect the alpha particles at all angles and not just those that were back-scattered. Part (iii) elicited a number of incorrect or imprecise responses. Very few candidates linked the range of alpha particles in air with this experiment as the question intended.

(b) Candidates demonstrated good understanding of the link between experimental observations and conclusions.

(c) Most candidates correctly identified the nuclear compositions of iron-56 and neon-20. Some candidates gave the number of electrons!

(d) Part (i) was well answered. The most common error was to use the wrong mass number for iron. Most candidates demonstrated their familiarity with the calculation of nuclear density as required in part (ii). The comparison of nuclear densities in part (iii) was not well answered as few candidates stated that nuclear density is independent of mass number.

Q6 This question was reasonably well answered.

(a) While most candidates responded correctly to part (i), a sizeable minority was unable to complete the equations for alpha and beta emission. In part (ii), the definitions of activity and half-life were generally sound.

(b) In part (i), the activity of the sample was correctly calculated by most of the candidature, most of whom went on, in part (ii), to calculate the samples half-life correctly. The graph in part (iii) was typically lacking in detail and was often of poor quality. Part (iv) was poorly answered with many candidates confusing activity and number of radioactive atoms.

Q7 Aspects of this question challenged many candidates.

(a) Definitions of mass defect were generally sound.

(b) In part (i), some candidates carelessly calculated the mass defect in unified atomic mass units incorrectly but the 'Error Carried Forward' protocol allowed them to receive credit for correctly converting to kilogram. In part (ii), many candidates were able to convert their mass defect in kg to MeV but failed to calculate the binding energy per nucleon. In part (iii), the graph was often poorly sketched and only a few candidates indicated the correct position of iron-56.

Q8 Many candidates found aspects of this question challenging.

(a) Explanations of nuclear fusion were generally good.

(b) A poor understanding of plasma confinement was demonstrated by the majority of candidates. Most responses focussed only on magnetic confinement.

(c) Magnetic confinement was well described. Unfortunately, descriptions of gravitational and inertial confinement were poor.

Quality of written communication: most candidates expressed ideas clearly using appropriate scientific terminology and through well linked sentences. Some candidates' spelling and punctuation were poor and this cost them marks.

Q9 Most candidates coped well with this data analysis question.

(a) A significant number of candidates failed to re-arrange the equation successfully.

(b) The table was well completed with candidates using the correct number of significant figures and the correct unit.

(c) In part (i), graphs were generally well drawn and labelled. In part (ii), many candidates were unable to correctly determine the velocity of sound in air because they did not calculate the gradient accurately.

Assessment Unit A2 2 Fields and their Applications

Q1 Most candidates found this question accessible.

(a) Newton's Law of gravitation was reasonably well known and most candidates received at least two of the three marks available. Some forgot to state that masses attracted each other and that the force was proportional to the product of their masses.

(b) In part (i) of this question when explaining *geostationary* many candidates failed to mention that the satellite had to be in equatorial orbit. In part (ii), a common mistake in calculating ω^2 was to omit to square ω correctly, writing $\omega^2 = T^2/2\pi$ rather than $T^2/4\pi^2$. Candidates could obtain credit for calculating the distance above the surface even if their value for the radius was incorrect, although some lost this mark by failing to realise that the radius of Mars was given in kilometres.

Q2 This question was reasonably well answered.

(a) In part (i), some candidates used the Boltzmann constant for their value of $1/(4\pi\varepsilon_0 r^2)$! Part (ii) proved very demanding for candidates, with many finding the difference between the field strengths set up by each of the charges, rather than their sum.

(b) The responses of most candidates indicated that they were familiar with the properties of gravitational fields and electric fields.

(c) This electric field calculation was well answered by most candidates.

Q3 Responses to this question were generally good.

(a) In part (i), quite a few candidates described an experiment to measure the discharge of a capacitor, but those who described the correct experiment often had incorrect circuit diagrams and failed to show how the capacitor was initially discharged. The graphs were frequently incorrect.

(b) Candidates coped well with part (i) of the calculation but that in part (ii) proved taxing.

Q4 This question was well answered.

(a) Frequently, this definition erroneously began "this is the force which causes…". Many candidates harbour misconceptions about the tesla!

