Rewarding Learning

CCEA GCE - Physics
(January 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 January 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 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

Contents

Subject Code	1210
QAN	500/2471/1
QAN	500/2438/3

GCE PHYSICS

Chief Examiner's Report

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 Candidate performance in this straightforward question was disappointing.

(i) Many candidates found it difficult to explain what base units are.

(ii) Most candidates answered this part well but confusion between base units and base quantities was an issue for a sizeable minority.

(iii) Most candidates successfully demonstrated their mastery of this technique.

Q2 Most candidates found this question very accessible.

(a) Almost all candidates received full credit in this question.

(b) This part was very well done with candidates indicating the correct application of Pythagoras's Theorem and trigonometry. However, many candidates indicated a less than complete appreciation of vector addition; resultant vectors were often drawn from the tip of one vector to the tip of the other.

Q3 Candidates were very familiar with this experiment and it was very well answered. Most candidates described a displacement versus time experiment which allowed easy access to all marks.

(i) Many excellent diagrams of the experimental arrangement were produced.

(ii) Almost all candidates received full credit for this part. Those who answered using the double-interrupt card and light gate method had to state that the dimensions of the card were input to the data logger.

(iii) Analysis of the experimental results was well explained by the majority of the candidature. Those using the double-interrupt card and light gate method had to provide some detail as to how the result was obtained from the data input to the data logger.

(iv) This part was often poorly answered as many candidates failed to make their responses specific to their experimental arrangement.

The quality of written communication was generally good.

Q4 This question provided some differentiation between candidates.

(a) Part (i) of this question was reasonably well done. In these 'show that …' questions it is obvious that many candidates 'play around' with the numbers until they get the correct combination – in such cases it is advisable that the incorrect attempts be deleted/scored out. Fewer candidates were successful with part (ii) of this question. Common errors were: using the wrong component of velocity and not recognising that the acceleration of freefall acts in the opposite direction to the initial velocity. Some candidates ignored the parabolic path of the clay pigeon and considered its path to the fence as a straight line; they then used trigonometry to calculate a height for the fence.

(b) A sizeable majority correctly disagreed with the statement in part (i), and most went on to explain that only the vertical component of the velocity becomes zero at the top of the trajectory. The calculation in part (ii) had two parts and these were considered independently when marked. Most candidates appreciated that 0.24 s had to be subtracted from the time taken to reach the maximum height and received due credit.

Q5 This question challenged many candidates.

(a) Many candidates stated the principle of moments with a lack of precision. Almost every candidate mentioned that (the sum of) the clockwise moments must equal (the sum of) the anti-clockwise moments but many omitted to say that the moments must be measured about the same point or that the situation described results in equilibrium.

(b) A large number of candidates successfully calculated the tension in the wire in part (i). Of those who didn't, most did not use the vertical component of the tension. In part (ii), it was common for candidates not to calculate the weight of the youth; however, many were able to establish that the wire will snap and had good calculations to justify that statement.

Q6 This question was very well done.

(a) The vast majority of the candidature correctly calculated the gain in gravitational potential energy. When the calculation was wrong, the most common error was to substitute an incorrect value for the change in height.

(b) Part (i) of this question was very well done. Part (ii) was less well done. Some candidates experienced problems accommodating the 80% efficiency and for others the relationship between energy, time and work was not apparent within the context of this question.

Q7 Most candidates found this question accessible.

(a) Most correct responses calculated the extension in each of the wires independently but there were some who calculated the force constant of the combined wire and proceeded from there. Power-of-ten errors were in evidence here as the force constants were given in N cm^{-1} and the total length was required in metre.

(b) Part (i) of this question was not well answered. Very few candidates satisfactorily referenced the graph in their explanations. Another significant error was in not clearly distinguishing between the proportional and elastic limits. In part (ii) many candidates made a single point in their explanation and did not attempt a second as the two mark allocation indicated. In addition, some candidates attempted explanations using words/phrases from the question; a strategy that is unlikely ever to be successful.

Q8 This question was well answered.

(a) The definition of electromotive force is generally well known.

