Oxford Cambridge and RSA

GCE

Physics B

Advanced Subsidiary GCE **AS H157**

OCR Report to Centres June 2017

Oxford Cambridge and RSA Examinations

About this Examiner Report to Centres

This report on the 2017 Summer assessments aims to highlight:

- areas where students were more successful
- main areas where students may need additional support and some reflection
- points of advice 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.

The report also includes:

- An invitation to get involved in Cambridge Assessment's research into **how current reforms are affecting schools and colleges**
- Links to important documents such as **grade boundaries**
- A reminder of our **post-results services** including Enquiries About Results
- **Further support that you can expect from OCR**, such as our Active Results service and CPD programme
- A link to our handy Teacher Guide on **Supporting the move to linear assessment** to support you with the ongoing transition

Understanding how current reforms are affecting schools and colleges

Researchers at Cambridge Assessment[1] are undertaking a research study to better understand how the current reforms to AS and A levels are affecting schools and colleges.

If you are a Head of Department (including deputy and acting Heads), then we would be very grateful if you would take part in this research by completing their survey. If you have already completed the survey this spring/summer then you do not need to complete it again.

The questionnaire will take approximately 15 minutes and all responses will be anonymous.

To take part, please click on this link: https://www.surveymonkey.co.uk/r/KP96LWB

Grade boundaries

Grade boundaries for this, and all other assessments, can be found on Interchange. For more information on the publication of grade boundaries please see the OCR website.

Enquiry About Results

If any of your students' results are not as expected, you may wish to consider one of our Enquiry About Results services. For full information about the options available visit the OCR website. If university places are reliant on the results you are making an enquiry about you may wish to consider the priority 2 service which has an earlier deadline to ensure your enquires are processed in time for university applications.

Supporting the move to linear assessment

This was the first year that students were assessed in a linear structure. To help you navigate the changes and to support you with areas of difficulty, download our helpful Teacher guide: http://www.ocr.org.uk/Images/345911-moving-from-modular-to-linear-science-qualifications-teachers-guide.pdf

[1] Cambridge Assessment is a not-for-profit non-teaching department of the University of Cambridge, and the parent organisation of OCR, Cambridge International Examinations and Cambridge English Language Assessment.

Further support from OCR

Active Results offers a unique perspective on results data and greater opportunities to understand students' performance.

It allows you to:

- Review reports on the **performance of individual candidates**, cohorts of students and whole centres
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- Identify areas of the curriculum where students excel or struggle and help **pinpoint strengths and weaknesses** of students and teaching departments.

http://www.ocr.org.uk/administration/support-and-tools/active-results/

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Advanced Subsidiary GCE Physics B (H157)

OCR REPORT TO CENTRES

H157/01 Foundations of physics

General Comments:

This was the second 'Foundation of Physics' examination for this new specification. The June 2016 paper and the sample material available will have provided candidates with an appreciation of the style and nature of the paper. Apart from the multiple choice questions, a lot of the specification content and assessment techniques were similar to those employed in the legacy Physics B AS papers, particularly G491 'Physics in Action' and this is anticipated to be used as preparation material.

Section A consisted of twenty multiple choice questions, each with four possible responses, and each worth one mark. Candidates will have had experience of this style of question from sample material, although will not necessarily have experienced questions on all of the content. The question paper requested that candidates wrote their response to the question in the box provided. While the vast majority did follow this instruction, some circled the letter in the question. In the absence of any obvious contradiction, this will be credited however candidates are strongly encouraged to use the box to avoid any possible confusion. This issue was noticeably less prevalent than last year, and it is hoped that this will be avoided in the future. Most candidates show suitable working in the space at the side of the question, showing how they reached their answer although this is not required. However, it is noted that those who do this are more likely to reach the correct response. As with last year, there were a number of candidates who did not attempt one or more of the multiple choice questions, although there is no penalty for incorrect responses. As there was no evidence of lack of time, it is assumed that the candidates were unaware of how to answer that question. It is important that any changes to the response are clearly identified; for the most part, when candidates changed their mind, they made this clear by fully crossing out the incorrect response and writing the new response next to it, often in a newly draw box. This is the recommended method. However, a few wrote over the original response, making it unclear which their final response was, which cannot be credited. Similarly, some candidates did not make the distinction between "B" and "D" clear enough. While other responses from that candidate are checked for their usual style, a small number could not be clearly identified and so could not be credited.