(b) In part (i), almost all candidates drew parallel field lines between the north and south poles of the magnet and, in part (ii), they were able to use Fleming's Left-hand Rule to determine the upwards direction of the force experienced by the conductor. In part (iii), most candidates recalled the correct relationship and navigated their way around the potential power-of-ten errors to obtain the correct answer.

Q5 Candidates were well prepared to answer questions on this experiment.

(a) Faraday's law is well known and the experiment was well described. Sketches were often poorly drawn and carelessly labelled which sometimes led to the candidate losing credit because the examiner was unable to positively identify an important detail.

Written communication was generally relevant and well-structured.

(b) Explanations of the use of high voltages were often incomplete with many candidates implying that the voltage was applied across the conductors rather than across the load.

Q6 This question was reasonably well answered.

Candidates performed well in the part (i) question to determine the electron velocity, although some confused v for velocity with V for voltage. In part (ii), most candidates correctly sketched the path of the electron beam and in part (iii) went on to accurately use F=Bev and obtain a value for the magnetic force acting on an electron in the beam. Equating the relationships for centripetal force and magnet force was apparent to most candidates and in part (iv) many correctly calculated the electron beam's path radius, although some did not convert their answer to millimetre.

Q7 There were aspects of this question that challenged many candidates.

(a) The properties of the accelerators were well known, apart from the maximum energies of the *linac* and the *synchrotron*.

(b) The calculation in part (i) proved difficult with many candidates failing to realise that two particles were annihilated and two photons were produced. In part (ii), the majority of the candidature did not use the data in the stem in relation to the emission of two photons and so answers to this part were poor.

Q8 Many candidates found this question very accessible.

In part (i), Table 8.1 was accurately completed by most of the candidature. In part (ii), candidate descriptions of the meaning of fundamental particle were typically very good. Part (iii) was less well answered as few candidates were able to state three differences between leptons and hadrons. Most candidates scored two out of three; the fact that hadrons experience the strong nuclear force while leptons do not was commonly overlooked.

Q9 This synoptic question proved stretching for many candidates who seem to have forgotten many earlier parts of the course.

(a) In part (i), the turns ratio was generally well answered. Unfortunately, in part (ii) the relationship between resistance, resistivity, length and area often was mis-quoted. The total length (13 m) and calculation of the area led to mistakes such as using the diameter as the radius and multiplying the resistance of one strand by 27, rather than dividing by 27 to reduce the total resistance. In part (iii), the application of an Error Carried Forward from part (i) allowed most candidates to get credit for their answer. In part (iv), the calculation of the cable energy loss the formula Energy = VIt was often quoted into which was frequently and incorrectly substituted the primary current and the supply voltage, which is not that across the cable.

(b) Some candidates, in part (i), were unable to establish that the blue photons are more energetic than red photons despite being given their respective wavelengths. In part (ii), many were also unable to correctly calculate the frequency and number of photons emitted by the diode. In part (iii), the limiting resistance of the resistor ***R*** was often calculated to be 120 Ω (the resistance of the LED), rather than 190-120 = 70 Ω.

Assessment Unit A2 3 Practical Techniques

Q1 This question was well answered.

(a) Most candidates measured the lengths correctly but many did not record them to 0.1 cm which would be consistent with the precision of the measuring instrument. Candidates exhibited good experimental technique for determining the period of the oscillations with almost all timing multiple oscillations to reduce the percentage uncertainty and repeating those timings to confer reliability upon the result. It should be noted that the context determines the number of oscillations timed and that there is no minimum number of oscillations required to obtain a mark. The number of oscillations timed should be such that the total measured time is sufficient to bring the percentage uncertainty in the period into line with the overall uncertainty objectives for the experiment. The calculation of periodic time was usually performed accurately, although there were some candidates who did not scale down their average multiple oscillation time to get their period. Most candidates stated their period to a level of precision (usually to 0.001 second) which is not possible using their timing apparatus.

(b) In part (i), almost all candidates demonstrated their ability to deduce a linear relationship between variables within Equation 1.1. Unfortunately, not all candidates rearranged Equation 1.1 accurately. The suggestion made by almost all candidates in part (ii) as to how the constant was to be found was consistent with their answer to part (i). Values for the T^2 (T^2D and D^2 in session 2) as required in part (iii) were generally consistent with the candidate's value(s) for the period.

