CCEA GCE - Physics
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Chief Examiner's Report

Foreword

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

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at www.ccea.org.uk

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GCE PHYSICS

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Assessment Unit AS 1 Forces, Energy And Electricity

Q1 This question was very well answered by most candidates.

(a) Almost all candidates accurately completed Table 1.1.

(b) Most candidates demonstrated competence in expressing the joule in its base units.

(c) This part was well answered, although a large number of candidates sketched the resultant vector incorrectly. Many simply completed the triangle and consequently forfeited the direction mark.

Q2 **(a)** Part (a) of this question was generally well answered; Part (b) was more challenging.

In Part (i), a surprising number of candidates did not indicate that a means of determining distance fallen was required in order to determine the acceleration of freefall. However, most candidates correctly indicated that the distance and the time taken to fall that distance were required. Not all candidates associated the question's requirement for accuracy with the need to obtain multiple values and forfeited the second mark in Part (ii). In Part (iii), responses were equally split between drawing a graph of distance fallen against time squared and using the gradient to determine a value for the acceleration of freefall and calculating g using $s = ½gt^2$ for each set of data and averaging.

(b) A number of candidates indicated their poor reading of this question by stating that the velocity became constant because the parachute had opened. Very few candidates were able to satisfactorily explain why the velocity reaches a maximum value. Disappointingly few responses to this question used the concept of force let alone balanced forces.

Q3 This question on projectile motion was well answered.

(a) Almost all candidates correctly determined the time taken by the golf ball to reach its maximum height. A small number of candidates used the wrong component of the velocity (or just used the speed).

(b) This question was answered well by most candidates. However, there were some who did not appreciate that the horizontal component of velocity was constant so that they were unable to complete this question correctly.

Q4 **(a)** There was some uncertainty amongst the candidature as to which of Newton's Laws of Motion was the second! Of those who knew the correct law, a sizeable minority did not indicate that the direction of the acceleration was the same as that for the resultant force. This omission was penalised one mark.

(b) This part was answered well by most candidates. The most common error was for the candidate not to add the 12 m travelled before the brakes were applied to the distance travelled during braking.

Q5 This moments question challenged many candidates.

(i) A large number of candidates omitted to include the weight of the beam in the total force.

(ii) This part of the question proved to be difficult for many candidates. Those who omitted the weight of the beam in (i) often repeated the mistake here. Of those who incorporated it, many made mistakes in determining the distance of the force. Most candidates realised that moments had to be taken about P or Q. Those candidates who realised that the sum of the forces acting at P and Q had to equal their answer to (i) received partial credit. Candidate responses tended to be poorly set out.

Q6 This question was well answered.

(a) Almost all candidates received the mark for correctly stating the conservation of energy principle.

(b) The calculation of the kinetic energy loss in Part (i), of potential energy loss in Part (ii) and energy dissipated per second in Part (iii) were all competently executed. Power-of-ten errors were common in this question.

Q7 This question was quite well answered by most candidates.

(a) Candidates' statements of Hooke's Law were good although some candidates confused proportional and elastic limits.

(b) Most candidates correctly identified the proportional limit, in Part (i), but many showed uncertainty about the elastic limit. Some candidates' labelling of the diagram was too remote from the graph and could not be credited. The calculation of the Young modulus was well done, apart from the determination of the wire's cross-sectional area. Power-of-ten errors were common in this question.

Q8 This question had sections that challenged most candidates.

(a) Definitions of electromotive force tended to be good.

(b) In Part (i) of this section a minority of candidates omitted to convert the 42 minutes to seconds. In Part (ii), a number of candidates correctly calculated the voltage drop across the internal resistance but did not then subtract that from the electromotive force. In Part (iii), many candidates did not read the question carefully enough and calculated the power of each of the sidelights!

Q9 This question, testing the determination of resistivity, was well answered.

(a) Most candidates knew the procedures to implement in order to obtain reliable data. However, the measurement of the length of the wire was frequently omitted and many candidates did not indicate a sensible procedure to ensure reliable data was collected.

(b) Very few candidates appreciated that the measurement of diameter contributed the greatest uncertainty; most stated that it was the measurement of length. Few candidates explained that the percentage uncertainty in diameter has to be doubled because the diameter value is squared to calculate cross-sectional area.

