CCEA GCE - Physics
(January Series 2013)

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 2013.

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 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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GCE PHYSICS

Chief Examiner's Report

General

Candidate responses indicated weaknesses in the following areas:

Q1 "Show that ……." questions. This type of question is asked when the numerical answer the candidate is asked to "show" is required for a subsequent question and the Error Carried Forward (ECF) facility is adjudged inappropriate in the context. Effective answering of these questions is best achieved by re-interpreting the question as a "calculate" type question. Candidates should then work through it by quoting the relevant equation, carefully showing all the substitutions into the equation and writing the answer to a greater number of significant figures to show that it is correct to the number of significant figures given in the question.

Q2 Candidates lose credit because they do not answer using the Equation, Substitution, Answer format. Candidates will generally receive credit for quoting the correct relevant equation for a given context if it is not from the Data and Formulae Sheet. Further credit will be awarded for accurate substitution of numerical data into those equations. Correct substitution includes, for example, the correct positive/negative sign associated with vector quantities and real/virtual distances; it also includes the input of data in its S.I. unit. Finally, credit is awarded for accurately computing the final numerical value.

Q3 Multiple answering. A candidate offering multiple responses to a particular question will be fully credited only when all responses are correct. Candidates are advised to cancel any material they do not wish an Examiner to mark.

Assessment Unit AS 1 Forces, Energy and Electricity

Q1 Many candidates found parts of this question challenging.

(a) Part (i) of this question was generally well answered. Part (ii) was less well done and very few candidates correctly responded to Part (iii).

(b) All parts of this question were well answered although some candidates quoted symbols rather than the 'name' of the base quantity as was required and consequently were not credited.

(c) This part challenged the majority of candidates. Very few obtained full marks although most obtained partial credit for appreciating the base units of force.

Q2 This question was generally well answered.

(a) Many candidates answered Part (i) very well although a sizeable number ignored or fudged the vector nature of the quantities. In Part (ii), a variety of approaches were employed to obtain the final answer. Most candidates were accurate in applying their chosen method but many responses evinced confusion.

(b) Most candidates sketched graphs indicating constant acceleration and received one mark. Very few candidates appreciated that the speed of the ball bearing after 1.60 s would be greater than its initial speed and so lost out on the second mark.

Q3 This question was extremely well answered.

(a) Almost all candidates correctly determined the magnitude of the resultant force from the perpendicular force vectors, as required in Part (i). Almost all successfully went on, in Part (ii), to determine the acceleration of the wooden block.

(b) In Part (i), almost all candidates successfully demonstrated the ability to use a velocity-time graph to determine acceleration. However, quite a number misread data from the time axis. Part (ii) challenged many candidates some of whom indicated their confusion by introducing the acceleration of free fall into their calculations.

Q4 Most candidates found this question accessible.

(a) A large number of candidates appeared unfamiliar with the relationship between power, force and constant velocity and consequently were unable to complete this question. 'Power-of-ten' errors were also prevalent.

(b) This part was answered well by most candidates. The most common error was for the candidate to use the track length as the change in height.

Q5 This question, testing the experimental techniques in determining the Young modulus, was very well answered.

(i) This part was well answered, although the use of an average diameter was not always stated.

(ii) The experiment to determine the Young modulus was usually well described, although details of how to obtain values for force, length and extension were often missing or lacking in essential detail.

QWC The general standard of candidates' written communication was good.

(iii) Most candidates obtained a correct value for the Young modulus but only rarely was the unit quoted consistent with the value.

Q6 This question was accessible to most candidates.

(a) Almost all candidates received the mark for stating that the extension produced is proportional to the applied load. Most candidates correctly asserted that the proportional relationship held to the proportional limit and received the second mark. Unfortunately, some candidates incorrectly stated that the proportional relationship held to the elastic limit.

(b) The calculation of the stiffness constant, in Part (i), was well done by almost all candidates. Fewer candidates were able to give a unit for the stiffness constant consistent with their calculation. In Part (ii), the majority of candidates successfully calculated the total length of the wire and quoted it correctly to three significant figures.

Q7 This question was quite well answered by most candidates.

(a) Candidates generally have a good understanding of electromotive force and current, and were able to identify these quantities from the definitions given in parts (i) and (ii) respectively. The definition of the volt given in Part (iii) was poorly identified; many candidates incorrectly suggested 'voltage'.

(b) Part (i) caused the greatest difficulty but parts (ii) and (iii) were usually correct, especially given that Error Carried Forward protocols existed for the current and the charge. A minority of candidates did not know the basic electrical equations required to complete this question.

Q8 This question had sections that challenged most candidates.