Section B consisted of five short answer questions covering a variety of topics and assessments, totalling 21 marks. Each question examined a single context, and the questions contained calculations, explanations, graphical analysis and estimation. There was little scope for extended writing in section B, although candidates are encouraged to use the mark allocation as a guide to depth of response required.

Section C consisted of three questions of a longer and more structured style, totalling 29 marks. There was opportunity for a little more extended writing and evaluation of calculations. The section also contained a practical and data analysis based question regarding a variation on double slit interference. This question required the candidates to follow through ideas of errors and uncertainties.

As has been noted, there was little evidence of lack of time for the vast majority of candidates; the latter questions were sometimes not answered but it was felt that this was more due to their relative difficulty. The additional answer space was used by few candidates, mostly replacing work which has been crossed out.

There were a large number of instances of "power of ten" errors in candidate's responses. These mostly occur when a candidate does not convert the given units into base units (for example, mm into m). While this will only be penalised once in a single response, candidates should be careful in applying this correctly. It can often lead to final numerical answers which are clearly unfeasible, and candidates should be encouraged to consider whether their answer is physically likely.

It was encouraging to note that calculation responses were often given to a sensible number of significant figures and that candidates avoid fractions or recurring decimals for the most part.

2. Comments on Individual Questions:

Section A (Questions 1 to 20)

Q1

Several candidates wrote the appropriate equation of motion next to the question, allowing them to see the relationship. However, this question was not answered well by the majority of candidates who often gave the incorrect response of B.

Q2

This response was done marginally better than question 1, although the incorrect response B was again common.

Q3

Candidates appeared to be familiar with an equilibrium situation, with many annotating the diagram to assist them.

Q4

This distractors were approximately answered equally along with the correct answer indicating that this graph, and what it explains, was not particularly well understood.

Q5

This question was very well answered; most candidates showed their understanding clearly in their calculation, and an encouragingly small number forgot to convert from bytes to bits.

Q6

Approximately half the candidates answered this correctly. Many showed their method by drawing arrows representing increases and decreases, and following this through logically. It was clear that the underlying concept in this question is generally well understood, although several made errors in the construction of their solution.

Q7

This was correctly answered by the overwhelming majority of candidates.

Q8

A good number of candidates were able to use equations to assist them in reaching the required response. There seemed to be a good understanding of the difference between the two graphs and few seemed to misunderstand the difference between quantities P and R.

Q9

This question was correctly answered by nearly half of the candidates. Most attempted to apply some idea of momentum, leading to D being a common incorrect response. Candidates who wrote out the momentum version of Newton's second law often were able to obtain the correct response.

Q10

This was a challenging question. The most common mistake was in appreciating that the air resistance is decreasing when the parachute has been opened, leading to C and D being common incorrect responses. The drawing of a diagram by candidates did not seem to help in this instance.

Q11
This question was correctly answered by a majority of candidates. The main error seemed to be in candidates not reading the vertical axis and thinking this was speed-time graph, leading to the incorrect answer of D.

Q12
This was correctly answered by around two thirds of the candidates. Many wrote equations at the side to show what the expressions equated to, and some broke the quantities into base units. Response B was a common mistake, presumably as candidates know this expression is often used in Joule heating.

Q13
This question was done correctly by nearly all candidates. The incorrect response was most often A, with candidates attempting to draw some form of convergence on the diagram.

Q14
This question was well done by a large majority of candidates. Most drew a vector diagram to the side and correctly applied Pythagoras' theorem.

Q15
Around half of the candidates were able to answer with the correct response. Many showed suitable working for this question, and the most common error came from the incorrect use of the extension.

Q16
Candidates showed a good ability in calculating uncertainties, with many able to obtain the correct response.

Q17
Nearly half of the candidates were able to set up a ratio to show how the strain changed. Most incorrect answers assumed that the strain and diameter were inversely proportional.

Q18
This question was well answered overall, but there is evidence that candidates are still not fully familiar with the definitions of resolution, precision and accuracy.

Q19
This was correctly answered by around half of the candidates, but an incorrect estimation of the wavelength of light meant that B was a popular incorrect answer.

Q20
This question was answered reasonably well, and candidates showed a variety of means to get to their answer. Long (but often successful) methods included making the resistance 1ohm, and then calculating the power dissipation in each. Candidates using a (V^2/R) approach were often able to answer it efficiently.

