Oxford Cambridge and RSA

GCE

Physics B

Advanced Subsidiary GCE **AS H157**

OCR Report to Centres June 2016

This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

CONTENTS

Advanced Subsidiary GCE Physics B (H157)

OCR REPORT TO CENTRES

H157/01 Foundations of physics

General Comments:

This was the first ‘Foundation of Physics’ examination for this new specification and the nature and style of the paper were necessarily new to candidates. However, almost all of the specification content and most of the assessment techniques were similar to those employed in the legacy Physics B AS papers, particularly G491 ‘Physics in Action’. Unlike that paper, there are 20 multiple choice questions and the paper is divided into three sections.

Section A consisted of twenty multiple choice questions, each worth one mark. Multiple choice questions are new to this specification. The candidates were required to write their response in a box; very few candidates did not understand this rubric, although some did circle the letter in the question. Many candidates did appropriate working in the spaces, showing how they reached their answer although this is not required. A significant number of candidates did not attempt one or more of the multiple choice, although there is no penalty for incorrect responses. When candidates changed their mind, many made this clear by fully crossing out the incorrect response and writing the new response next to it, often in a newly drawn box.

Section B has questions of a similar length and style to section A questions in G491 ‘Physics in Action’. Section B consisted of 6 questions, totalling 20 marks. They typically each examine a single context, and may contain estimation, structured answers, calculations or problem solving. There is little room for extended writing in section B.

Section C, consisted of three questions in a similar style to section B of G491 ‘Physics in Action’. There was one opportunity for limited extended writing worth 4 marks. It also had a practical and data analysis based question regarding terminal velocity. Many of the techniques needed for this question had been covered in the previous specification.

There was little evidence of lack of time for the vast majority of candidates. The additional answer space was used by few candidates, mostly replacing work which had been crossed out.

Comments on Individual Questions:

Section A (Questions 1 to 20)

Q1
Many candidates wrote the units of the quantities next to the ratio but often got into difficulty in reducing them to base units. C was a common incorrect response.

Q2
Although the diagram included many labels, these appeared not to have confused the candidates. Many candidates wrote work = force × distance, but then used the wrong distance; this lead to the common incorrect response of A.

Q3
This question was not well answered and it appears that candidates are not confident about the differences between stress-strain and force-extension graphs.

Q4
Many candidates wrote the definitions alongside the terms and this question was well answered, as candidates were able to see which terms applied to a ceramic.

Q5
This question was well answered, and many candidates were able to use $P=F/A$ to separate the pascal into base units correctly.

Q6
Those candidates who are confident about using curvature were able to correctly solve this with ease. Using the appropriate sign convention caused some difficulties amongst weaker candidates.

Q7
This was correctly answered by the vast majority of candidates.

Q8
It is encouraging to see that candidates have a reasonable grasp on magnitudes of wavelengths of the electromagnetic spectrum. This question was correctly answered by around half of the candidates.

Q9
A good number of candidates answered this correctly. Several candidates wrote $F=ma$ alongside the graph which will have guided them to the correct answer.

Q10
As expected, this was only correctly answered by the better candidates. Several candidates labelled what was happening at each point on the graph. A common incorrect answer was B.

Q11
This was anticipated to be a challenging question; most attempted to use the equations of motion but got into difficulty with the algebra.

Q12
While many candidates correctly wrote out the equations for momentum and kinetic energy they were unable to correctly manipulate them to give the correct response.

Q13
This question was done correctly by nearly all candidates. Many drew the resultant on the diagram, with a correct calculation shown.

Q14
Many candidates assumed that the factor of ½ would be carried from voltage through to speed. These candidates showed little working. Those who correctly set up the formula of $eV = \frac{1}{2} mv^2$ invariably followed through the algebra correctly.

Q15
This question placed a relatively simple power question into a context which is explained. This was well answered.

Q16
A large majority of candidates got the correct response for this question.