Q10 Most candidates were able to respond positively to this question.

(a) Most candidates sketched graphs that correctly showed how the resistance of an ntc thermistor varies with temperature.

(b) The responses of many candidates indicated little appreciation of the molecular model for electrical resistance. Very few candidates understood that at higher temperatures there is an increase in molecular vibration and a consequent increase in collisions between conduction electrons and the lattice molecules. Some candidates thought that there would be more charge carriers in a hotter filament!

The standard of written communication was generally good.

Q11 Parts of this question challenged many candidates.

(a) Part (i) of this question was badly answered. Frequently the candidate was only able to calculate the current flowing when the switch was closed. In Part (ii), only a few candidates realised that the connecting wires would themselves have a small resistance.

(b) The calculation of the resistances in Part (i) and Part (ii)(1) were well done. Part (ii)(2) was less well answered; candidates frequently made incorrect substitutions for the resistance values into the potential divider equation. The layout of candidate responses here was poor!

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 This question was very accessible to the majority of candidates.

(a) In Part (i), almost all candidates knew the meaning of the term 'monochromatic'. A large number of candidates in Part (ii) failed to appreciate that the angle they were asked to calculate was the complement of the incident angle and lost the third mark.

(b) Candidate statements, in Part (i), of the meaning of the term 'critical angle' were varied. A large number of candidates omitted to state that it was an 'incident angle', while others were less than precise in their comments and often were not awarded this mark. In Part (ii), most candidates successfully calculated the critical angle for the glass-air boundary but few were able to work through the geometry to obtain the required angle.

Q2 Answers to this question were often good.

(a) The diagrams drawn by candidates, in Part (i), to show the arrangement of the apparatus were generally of a high standard and most candidates were awarded the full two marks. A large number of candidates did not include a metre rule in their diagram and forfeited the second mark. In Part (ii), many candidates overlooked the focus of the question and provided information on analysing the data as well as on how reliable data was obtained.

(b) This calculation challenged many candidates. While almost all candidates correctly evaluated the magnification and most went on to obtain a value for the image distance, a very common mistake was not to make the (virtual) image distance negative in the lens equation.

Q3 Many candidates found this question challenging.

Almost all candidates identified polarisation as the phenomenon responsible for the difference in the photographs. However, the quality of the explanations offered by most candidates did not allow for more than three or four of the six marks to be awarded. Very few candidates explicitly stated that the parallel (or perpendicular) relationship was between the plane of polarisation of the lens and the plane of the polarised light.

The quality of the candidates' written communication was generally good.

Q4 The basic physics involved in this question was well known but imprecision cost many candidates marks.

(a) In Part (i) many candidates were unable to satisfactorily state, or imply, that coherent waves have a constant phase difference. In Part (ii), describing 'in phase' was poorly done. Most candidates had the correct idea but the mention of crests or troughs in their description lost them the mark.

(b) In Part (i), most candidates appreciated that the sound would be loud at that location. Few explained this in terms of the path difference (the preferred option), but most chose to explain that there would be constructive interference at that location. Most candidates correctly described the variation in loudness along the detection line as required in Part (ii). The calculation in Part (iii) allowed most candidates to access the first two marks for determining the wavelength of the sound. Many went on to correctly work out the path difference.

Q5 Candidates responded positively to most parts of this question.

(a) Most candidates correctly stated what I_0 represents. However, there were two common causes for losing the mark. First, some candidates referred to I_0 as the 'sound intensity level' while others did not indicate that I_0 was an 'intensity'.

(b) In Part (i), the calculation was well done by almost all candidates. In Part (ii), a large number of candidates did not seem to appreciate how the intensity had fallen 2 km from the aircraft.

Q6 Most parts of this question on experimentally determining the speed of sound were well answered.

(a) The general technique for performing this experiment was well known but the responses from many candidates lacked sufficient detail. For example; the first mark was for explaining how the first (or second) position of resonance was obtained experimentally; the responses of many candidates did not isolate the first (or second) position. Many of the descriptions of the length to be measured were equally imprecise. Many candidates described the theory and data analysis in this part!