Section B (Questions 21-25)
Q21 (d.c. circuits)
In part (a), the expected response was an algebraic statement of Kirchhoff's current law. This could be expressed in words, although vague responses such as "the currents add up" could not be credited. This was well done by the vast majority of candidates. For part (b), it was important that the inverse ratio of current and resistance was given. Many candidates expressed their answers in terms of "twice as many resistors" which is not sufficient for this mark. The second mark needed the use of a constant voltage across the resistors to complete the explanation. Better candidates were able to state this, although some calculated the currents using 12V, which was incorrect and not credited. Part (c) required the calculation to be followed through to

achieve 167ohms. Many candidates were unable to calculate the parallel branch resistance correctly, but by appreciated that it needed to be added to 100ohms, and so could score a mark for this. A common response was 100.015ohms; this is so far away from the "show that" value, it would be expected that candidates should appreciate something has gone wrong. Part (d) was well done for the most part, with error carried forward being applied. Several candidates calculated the current first for use in $P=IV$, although candidates should aim to keep significant figures displayed on their calculators for use in subsequent calculations.

Q22 (Lens calculation)
While most candidates were able to have a good attempt at this, with around 50% scoring all marks, there were several areas where difficulties could occur. Using a different sign convention to that given in the specification, if followed through correctly could score all marks although there was confusion over the use of the negative sign in many candidates' responses. Power of ten error, from not converting from cm to m, was also a common mistake. This question required candidates to give their answer to 2sf only, which was correctly done for many candidates.

Q23 (Material properties)
Candidates will be familiar with proportional stress-strain graphs, and have to apply their knowledge of these to a situation of changing gradient for a polymer. Part (a) required candidates to describe the changes of stiffness at different strains, by relating to the changes in gradient. In general, this was poorly done, with several candidates thinking there was an inverse relationship between gradient and stiffness and so describing the opposite of what was happening. Other candidates gave very vague answers which made no attempt to answer the question. However, they could score the second mark which wanted a value from the graph where a change in stiffness clearly occurs. This was missed out by a significant number of candidates. Part (b) was generally well done by a large number of candidates, who appreciated the need to make a tangent. Although the question did say estimate, it is good practice to use large values, and the use of a tiny gradient triangle often resulted in a gradient outside of the (generous) range. Some candidates simply divided the stress by the strain at the fracture point.

Q24 (Estimation of molecular size)
This experiment is stated in the specification, although it appeared that it may have been unfamiliar for some candidates; however enough information was given in the question for it to be answered fully. Several candidates did not state an assumption, either because they were unsure or perhaps had missed it in the question. Many wrote their assumption during the working of their solution, which was a useful way to support and assist their calculation. A noticeable number of candidates though, simply restated the assumption that had been given in the question, which could not be credited. The conversion of mm and cm to m caused confusion for some candidates resulting in a final answer which was many orders of magnitude from the atomic size. It would be expected that candidates had a feeling for the magnitude of this quantity and would go and check the calculation if this were the case. Any order of magnitude error would only be penalised once, allowing the candidates to gain one mark for correct working. Candidates who set up their solution algebraically, or who described what they were doing, were more likely to reach the correct answer. This is good practice and should always be encouraged. Many candidates did not convert their diameter to a radius in the calculation, which would be penalised. Some candidates attempted to use the shape of the molecule as a cube, but invariably ran into difficulties. There were also several algebraic errors, such as stating the correct formula for the volume of a sphere, but then only squaring the radius. This question required care in many areas for the candidates to be awarded both marks for the calculation.

Q25 (Refraction)
Part (a) required the correct use of Snell's Law to calculate a ratio for the first mark. This was done well by the vast majority of candidates, although those who simply calculated the ratio of (27/42) could achieve a value close to two-thirds. For the second mark, candidates were required to show that this ratio led to a ratio of the speeds of around two-thirds. Many candidates did not take this additional step, although it was clear that this was the basis of the question. Part

(b) required use of the diagram to complete the explanation. Again, many candidates were able to obtain the first mark by stating how the speed changes, but not all explained why. Although the question was mainly about the water-glass speeds, many candidates also described the changes of speed from glass to air, which if correctly described, could be credited for the first mark.