(a) The most common error, in Part (i), was to omit a means of varying voltage and current. The drawing by some candidates was of a very poor standard and consequently many were not awarded the third mark. Part (ii) was very well answered with most candidates appreciating that ohmic behaviour requires a linear current-voltage graph passing through the origin.

(b) The sketch graph, in Part (i), proved testing for many. Almost all candidates drew curves but often they did not start with a finite resistance at zero degrees Celsius, or else they curved upwards near the time axis or touched the time axis. Hardly any candidates scored full marks in Part (ii). Most candidates were awarded the first mark for appreciating there was an increase in the number of charge carriers, but the idea that this overcompensated for increased molecular collisions was not widely appreciated.

Q9 Parts of this question challenged many candidates.

(a) Part (i) proved harder than expected with many candidates opting to use the ratio method. It was not unusual to see the currents the wrong way round. Most candidates were awarded the first mark in Part (ii) for stating that the total current into the junction equals the total current exiting the same junction but very few candidates related current and charge to fully answer this question.

(b) In Part (i), the majority of the candidature was able to correctly combine the resistances. Part (ii) proved very challenging. Most candidates attempted to use the potential divider equation but substitutions into it were usually incorrect.

Assessment Unit AS 2 Waves, Photons and Medical Physics

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

(a) Almost all candidates knew the seven regions of the electromagnetic spectrum and their order in terms of increasing wavelength.

(b) Some candidates in Part (i) incorrectly stated that satellites used infra-red waves and a large number of answers to Part (ii) had 'power-of-ten' errors.

(c) Most candidates correctly named another example of a transverse wave in Part (ii) and an example of a longitudinal wave in Part (ii). Equally well answered was Part (iii) with most candidates accurately describing the difference in the nature of the vibration of the propagating medium.

Q2 Answers to this question were often good.

(a) The diagrams drawn by candidates, in Part 1, to show the arrangement of the apparatus were generally of a high standard and most candidates were awarded the full two marks. The majority of candidates were aware of the procedure to be followed in order to obtain the values for the angles of incidence and refraction. Unfortunately, in Part 2, on a large number of diagrams the labelled refraction angle was not consistent with the labelled incident angle; candidates labelled the incident angle of the first refraction and the angle of refraction of the second refraction. In Part 3, the verification was often not done. Many candidates used a valid graph to obtain a value for the refractive index and forfeited the second mark as they did not state that the graph verified Snell's law because a straight line passing through the origin indicted that the plotted variables were proportional.

QWC The general standard of candidates' written communication was good.

(b) This calculation was well done by most candidates. Almost all candidates correctly evaluated the angle of refraction but some did not continue to determine the angle of deviation.

Q3 Many candidates were challenged by parts of this question.

(a) Almost all candidates correctly drew a diverging lens and marked its principal foci. Whilst most candidates drew the correct rays some did not add arrowheads to indicate the direction of the ray and were penalised one mark. The location of the virtual image was well known as was the position of the eye to view the image. On this occasion there was no penalty for failing to dash virtual rays/images.

(b) The diagrams illustrating uncorrected long-sightedness, in Part (i), and corrected long-sightedness, in Part (ii), were usually correct. Part (iii) discriminated first between those candidates who realised that the uncorrected near point of the eye became the image distance and that the corrected near point of the eye was the object distance. The second discrimination occurred in establishing that the uncorrected near point distance is virtual while the corrected near point distance is real! In Part (iv), a surprising number of candidates experienced difficulty with the calculation of lens power required.

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 energy was not transferred in a standing wave. Fewer candidates were able to identify the two conditions necessary to produce a standing wave that was asked for in Part (ii). In Part (iii) some candidates appreciated that superposition was the principle that explained the formation of a stationary wave.

(b) In Part (i), the diagrams showing the modes of vibration were often poorly drawn and/or incompletely labelled. In Part (ii), the frequency of the first mode of vibration was usually correctly calculated. However, few candidates recognised that the frequency of the second mode of vibration was the third harmonic and so has a frequency three times that of the first mode.

Q5 Candidates responded positively to most parts of this question.

(a) The sound intensity level and sound intensity calculations in parts (i) and (ii) respectively were very well answered.

(b) In Part (i), the position on the curve of the minimum threshold of hearing was appreciated by almost all candidates and in Part (ii) the frequency at which this intensity occurred was also well known. Many candidates missed the point of this question and worked out the difference between 60 Hz and 1 kHz giving the answer 940 Hz. The frequency range detected by the human ear was very well known and most candidates were awarded the mark for Part (iv).

Q6 This question on medical imaging was very well answered.