(b) Most candidates struggled to attain two of the three marks available for Part (i). It was hoped that candidates would calculate percentage uncertainties, conclude that a lower range of frequencies would improve the percentage uncertainty in the value for the speed of sound and perform another calculation to prove it. However, the mark scheme was adapted to credit responses that indicated that longer air column lengths would have smaller percentage uncertainties and that this could be achieved by decreasing the frequency range. Part (ii) was well answered. Most candidates opted to describe a graphical treatment of the results and many did so accurately.

Q7 Aspects of this question challenged some candidates.

(a) Most candidates' responses indicated familiarity with the major components and processes of nuclear magnetic resonance. However, very few answers indicated that the process was understood. It was rare for a candidate to be awarded all three marks for this part.

(b) Almost all candidates realised the design feature was superconductivity. However, very few candidates identified the scanner magnet as being the component with the superconducting coils.

(c) Candidate responses to the credit card, in Part (i), were generally good but again there were responses that lacked precision. For example, stating that the credit card was damaged was not sufficiently precise for the mark to be awarded. Responses to Part (ii) were very poor; the vast majority of the candidature appeared to believe that gold is ferromagnetic!

Q8 This question was well answered by most candidates.

(a) Almost all candidates received full credit for this section.

(b) Again, most candidates responded accurately to this section. Some mis-conceptions were evident here: a number of candidates thought the delocalised electrons were in different energy levels, while some others felt that the photon would lose some energy on its way to the 'lower' electron.

(c) Most candidates completed this section successfully. In part (i), the most common candidate mistake was not converting the work function energy to joules. In Part (ii) there were a number of power-of-ten errors in converting to nanometres. A minority of candidates incorrectly stated that 279 nm was part of the visible spectrum in Part (iii).

Q9 This question challenged many candidates' understanding of basic laser action.

(a) Very few good answers to this question were received. Most candidates correctly stated that there were more electrons in an excited state than in the ground state but many also provided additional information so that it became unclear what, exactly, population inversion referred to in their answer!

(b) Responses to this question were not good. Many candidates used the term 'stimulated emission' but did so incorrectly in the context of their response. A common misconception is that the photons cause the electron excitation.

(c) Responses to this question were generally good. Candidates should note that providing some detail enhances the answer to this type of question and increases the chance of the mark being awarded. Compare the response 'DVD player' to 'Reads the data stored on a DVD' and it's easy to see which is more likely to be credited.

Q10 Candidates responded positively to most parts of this question.

(a) In Part (i), candidates were generally familiar with the use of the wave and particle models in describing phenomena. However, the ability of particle theory to explain reflection was often not appreciated. In Part (ii), most candidates correctly explained that the de Broglie equation equates wavelength (a wave model concept) with momentum (a particle model concept).

(b) This calculation was well done by the majority of candidates. It was incumbent upon candidates to calculate AND STATE the de Broglie wavelength of the electrons travelling at 5×10^6 m s^{-1} and then quote the same magnitude as the molecular separation.

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

Q1 This question was generally well answered.

(a) Most candidates scored only one of the two marks available as many failed to state that the total momentum before and after the explosion was zero.

(b) **(i)& (ii)** Most candidates scored full marks in all parts. A few candidates incorrectly used momentum rather than kinetic energy when showing that the collision between the bowling ball and the pin was inelastic in Part (ii) 2.

Q2 Many candidates found aspects of this question difficult.

(a) This section was correctly answered by the majority of candidates.

(b) This section was correctly answered by the majority of candidates. However, some candidates attempted to use $E_k=½mv^2$ instead of $^3/_2 k\Delta T$ to calculate the difference in kinetic energy.

(c) **(i)** This part was poorly answered by some candidates. The trend was for candidates to score either 2/2 or 0/2.

(ii) This part significantly challenged the majority of candidates. Many candidates could not convert cm^3 to m^3; others could not find the correct mass and used 44.01 g as their value. The majority did, however, score one mark for correctly calculating the gradient of the graph.

Q3 Most candidates were familiar with this experiment and responded positively to the question components.

(a) **(i)** This was well answered by the majority of candidates although in a minority of cases, this question was left unanswered.

(ii) Many candidates failed to appreciate that this question was testing the flawed procedure described in its opening paragraph. Many candidates discussed using oil to improve thermal contact while others discussed heat losses due to poor insulation (despite being told in the question that the insulation was perfect)! Many of those candidates who did discuss the correct procedure failed to obtain the second mark because they did not base their explanation on the equation $Q = mc\Delta\theta$.