Section C (Questions 26-28)

Q26 (Work, stress and strain in a cable)

Part(a) required the candidates to resolve the force and then calculate the work. This was well done by the majority of candidates, although several resolved the force and left that as the final answer. A common error was to simply state that 1.5 was approximately equal to 1.4.

Part (b) needed the use of the previous value, with around half of the candidates doing this successfully. Most candidates did this by the use of $P=Fv$ although some followed a lengthy (but often successful) energy route. Several candidates used the value of 1.5 from the question, rather than their value of 1.4.

Part (c)(i) was generally well done and there was good evidence of calculation ability with more than half gaining all three marks. A relatively small number used the diameter instead of the radius in their cross sectional area calculation and most seemed to be able to convert from mm to m correctly. Some candidates seemed confused by being given the value of the Young modulus at this point and tried to calculate the stress using that value. For part (c)(ii), it was important to comment on whether the procedure was safe; while many were able to comment on relative stress values, they did not complete their answer. Part (c)(iii) was correctly done by around two thirds of the candidates, although a small number used the breaking stress rather than the working stress and there were problems with the use of gigapascals.

Q27 (Digitisation and information transfer)

Part (a) anticipated the candidates would describe the two stages of digitisation; namely sampling and quantisation. Most candidates were able to describe, or draw, a suitable means of sampling at a regular time interval. Equally spaced vertical lines on the horizontal axis, ending at the signal, would be sufficient for this mark and many were able to do this although a significant number had these clearly unequally spaced. For the idea of quantisation levels, that statement alone was not sufficient, but the idea of some equally spaced level was needed. A lot of candidates thought that only seven values were available, which was acceptable if clearly stated or shown. Those who drew on more, and rounded the signal value to the nearest level could clearly demonstrate their understanding of digitisation. It was not easy, but possible, to score all marks from annotations on the graph; when the question states “you may draw on the graph” it seems to be suggesting that this would be beneficial.

Part (b)(i) was generally well done. There was a reasonable level of tolerance on the line, although it needed to be clear that it was not going through the origin. A small number of candidates did not plot these points, which lead to difficulties in the remainder of the question. Plotting errors were not common, although broken lines (and those without a ruler) were which would be penalised. Part (b)(ii) was done well by around half of the candidates, with the idea of proportionality being a common incorrect response. Part(b)(iii) needed a gradient calculation, although it was judged that using the last two data points would give a suitable approximation. Many candidates simply selected other data points, which were then out of range which could not then earn further credit. However an encouraging number were able to calculate the gradient and carry out the necessary conversions.

Q28 (Interference of sound from two speakers)

Part (a) required the candidates to suggest difficulties with taking measurements. The use of the word precise in this context suggests that the response should consider a small spread around the mean. This implies that the measurements are taken more than once, although this does not have to be explicitly stated in the candidates' responses. Part (a)(i) was reasonably well answered, with many candidates appreciating that the minimum is not exactly defined. Part (a)(ii) was considerably less well answered, with many candidates thinking that the distance along the dotted line in the diagram was to be measured. Most candidates who gave correct responses to this part understood the difficulty in finding exactly where the sound is being produced or received.

Part (b)(i) was correctly answered by over half of the candidates; some candidates clearly misunderstood the process and added or divided the two given distances, or attempted to use the diffraction grating equation. Those candidates who gave correct responses mostly showed clearly that they understood the concept of path difference. Part (b)(ii) was poorly answered, with only a small percentage scoring both marks. Many candidates confused percentage error with accuracy, and had little appreciation for the relative sizes of the various percentage errors.

Part (c) was done well overall with around half of the candidates gaining three or four marks. Most candidates were able to calculate a speed correctly, but the calculation of the errors was more challenging. The two possible routes (max/min, or percentage errors) were approached by roughly equal numbers of candidates, but the max/min route was generally more successful. Credit was given to a variety of values and approaches, so that a candidate who had made a suitable approximation was not penalised. The final mark, for appreciating that the place value of an evaluation and its uncertainty should not significantly differ, was given as a standalone mark. Many candidates who gained full marks were very clear in their explanation of this and it is encouraging to see such skills evidenced.

Part (d) was generally well understood and answered for a single mark, but the explanation in terms of phase difference was often omitted.

H157/02 Physics in depth

General Comments:

This is the second entry for this specification. The entry was about half of that for last year, but the standard seems very similar.