(b) Most candidates were able to calculate the current flowing in the circuit, as required in part (i). However, in part (ii), a large minority incorrectly calculated the potential difference across the internal resistance. The majority of candidate responses to part (iii) indicated a sound appreciation of the impact a lower internal resistance would have on the performance of the circuit.

Q9 The majority of candidates performed well in this question.

(a) Only a few candidates did not correctly describe non-ohmic behaviour. Of those who didn't, it was surprising that some thought they would receive credit for stating that such devices "did not follow Ohm's law".

(b) In part (i), the sketch graphs were generally poorly drawn. In part (ii), most candidates went on to correctly state the property of negative temperature coefficient semi-conductors responsible for the decrease in resistance with temperature.

Q10 Few candidates experienced significant problems with this question.

(a) Most candidates were able to correctly calculate the total resistance of the circuit and knew to divide that into the battery potential difference to answer part (i). The majority of candidates answered part (ii) by considering the ratio of the current split rather than establishing the potential difference across the parallel section and proceeding from there. Most worked through the calculations accurately although some reversed the ratio of the current split and obtained the wrong answer.

(b) The impact of the short circuit on the circuit action did not provide much of a challenge; almost all candidates obtained full marks for this question.

Assessment Unit AS 2 Waves, Photons and Medical Physics

Q1 This question was well answered.

(a) Most candidates were able to describe how to distinguish between transverse and longitudinal waves as required in part (i). Of those who did not receive full credit it was either because they did not specify what was oscillating or they did not identify the particle/medium motion as a vibration/oscillation. In part (ii), there was a sizeable minority that was unable to ascribe all the waves to their correct category.

(b) This question was well answered. Responses that didn't receive full credit typically confused the direction of propagation and the plane of particle oscillation.

Q2 Candidates were very familiar with this experiment and consequently responses were generally very pleasing.

(a) Most statements of Snell's law were inaccurate. Two common errors were apparent; first, some candidates did not appreciate the significance of the two media through which the wave is propagating and secondly, some candidates did not state that the sine ratio was a constant.

(b) All aspects of this experiment were very well answered. Contradictions sometimes existed between part (i) the labelled diagram and part (ii) the description in identifying the angles to be measured. In part (iii), a large number of candidates used a correct linear graph to determine the refractive index rather than explain how the graph verified the law.

The quality of written communication was generally good.

(c) A majority of candidates didn't appreciate that the angle of incidence was not given in Fig 2.1 and so got the calculation wrong.

Q3 Many candidates found aspects of this question challenging.

(a) Almost all candidates appreciated that a convex lens was required to satisfy the conditions in part (i) and many were able to produce high quality ray diagrams in response to part (ii). A common mistake was not to identify the direction in which the ray was travelling.

(b) In part (i), almost all candidates correctly identified the correcting lens. The calculation of focal length provided a greater challenge. Many candidates substituted incorrectly into the lens equation with the virtual nature of the image position commonly overlooked. Confusion between object and image distances was also evident. In contrast, candidates were very competent in calculating lens power as required in part (ii).

Q4 The physics tested in this question was well understood in general terms. However, many candidates struggled with the detail required.

(a) Few candidates were able to state the principle of superposition in a way to attract all three marks. That the total displacement, at a point, is the algebraic (or vector) sum of the individual displacements at that point was often omitted or expressed in a confused way.

(b) The resultant waves drawn in part (i) indicated that most candidates understood the application of the principle. Many, though, were careless in their vector summing and some sketches were poorly drawn. In part (ii), not all candidates appreciated that the resultant wave had a frequency equal to that of the wave with the larger amplitude.

Q5 Aspects of this question were poorly answered.

(a) In part (i), most candidates provided a satisfactory meaning of coherent. Part (ii) was much less well answered. Many candidates stated that the two waves should be out-of-phase but very few noted that the amplitude of the two waves had to be the same.