(a) In Part (i), most candidates clearly stated that one bundle was to transmit light into the body while the other was to transmit the image out of the body. The relative arrangement of the optical fibres in each case was appreciated by most candidates. Candidates responded well to Part (ii) and a range of valid functions for the other channels was given. The calculation of light transit time through an optical fibre, in Part (iii), was correctly answered by the majority of candidates.

(b) Most candidates appreciated, in Part (i), that electromagnets produced the magnetic field in an MRI scanner. In Part (ii), it was widely known that the coils are superconducting to reduce costs. In Part (iii), most candidates outlined an advantage of MRI scanning over CT scanning.

Q7 Aspects of this question challenged some candidates.

(a) A surprising number of candidates did not draw a correct graph to show the inverse relationship between photon energy and photon wavelength.

(b) In Part (i), the concept of work function was well known by candidates. The calculation of maximum wavelength, in Part (ii), was well answered although many candidates did not answer in nanometres as required and lost the fourth mark.

(b) Candidate responses to the energy level diagram for hydrogen were generally good. Only a small number of candidates identified incorrect transitions and lost the mark for Part (i). Of those candidates who were correct in Part (i) a very small number indicated the wrong direction for the transition and lost the mark for Part (ii).

Q8 Many candidates were challenged by parts of this question.

(a) In Part (i), electron diffraction descriptions frequently omitted the necessity for a vacuum and a fluorescent screen. Some diagrams included laser beams and others double slits! In Part (ii) diagrams of the diffraction pattern were usually correct though often poorly drawn. In Part (iii), explanations of changes to the diffraction pattern as a result of changes in electron velocity were often incomplete and so candidates could be awarded only one of the two marks available.

(b) A number of candidates found these calculations difficult. In Part (i), some candidates were unable to perform the algebra required to obtain the velocity of the electrons from the kinetic energy, others seemed unaware that the electron mass can be found from the Data and Formulae Sheet. In Part (ii), the use of the de Broglie relationship was appreciated by most candidates and application of the Error-Carried-Forward (ECF) protocol for electron velocity resulted in most candidates being awarded both marks.

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

Areas for Improvement

Candidate responses frequently lacked rigour and detail particularly in the following areas:

- "Show that ……." questions. Effective answering of these questions is best achieved by re-interpreting the question as a "calculate" type question. Candidates should then work through it by quoting the relevant equation, carefully showing all the substitutions into the equation and writing the answer to a greater number of significant figures to show that it is correct to the number of significant figures given in the question.
- Candidates lose credit because they do not answer using the Equation, Substitution, Answer format. Candidates will generally receive credit for quoting the correct relevant equation for a given context if it is not from the Data and Formulae Sheet. Further credit will be awarded for accurate substitution of numerical data into those equations. Correct substitution includes, for example, the correct positive/negative sign associated with vector quantities and real/virtual distances; it also includes the input of data in its S.I. unit. Finally, credit is awarded for accurately computing the final numerical value.
- Multiple answering. A candidate offering multiple responses to a particular question will be fully credited only when all responses are correct. Candidates are advised to cancel any material they do not wish an examiner to mark.

Q1 This question was quite well answered.

(a) Parts (i), (ii) and (iii) were correctly answered by many candidates but there were other candidates who confused angular velocity and linear velocity. Confusion was also evident between the quantities frequency in hertz, rotary frequency in revolutions per minute and periodic time in seconds which led to incorrect answers due to unit inconsistencies.

(b) This part was not well answered as most candidates did not realise that the motorcycle weight was the limiting value for the centripetal force. Among the incorrect attempts was the consideration that the kinetic energy of the motorcycle was transformed to potential energy relative to the centre of the hump-backed bridge. This did show some physics reasoning but could not be considered to be worthy of any credit; however, it was considered a reasonable attempt compared to the commonplace "fiddling" with angular motion equations or leaving a blank space.

Q2 This question was not well answered.

(a) Most candidates correctly defined specific heat capacity and quoted its units. The temperature units 'degree Celsius' and 'kelvin' were both used and credited.

(b) The descriptions of the electric experiment to determine the specific heat capacity of water were adequate but details of the readings were frequently glossed over. For example, the actual heating time and the consequent temperature change were often covered by phrases such as 'start the stopwatch and read the thermometer'. Additionally, the electric energy input to the heater and the thermal energy received by the water could have been better distinguished.

(c) This calculation was poorly answered. Most candidates could not reason that the heat lost by the tank water was received by the added water and consequently few of the three marks available could be awarded. Some candidates were able to obtain a correct answer using an alternative method.

Q3 This question was very poorly answered.

(a) Most candidates explained the meaning of 'perfectly elastic' well and were awarded the mark.