Q17
The majority of candidates got the correct response for this question. It was noted that many carried out several calculations to achieve their answer.

Q18
This question required several steps of calculation, noting carefully the various units. This was challenging, but many successful candidates were able to follow through the calculations carefully.

Q19
The vast majority of candidates got the correct response for this question.

Q20
A significant majority of the candidates got the correct response for this question.

Section B (Questions 21-26)

Q21
The specification states that candidates should be able to estimate magnitudes of everyday quantities and this question was intended to be a gentle introduction with a generous range of accepted values. Of the three parts to this question, candidates were most successful in part (a) with the response of 1 being common. Many candidates showed working, using $W = mg$, with a reasonable estimate in kilograms. Parts (b) and (c) were less successful, with less than half of the candidates giving a correct estimate for each part. Calculations were often seen in part (b), usually calculating the current from $I = P/V$ although power values were often underestimated leading to a current below the bottom of the allowed range. In part (c), it was clear that many candidates are unaware of how large a volume of 1 m^3 is. While there were few answers below the lower boundary, many were some way above, with several values above 10 m^3.

Q22 (Microwave polarisation)
While most candidates had an idea of what was meant by polarisation in part (a), poor use of clear scientific terms meant that many descriptions of movement (rather than oscillation) in planes could not be awarded a mark. Candidates who did not fully appreciate polarisation often resorted to defining a transverse wave. Similarly, part (b) needed the detailed idea of the minimum occurring at 90 degrees rotation; weak answers of falling and rising were not credited.

Q23 (Sampling)
In part (a) the 0 level and highest level labels on the graph were designed to give candidates an indication that a number of levels were to be counted. Better candidates gave simple and clear solutions, but others gave complicated – and ultimately incorrect – solutions. Some candidates appeared to take the digitised signal as being noise. Several candidates obtained the correct answer of 4 by an erroneous method and so were not credited. Part (b) was poorly done, with many candidates attempting to calculate a sample rate. Those who did use the analogue signal often used the whole time of the given signal and some did not convert from ms.

Q24 (Charge flow)
Although this may be an unfamiliar situation for many candidates, enough information was given in the question for it to be answered fully. In part (a), it was expected that candidates would describe the current flow in terms of charge flow between the plates. Many candidates defined current correctly but then went on to describe electron flow in the wires. It was not obvious that many candidates appreciated that charge was moving between the plates, as descriptions were often based on static charge attraction. Part (b) was answered well overall, with only a few candidates incorrectly converting from μA to A. Several candidates set up their calculation correctly but then inverted their final answer.

Q25 (Wrecking ball)
Part (a) required candidates to recognise that the system is in equilibrium rather than applying Newton's 3rd law. Part (b) needed a fairly simple vector resolution and most candidates were able to do this; however with the data in this question given to 2 significant figures, more than 3 in the final answer were penalised. This is the only place in the paper where a penalty is given. It was encouraging to see how many candidates used the correct number of significant figures in their answer. Several candidates resolved incorrectly, using $W \cos\theta$ rather than $W / \cos\theta$. Those who drew triangles on the diagram, or set up formula over a couple of steps were more successful. Those who used the correct method for part (b) generally, although there were many who calculated $W \sin\theta$.

Q26 (Lorry-truck collision)
Part (a) was pleasingly done by the majority of candidates, with many structuring their answers clearly demonstrating that they had prepared well for this style of question. Although the velocity of the truck was given as negative, a number of candidates ignored this, taking the velocity of the truck to be positive. This gave an answer of 25.9 $m\,s^{-1}$ which was then assumed to be correct. However, part (b) was poorly done. Most candidates were aware of the need to apply $F = \Delta(mv)/\Delta t$, but used the combined mass of the lorry and truck rather than calculating the change in momentum of either vehicle. A number attempted a route using $F = ma$, but most again used the combined mass so could not score any marks.