(b) This part of the question was poorly answered. In part (i), very few candidates satisfactorily explained path difference whether referring to Fig 5.1 or not. In contrast, part (ii) was well answered and most candidates realised that a bright fringe would be observed at point Z. Only a small number of candidates convincingly explained destructive interference in terms of path difference. Consequently, part (iii) was very poorly answered.

Q6 Most candidates found this question accessible.

(a) The diagrams produced in response to part (i) were generally very good. Most candidates provided reasonable descriptions to find a position of resonance in part (ii), but significantly fewer described how to find the first position of resonance.

(b) In part (i), the calculation of frequency was not well done. Some power-of-ten errors were introduced as a result of the time base setting being given in ms cm^{-1}. In part (ii), the majority of candidates correctly calculated the wavelength of the sound wave for their frequency and most knew that, at the first position of resonance, the tube length is one quarter of the wavelength.

Q7 Most candidates found this question challenging.

(a) Part (i) was very poorly answered. Very few candidates clearly explained that the x-rays that were fired at one part of the body were detected on the opposite side of the body. Part (ii) was equally poorly answered. Most candidates appreciated that the x-ray tube (and detectors) rotated around the patient in a CT scan and some candidates correctly commented on the computer generation of the image but only a very small number of candidates appreciated that the patient is moved through the scanner during the CT scan.

(b) The vast majority of the candidature appreciated the danger of exposing the patient with the ferromagnetic pin to the magnetic flux density produced during a MRI scan.

Q8 This question was well answered.

(a) The meaning of work function, in part (i), was well known. In part (ii), most candidates correctly calculated the photon energy in joule and many went on to convert that into electron-volt.

(b) Not all candidates were able to work their way through this calculation. Some experienced difficulty accommodating the efficiency while others had more fundamental problems such as relating power, energy and time in this context.

Q9 Most candidates performed well in this question.

(a) In part (i), the meaning of 'ground state' was well known by almost all candidates. Consequently, in part (ii), most were able to state the ground state energy level.

(b) In part (i) of this question many candidates did not identify the correct transition for longest wavelength emission and were penalised a mark. However, most candidates were able to demonstrate their ability to convert from an energy in eV to a wavelength in μm. Many candidates introduced power-of-ten errors into their calculations. In part (ii) many candidates, mistakenly, had the arrow indicating an electron being excited.

Q10 Most candidates found this question accessible.

(a) The Davisson-Germer experiment is not well known and the diagrams were often of a poor standard. The most commonly omitted component was the fluorescent screen.

(b) The calculation of electron wavelength, in part (i), was generally well done although many candidates failed to use the Data and Formulae Sheet to obtain the electron mass. Part (ii) was poorly answered with few candidates clearly stating that wavelength, which is a property of a wave, is equated to momentum, which is a property of a particle, in de Broglie's equation.

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

Areas for Improvement

- The quality of the diagrams produced by candidates.
- Candidates should be advised to cancel responses which they do not wish the examiner to read.

Q1 Candidate performance in this question was strong.

(a) Almost all candidates accurately stated the principle of momentum conservation.

(b) Only a few candidates, in part (i), were unable to state the direction moved by the body of the plane. However, not all candidates who stated the direction correctly were able to provide a sound explanation for it. The calculation in part (ii) was generally well answered. The most common mistake was in establishing the mass of the plane after ejection.

(c) Most candidates provided accurate descriptions of the term 'elastic' as used in this context. However, a significant number answered the question using the fact that before the explosion the kinetic energy of the system was zero.

Q2 Candidates scored well in this question.

(a) Many candidates wrote vague responses indicating their uncertainty about the nature of the internal energy of a gas.

(b) A large majority of candidates described Gay-Lussac's pressure law experiment but a sizeable number described Charles's experiment. Few high quality labelled diagrams were produced; however, the results to be taken were usually clearly stated. For those describing Charles's experiment it was important that the response didn't jump between the length of the gas column and the volume of the column without an explanation. The sketch graphs produced were generally good. Some candidates erroneously indicated that their temperature was measured in kelvin. Almost all candidates were awarded both marks for their determination of absolute zero. However, many candidates had to rely on the extrapolation shown on their sketch graphs. Few candidates clearly stated that absolute zero was the temperature at zero pressure (or volume).