(b) In Part (i), few candidates could construct the equation for the conservation of momentum or the equation for the conservation of kinetic energy. The most common mistake was for candidates to combine the masses after the collision. In Part (ii), many candidates selected the correct velocities but could not give a suitable explanation for their selection.

Q4 This question on harmonic motion was quite well answered.

(a) Most candidates knew how to define simple harmonic motion. The requirement of a fixed or equilibrium point in the definition was not always clearly stated and such answers often lost the second mark.

(b) The calculations in (b)(i) 1 and 2 were well answered by good candidates but others struggled. A common error, in Part 2, was in the evaluation of cosine of the angle as many candidates had their calculator in degree mode rather than radian mode. Part (ii) 1 allowed many candidates to respond appropriately with a method of increasing the damping force. In Part (ii) 2, few candidates could clearly state the effects of increased damping on the oscillating mass-spring system that were required for full credit to be awarded.

Q5 Reasonably good answers were obtained to this question.

(a) In Part (i), most candidates knew the meaning of the symbols in the equation for nuclear radius and were able to state the specific values for bromine. In Part (ii), most evaluations of the volume of the bromine nucleus were correct. Part (iii) was well answered with three methods of determining nuclear density in evidence; using the equation $\rho = \dfrac{3m}{4\pi r_o^3}$, using the mass and volume of the bromine nucleus and using the mass and volume of a single nucleon.

(b) Very few candidates were awarded the mark for estimating the order of magnitude difference between nuclear and atomic density. However, many candidates appreciated that the difference was due to the closeness of particle packing and were awarded the second mark.

Q6 This question was well answered by many candidates.

(a) In Part (i), most candidates offered acceptable definitions of half-life. In Part (ii), the quantities in equation 6.1 were generally well defined. Some candidates lost the first mark because they didn't link the activities with the time at which they occurred. In Part (iii) most candidates showed the derivation of the equation adequately but some did not show a logical or complete explanation and lost marks.

(b) In Part (i) most candidates knew how to calculate the number of iodine atoms but many of them failed to write down an answer to more significant figures than the value they had been given to prove and often lost a mark as a result. Part (ii) was generally well done but there were some candidates who confused the time periods for half-life and elapsed time. In Part (iii) the most common mistake made by candidates was in not appreciating the consistency between the units of activity and half-life and consequently calculating the activity in 'per day', for example.

Q7 The quality of answers to this question was mixed.

(a) The explanation of binding energy offered by many candidates was excellent. However, a sizeable minority offered responses that hinted at the correct idea but were too imprecise to be credited.

(b) Most candidates scored well in this question. There were some candidates who incorrectly calculated the mass defect and others who were unable to convert between unified atomic mass units and kilograms and/or from joules to mega-electronvolts.

(c) Part (i) of this question challenged many candidates. A very common omission in many answers was in not finding a value for the binding energy per nucleon for carbon-12 from the graph and comparing that with the binding energy per nucleon for carbon-14, calculated from Part (b). Some candidates appeared uncertain as to the link between stability and binding energy per nucleon. In Part (ii) candidate answering technique was often found to be inadequate. Few candidates offered sufficient detail related directly to the graph.

Q8 This question evinced more poor answers than good answers.

(a) In parts (i) and (ii) many correct answers were obtained, but a number of candidates confused the function/purpose of control rods and moderators.

(b) Very few candidates appreciated that 'confinement' was the process by which reactants are provided with the opportunity to collide. More candidates were able to state that in the Sun, the method of confinement was gravitational but few explained that it was only successful if the mass involved was enormous.

(c) The comparison between energy yields per nucleon from fission and fusion reactions often appeared to be answered by recall rather than the quoting of evaluated data from the equations. Full credit could not be given in the absence of data.

Q9 This was not a high scoring question.

(a) In Part (i) a very common error was not to apply the square root to the M term. Almost all candidates quoted y=mx+c and mapped it to their equation. In Part (ii), nearly all candidates successfully worked to three significant figures. In Part (iii), many candidates produced good graphs but there were many who lost a mark for small or otherwise unsuitable axes scales. A large number of candidates did not use a zero on either axis which in this question was quite acceptable. Points were accurately plotted and lines of best-fit were good.

In Part (iv) a gradient, derived from widely separated points on the best-fit line, was correctly determined by the majority of the candidature. Unfortunately, not all candidates were able to use their gradient to work out a value for M.

(b) Part (i) was adequately answered with correct substitutions into Equation 9.2 but a number of candidates evaluated incorrectly and had some candidates had problems with powers of ten. In Part (ii), power of ten problems persisted. It is a cause for concern that some candidates at this level seem to have difficulty in calculating percentages. In Part (iii) not many candidates could obtain an expression for the energy of a photon and so were unable to evaluate the Rydberg unit of energy.

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