Section C (Questions 27-29)

Q27 (STM of iron atoms)
In part (a), while the vast majority of candidates appreciated that a distance needed to be divided by the number of atoms only around half included the factor of π in their calculation.

For part (b)(i), many candidates simply described evidence of waves, rather than a wavelength. The correct response needed an idea of a constant separation between the ripples, rather than simply their presence. Part (b)(ii) needed a measurement from the diagram combined with some idea of scaling to give an answer around 0.7 nm. The scaling of cm or mm measured from the diagram scaled to nm caused confusion for several candidates and credit was not given unless it was clear correct orders of magnitude were used. Using the distance between consecutive "peaks" lead to an answer of around 0.35 nm, candidates often realised that this had to be doubled to come close to the expected value. While some may not have appreciated why this had to be done, there was no penalty applied. Part (b)(iii) was well done by most candidates although some multiplied the mass of the electron by the speed of light. Part (b)(iv) required a little algebraic manipulation which caused some confusion in weaker candidates, in particular incorrect use of squares.

Q28 (Diodes)
Part (a)(i) was a simple introduction with candidates being able to gain this mark. Some described the diode in terms of not conducting in the reverse direction which is not evident from the given graph. Only a very small number related graph B to the diode. Part (a)(ii) was also well done by the majority. There were few misreadings from the graph although candidates who did not convert from mA lost this mark.

In part (b)(i) it was hoped that the graph would prompt a response of a very high current at this given voltage. Vague answers such as the diode breaking, or the circuit not working properly could not be awarded. Part b(ii) was very poorly done with only a handful of candidates scoring any marks. Many candidates stated (correctly) that current drawn should be the same, but then taking the reading of 55 mA where the two lines crossed. Several candidates applied $V=IR$ in a variety of ways using readings from the graphs, often leading to very large currents.
Part (c) gave candidates an opportunity to use some extended writing. Over half of the candidates scored zero on this question by not giving sufficient detail in their response. Many

simply described the diode characteristics without reference to the ammeter. It was expected that candidates would use data from the graph to carry out calculations which would then inform their answer and good responses did this although all four marks could be obtained without a calculation. The question asked for two conditions, normal and overload, and some excellent responses did not get all four marks as they did not describe the normal operation.

Q29 (Terminal velocity)
This question required the candidates to use their knowledge of errors and experimental techniques which will have been covered during their study of practical work.

Most candidates correctly calculated the mean time in part (a)(i) with only a handful including the outlier in their average. However, the second marking point required both a correct estimate of the uncertainty and correct decimal places in the mean time and uncertainty. Many candidates gave more decimal places for the mean time than their value of uncertainty allowed. Part (a)(ii) proved more difficult than it should have been; many answers were vague, simply describing the 1.6 s reading as being far from the others. Part (a)(iii), which required some detailed error calculations, was done well by many. Although it was expected that percentage errors would be used, it was more common to see max or min values, using their values from (a)(i). There was no penalty for decimal places here but it was encouraging to see nearly all uncertainties being limited to 2 significant figures at most. Several candidates simply tried to add the raw errors in the two quantities, leading to a plausible but incorrect error. A surprisingly large number of candidates were unable to calculate the terminal velocity correctly. Part (a)(iv) required candidates to state a systematic error in the procedure; there did not seem to be a clear understanding of the difference between this error and a random error in many responses.

Part (b)(i) was poorly done by the majority of candidates. Few used the blank column in the table which would have given an indication of the correct answer. Many simply divided the total distance fallen by the time taken. Those who calculated the gradient did so correctly for the most part, although going outside of the linear region meant that the answer would not be within the accepted range. Part (b)(ii) was not answered by a noticeable number of candidates although it did not appear that timing was an issue for the paper overall. Many candidates went into some detail regarding light gates, which while a valid method for determining terminal velocity in general would not give the data in the question, as was required. The justification relied on a good response to their answer to (a)(iv) but could be awarded independently of the first two marks.