Q3 Most candidates found this question accessible.

(a) Part (i) of the question was very well answered. It was pleasing that most candidates calculated the angular velocity to at least three significant figures in order to show that the answer does round to that given. Part (ii) of the question was also very well answered.

(b) Part (i) was well answered. On some scripts this part was unanswered, probably because the candidate did not carefully read part (i). The calculation of centripetal force, in part (ii), was performed very well. The explanation required in part (iii) was less well answered. Many candidates did not refer to the weight of the hammer. Another common problem was failure to refer to the components of tension in the chain.

(c) Most candidates answered this straight forward question very well.

Q4 Many candidates found parts of this question difficult.

(a) In almost all cases simple harmonic motion was defined well.

(b) Constant A was correctly identified as the amplitude by almost all candidates. Many fewer were able to obtain a numerical value for ω.

(c) A large number of candidates convincingly described the cause and effect of damping and resonance. Some candidates lost focus during this question and discussed over, under and critical damping.

Q5 Responses to this question indicated a good understanding of radioactive half-life.

(a) Definitions of radioactivity were generally very good.

(b) In part (i) of this question, satisfactory explanations as to why aluminium-28 was chosen to experiment on were common. The decay curve drawn in part (ii) was usually competently executed and the calculation, part (iii), was generally well done. Some candidates calculated the decay constant in per second (s^{-1}) and introduced an added complication which not all were able to handle.

(c) The candidature was familiar with the analysis of this semi-log graph to determine half-life.

Q6 Many candidates found the second part of this question difficult.

(a) Most candidates successfully substituted correct values for mass and temperature change into the thermal energy equation as required in part (i) of this question. Part (ii) was equally well done with accurate substitution into the mass-energy relationship.

(b) Many candidates struggled with this stretch and challenge question. Lots of candidates incorrectly stated that steam was given off. Others were distracted by the miniscule loss in mass due to cooling and erroneously focussed on how to measure this loss.

Q7 This question was very well answered.

Most candidates successfully named the role played by three of the materials and went on to describe how that role was achieved.

The quality of written communication was generally good.

Q8 Many candidates found aspects of this question challenging.

(a) A large number of candidates successfully completed this calculation. Of those who didn't, many omitted to convert the energy from electron-volt to joule before substitution into the average kinetic energy of a molecule equation.

(b) Part (i) of this question was well dealt with by most candidates. Some responses were too general to receive credit. Many candidates had difficulty, in part (ii), in making three valid points in their description of confinement in the JET fusion reactor.

Q9 This data analysis question was well handled by the majority of candidates.

(a) A minority of candidates, in part (i), experienced difficulty explaining why Equation 9.1 can be rewritten as Equation 9.2. Part (ii) was very poorly done; many candidates appeared not to know the base units.

(b) The mapping of Equation 9.2 to y=mx+c, in part (i), was almost always effectively done. Calculation of logarithms to base ten, in part (ii), was accurately done, although few candidates recorded the values to the correct number of decimal places. They lost no credit unless their values of $lg_{10}(n/m^{-3})$ were to fewer than three significant figures. In part (iii), the graphs were often poorly done, typically with inadequate scales that did not make good use of the whole graph grid and incorrect labelling of axes despite the labels being given in the table. The point 1.08 was commonly incorrectly plotted as 1.008! Best fit lines were generally acceptable. In part (iv), the majority of candidates calculated the gradient from widely separated points on the best-fit line and determined a consistent value for B. In part (v), a large number of candidates were unable to calculate a value for the Fermi energy that was consistent with their B value. Some candidates used the Boltzmann constant for k.

Contact details

The following information provides contact details for key staff members:

- Specification Support Officer: Nuala Braniff
  (telephone: (028) 9026 1200, extension 2292, email: nbraniff@ccea.org.uk)
- Officer with Subject Responsibility: Kevin Henderson
  (telephone: (028) 9026 1200, extension 2270, email: khenderson@ccea.org.uk)