(c) The overwhelming majority of candidates exhibited a high facility with graphs. Scales were well chosen, points were accurately plotted and suitable best-fit lines were drawn.

(d) Session 1: Candidates continued to demonstrate their graphical skills here. Gradients, usually, were accurately found using widely spaced points then used correctly to obtain a value for the constant consistent with their gradient.

(d) Session 2: In part (i), most candidates continued to demonstrate their graphical skills. The intercept was found accurately and then used correctly to obtain a value for the constant consistent with their intercept. In part (ii) most correct responses equated the intercept unit with the units in the term $4\pi^2k/g$ and cancelled to find the units of k.

(e) The answering technique of some candidates let them down in this 'show that …' question. In this type of question each stage must be clearly presented for the examiners inspection. Many candidates effectively proved *to their own satisfaction* that the assertion in the question was correct.

Q2 Most candidates found this question to be very accessible.

(a) The correct manipulation of apparatus and the accurate reading of values from the milliammeter and voltmeters were accomplished by almost all candidates.

(b) Few candidates exhibited any difficulty, in part (i), in calculating consistent values for resistance. The single most common mistake was in not realising that the current was in milli-amps and erroneously recording a resistance value in kilo-ohms as being in ohms. In part (ii) there were as many correct answers using the maximum-minimum technique as there were using the percentage uncertainty technique. Some candidates did not extract their raw data from the bottom row of their table as they were instructed to do in the question.

(c) In part (i), the calculation of 1/V2 values posed no problem to candidates. The graphical skill possessed by almost all candidates was again in evidence in part (ii) of this question. Scales were appropriately selected, points were accurately plotted and a suitable best-fit line was almost always drawn. Some candidates chose to compress the origin and in this case were penalised because the origin was marked on the grid (Fig. 2.3) provided on the paper.

(d) In part (i) almost all candidates realised that constant A was equal to the gradient of the graph. Gradients were usually accurately computed using points on the best-fit line that were widely spaced. In part (ii), the majority of candidates appreciated that constant B was equal to the gradient and that it was not possible, on this graph, to read it off directly since there was no negative y-axis. Most candidates went on to calculate a value for B, in part (iii), but some did not use a point from the best-fit line.

(e) Almost all candidates obtained this mark, indicating that they had skilfully performed the entire experiment.

Q3 Most candidates were challenged by aspects of this question.

(a) In part (i), most candidates appreciated that the microphone had to be connected to the oscilloscope, that the loudspeaker had to be connected to the signal generator and that the sheets of test material had to be between the loudspeaker and the microphone. Few candidates commented explicitly on the alignment of the loudspeaker, test material and microphone and consequently forfeited that mark. Many candidates misread or misinterpreted "*describe how this apparatus should be arranged*…" as they went on to explain how Equation 3.1 should be manipulated, the linear graph to draw and how that graph could be used to obtain a value for the sound absorption coefficient. In part (ii), many candidates named the time-base but few could name the y-amplifier (or offer an acceptable alternative name). In part (iii), most candidates knew to multiply the y-amplifier setting by the length, in centimetres, of the trace to obtain the voltage. It was not significant whether the amplitude voltage or peak-to-peak voltage was measured.

(b) This part was poorly answered. Many candidates did not consider how to ensure a fair test and so failed to mention specific factors to control, such as speaker-microphone distance or initial amplitude. Some candidates missed the significance of "*sufficient readings……. to plot a meaningful graph*" and did not combine the sheets of test material to obtain five or more sets of results.

(c) **(i)** Session 2: Most candidates performed very well in this question. The correct linear graph to draw was apparent to a large majority of the candidature as was the significance of the gradient. Many candidates lost a mark for omitting to comment on the negative value of the gradient. Very few candidates described a non-graphical analysis of results.

(ii) Session 2: Many candidates appreciated that the intercept of their graphs would be unchanged if a different test material were used, and correctly explained that the amplitude of the initial sound wave was unchanged.

(d) **(i)** Session 1: Many candidates realised that the thickness of the test material had to remain constant and that the frequency of the incident sound would have to change. Lots of candidates explained unnecessarily how frequency was measured using the oscilloscope.

(ii) Session 1 and Session 2: Many candidates failed to focus on identifying a factor that would change the sound absorption coefficient measured. Instead, most identified a factor that would make the determination of the sound absorption coefficient difficult.

Contact details

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