(b) This question was very well answered with most candidates scoring full marks.

Q4 This question on circular motion was very well answered.

(a) Few candidates experienced any difficulty in calculating these angular and linear velocities.

(b) **(i)** Almost all candidates appreciated the significance of the radius in determining the magnitude of the linear velocity.

(ii) The diagrams offered by many candidates did not always clearly illustrate the candidate's answer. For this reason, many candidates scored only one of the two marks available.

Q5 Aspects of this question comparing SHM and circular motion challenged many candidates.

(a) **(i)& (ii)** The definitions of 'period' in circular motion offered by most candidates were good while those of 'period' in SHM were often poor.

(iii) Many candidates did not fully answer this question. The failure, by many, to compare the magnitude of the forces involved in circular motion and SHM led to a forfeit of two marks. Of those candidates who did discuss the forces, many found it difficult to explain how the magnitude of the force in SHM varied. Few candidates scored full marks in this part of the question.

(b) Most candidates correctly stated that the amplitude decreased with time but incorrectly stated that the period also decreased. Very few candidates were able to convincingly explain how and why the speed decreased.

Q6 This question on nuclear density was generally well answered.

(a) Many candidates introduced errors when calculating nuclear radius and/or nuclear volume. Amongst them, a significant minority used a value for the nuclear mass that was inconsistent with their value for nuclear radius. Candidates who choose to perform this type of calculation using a different number of nucleons from that identified in the question are advised to state in their answer something to the effect that nuclear density is constant or is independent of the number of nucleons etc.

(b) Almost all candidates were able to calculate the density of (atomic) iron.

(c) The majority of candidates appreciate that iron atoms are mostly empty space with all the mass concentrated in the nucleus.

Q7 Poor answering technique in this radioactivity question cost many candidates marks.

(a) A surprising number of candidates did not score this mark. Many answered in terms of 'atoms' or 'particles'.

(b) **(i)** Almost all candidates correctly calculated the number of dice remaining after throws three and seven.

(ii) Many candidates did not start their graph at N = 250 and forfeited the second mark.

(iii) The majority of candidates scored only one of the two marks available since only one set of values was used to determine the half life equivalent. Answers were often not given to one decimal place.

(iv) &(v) These parts were generally very well answered by all candidates.

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

(a) Almost all candidates correctly found the mass increase of the hot gold bar.

(b) Very few, if any, candidates scored marks in this question. Most candidates answered in terms of mass defect, binding energy and nucleons.

(c) Candidates either did extremely well (scoring full marks) or quite poorly (scoring one or zero). Those who scored poorly drew very inaccurate graphs and were awarded the mark only for the general shape of their graph.

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

(a) This part was poorly answered by almost all candidates. Few gave a clear outline of the process leading to a chain reaction.

(b) **(i)** The majority of candidates scored only one mark. Many did not discuss how maximum absorption would occur if the rods were fully inserted.

(ii) This part was well answered although a significant number of candidates failed to discuss neutron absorption.

(c) Many candidates discussed the disposal of radioactive waste without reference to decommissioning.

Q10 This question was very well answered with many candidates scoring full marks.

Only a few candidates failed to score highly in this question. Most responses evinced sound answering technique by engaging with each of the four bulleted enablers.

A high quality of written communication was also in evidence among the candidature. Most responses were well structured; comments were relevant and technical vocabulary was correctly used.

Q11 Aspects of this question challenged many candidates.

(a) A surprising number of candidates could not give the correct base units for viscosity (or pressure).

(b) **(i)** Very few candidates scored any marks in this section. Many responses indicated that the information about the measuring cylinder provided in the stem of the question had been overlooked.

(ii) Few candidates scored full marks in this section. Many correctly stated how the gradient was related to the tube radius, pressure difference and fluid viscosity but did not explicitly state that to verify Poiseuille's law the graph has to be a 'straight line through the origin'.

(c) **(i)** This part was poorly answered with candidates taking the anomalous result from the graph as (1/2.9) = 0.345 m, rather than the table (0.35 m). The value of Q given by a large number of candidates included power-of-ten errors.

(ii) Many candidates did not use points sufficiently far apart on their best-fit line to obtain the gradient and gave an answer outside the acceptable range. The unit for the gradient was correctly stated by the majority of candidates.

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