H157/02 Physics in depth

General Comments:

This was the first ‘Physics in Depth’ examination for this new specification and the nature and style of the paper were necessarily new to Candidates. However, almost all of the specification content and most of the assessment techniques were similar to those employed in the legacy Physics B AS papers, particularly G492 ‘Understanding processes/Experimentation and data handling’. Unlike that paper, there was no advance notice material to prepare candidates for section C in this paper, although the specification explicitly lists, in modules 1 and 2, the generic skills required in the examination. The sub-sections (d) of the ‘content’ sections 3.1.1, 3.1.2, 3.2, 4.1 and 4.2 list the 18 experimental activities of which Candidates are required to demonstrate and apply knowledge and understanding, so candidates are expected to be familiar with these. In this paper, the activity examined in Section C was 4.2(d)(ii) ‘determining the acceleration of free fall, using trapdoor and electromagnet arrangement, lightgates or video technique’.

Section A consisted of three shorter questions where the context in which the questions were set was not intended to be novel. However, these did not in the event prove easier for candidates: the most accessible question in the paper proved to be question 5 whereas each of the other five questions had very similar mean marks.

As section A questions are now about double the length of Section A questions in examinations on the previous specification, it is important that candidates scan each question in its entirety before working through it. This is also true of sections B and C of course, but in longer questions it was always expected that candidates should scan questions to reveal the ‘story’ being developed in the question and to help candidates to avoid duplicating their analysis.

Section B questions are now significantly longer than the context-based section B questions in previous examinations and typically examine different linked areas and skills within a single context. One question in this section had an extended-writing (6-mark) part, and candidates performed well on this; they are accustomed to such questions from GCSE Physics, of course.

Section C, consisting of a single question, was similar in style to the experimentation/data analysis question in the preceding specification’s G492 paper. It also had an extended-writing part which was generally answered reasonably well, although candidates may have been short of time, as it was the very last part of the examination.

Comments on Individual Questions:

Section A (Questions 1 to 3)

Q1 (Images)

Almost all candidates could relate the power of a lens to its focal length in part (A). In (b)(i) it was necessary to use the lens equation to find the new image distance, and to show that the movement of the lens needed to focus the closer object was less than 0.1 mm. Some candidates used the ‘real is positive’ convention, but were not penalised provided that the conventions were followed correctly. There were frequent sign errors, often resulting in an incorrect image distance smaller than the focal length, but a significant number then failed to get the last mark by showing that their *v* (whether correct or incorrect) was within 0.1 mm of the 4.00 mm focal length. Some candidates lost a mark by rounding 4.06779… mm incorrectly to 4.06 mm. In (b)(ii), better candidates were able not only to calculate the magnification but also apply it to find the image size and similarly. In (b)(iii) many could calculate the size of one pixel on the CCD but not then use the magnification to find the corresponding size on the object. In (b)(iv) only the most successful candidates interpreted the question correctly, many thought they had somehow to apply the noise/signal relationship to this context. Over a quarter of all candidates omitted this part.

Q2 (Microwave superposition)
Many candidates lost one or both marks in part (a) for not interpreting the diagram qualitatively in terms of two different pave paths interfering destructively; quite a number of these went on successfully to explain the phase/path difference relationships at the position y_1 and y_2, but few were able to explain the minimum at y_3 in terms of one fewer (or one extra) wavelengths compared with y_1. For a situation with the wavelength halved, the fact that the actual positions of y_1, y_2 and y_3 may be different was not important: the key fact, that the number of such maxima and minima would double for the same movement of the reflector was identified by stronger candidates, although many expected the position of maxima and minima to swap around rather than become more frequent.

Q3 (Light sensor)
In (a) many candidates recognised that log plots allow a greater range of data to be displayed, but few identified the disadvantage as the difficulty in interpolating between scale divisions, even though many must have had that same difficulty subsequently in part (b). Explanations in part (b) were rarely seen and would have benefited candidates who confused kΩ with Ω.

Section B (Questions 4 & 5)

Q4 (LED lamps)
In (a), better candidates realised that the explanation had to relate to the principle of conservation of energy but many candidates tried to use the de Broglie equation, or just to say that blue was the smallest possible wavelength of light, so light could not have a smaller wavelength than that. Part (b) was well done: virtually all could show that the grating spacing was as described, and most could use the diffraction grating equation correctly, although some lost a mark for a rounding error, such as converting 481.7 nm to 481 nm and other could not convert m to nm. Some unexpected answers were seen, almost certainly due to candidates having set their calculators to radian mode. This occurred also in 5(b).

A surprising number of candidates here and in other places rounded their answers to 1 significant figure while other used all the figures given by their calculators. Neither was penalised here, but candidates should always express their answers to the same number of significant figures as the data (2 s.f. in this case), but during the calculations should be encouraged to use one or two more.

Sketching the spectrum described in (b)(iii) proved difficult for many: graphs showing direct proportion, or those similar to the photoelectric effect V-λ graph, were seen.

In (c)(i), many candidates saw 4.1×10^{-19} J as one of the energy levels, rather than the required difference between them, and in (c)(ii) some tried to explain in terms of the photoelectric effect.

The discussion in part (d) was often circular, and left out some data, but more successful candidates recognised that LED lamps had lower capital costs compared over the same times, lower running costs, greater light output in lumens and did not contain hazardous mercury.

Q5 (Archery)
Part (a)(i) proved hard, with the majority of candidates, rather surprisingly, making the gross error of physics of using work done = maximum force × distance moved. Calculation of the kinetic energy was generally done well but only better candidates suggested why energy seemed not to be conserved.

In part (b) many could successfully find the horizontal and vertical components of initial velocity and use the *suvat* equations to find the time and horizontal displacement of the motion.
In the extended-response part (c) many candidates had to use the Additional Answer Space on the last page of the paper, which was acceptable. Good comparison of the material properties of the two bows were seen, and better candidates could relate these differences to accuracy, range and consistency.

Section C (Question 6)

Q6 (measuring *g* by free-fall)
Part (a) was intended to be a gentle start, asking how the values for u and Δu were obtained from the raw data and how the number of significant figures was decided upon, but a number of candidates interpreted this as asking how the actual measurements of u had been made. Many could relate the appropriate *suvat* equation to the forthcoming straight-line graph in (b).

Calculating the vertical size of the $\Delta(v^2 - u^2)$ uncertainty bars in (c)() was done by many using percentage uncertainties: this was allowed, even though it is not technically correct in this case. It also requires more stages than the preferred technique of calculating an extreme value of $v^2 - u^2$ and finding the difference between that and the mean value (which was given). In (c)(ii) many realised that increasing s meant that the card would be travelling faster when it passed through the lower lightgate but could not suggest how this might affect the uncertainty in the measured velocity.

The graph drawing in part (d) had three stages: drawing at least two straight lines, finding their gradients (using triangles of a reasonable size) and hence finding g and Δg. A surprising number had forgotten that the gradient was supposed to be $2g$, as they had already explained in part (b).

In the final extended-response part, this experiment was compared with a slightly modernised version of a multi-flash photograph. Most could see what was happening, but could not explain in sufficient detail how to analyse it. There are a number of possible ways to analyse this: many canny (and very good) candidates suggested that $u = 0$, that v would be found several times using the measured inter-ball distances and the known inter-image time of 1/30 s; the mean position of the ball for each image pair gives s, whereupon the analysis of parts (a) to (d) could be repeated to give g. Weaker candidates were too vague, writing comments such as 'find the distance', 'find the time', 'and so you can find *g*' without any suggestions how. A number of weaker replies (possibly due to shortage of time) also omitted to make any comparison between the two methods.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

PART OF THE CAMBRIDGE ASSESSMENT GROUP