Few candidates seem to have been short of time in this paper, and the extended writing questions (6c and 8c) were generally tackled well, although many candidates spent rather longer on the former than was needed and then rushed or even omitted the latter. In general, candidates handled the algebraic and the descriptive aspects of the paper well and most coped well with the practical-based question 8 which focussed on Specification area 4.1 (d)(i) 'investigating the motion and collisions of objects using trolleys, air-track gliders etc. with data obtained from ticker timers, light gates, data-loggers and video techniques.'

Comments on Individual Questions:

Section A (Questions 1 to 5)

1 (Diffraction grating)

Parts (a) and (b) were generally well answered. Many candidates obtained partial credit for part (c) [explaining why third-order yellow spectrum is not obtained] for calculating $n\lambda/d$ but few were convincing in explaining the significance of a value of 1.166; stating that 'sin θ is not possible' gained the mark, even when it was followed by 'this means that θ is greater than 90°' or some such. Convincing candidates calculated the maximum value of *n* for this wavelength being the value giving θ = 90° (i.e. 2.57) and then deduced that 3 was impossible.

2 (Resistance and conductance)

Candidates who laid out their work logically and systematically tended to avoid errors in these types of multi-stage calculations. There were a number of 'Power of 10' errors in part (b) where candidates failed to convert from mS to S. Many candidates preferred to use $R = 1/G$ and $V = IR$ rather than $V = I/G$ directly, but that was fine, even though it gave them extra work.

3 (Phasors)

Most were comfortable with part (a), although a number of candidates failed to draw the resultant phasor, or else drew one roughly free-hand without trying to get the length (approximately) correct. In (b), a reasonable nose-to-tail equilateral triangle was expected, and the more difficult part (c) required constant phase differences between each adjacent phasor pair of 180° - very few of these were seen, but many candidates gained one mark for having similar angles for the two phase differences A to B and B to C.

4 (Dislocations)

Most candidates identified the dislocation in the diagram, and the majority explained very well how atoms movement caused dislocation movement resulting in ductility. It was clear that many candidates thought that the stress in the diagram was left-to-right, rather than up the page.

5 (Photons)

Calculation in (a) of the photon energy by $f = c/\lambda$ followed by $E = hf$ (or directly via $E = hc/\lambda$) was well done by most candidates, and relating photon energy to laser power was done better than in previous examinations for Physics B. In (b), weaker candidates wanted to use $p = mv$ ($v = c$, of course) and many candidates did not spot the 'story' in the question by which answer (c) = answer (a) × answer (b) and wanted to evoke $P = Fv$. Nearly a quarter of all candidates omitted 5(c).

Section B (Questions 6 and 7)

6 (Projectiles)

Part (a)(i) rewarded the systematic and organised candidate. There are a number of valid alternative ways of proving that $t = \frac{2v \sin\theta}{g}$, and the most successful candidates made it clear what values of *suvat* were being used; after that, it was straightforward to use an appropriate equation to prove the required equation. Part (a)(ii) was well done by nearly everyone, with candidates able to apply the equation and present their answer in the same form as the rest of the table without being prompted to do so.

Part (b) was not a *h*-θ graph for a single projectile, which many candidates thought. The best answers discussed the reduction in range in terms of the effect that drag had on the horizontal component of the velocity. Those trajectories that produced the longest ranges were the most affected as the drag acted for longer.

Part (c) was the first of the two extended-writing six-mark questions. Many very thoughtful answers were seen, but some candidates may have spent over-long on this part, to the detriment of the other six-mark question later. Successful candidates linked equations such as *F* = *ma* and the mass of the projectile to identify differences in initial velocity, and the differences in launch velocity (and their causes) between the equal-mass hammer and shot were often well explained. The advantage of the run-up for the low-mass javelin was often well described. Very few candidates used the thread of the previous part of the question to mention the link between the angle of launch and ultimate range. One point which would be worth passing on to candidates is the frequent misuse of the term 'power'. Momentum and impulse were often correctly used, but 'power' often meant 'effort' or 'kinetic energy'. Many candidates, having correctly identified the reduced air resistance of the streamlined javelin and/or discus, went on to claim the un-streamlined shot and hammer would be greatly affected by air resistance. Weaker candidates often also claimed that gravity will have a greater effect on the heavier projectiles and bring them to ground faster.

7 (Digital images and signals)

Most realised in 7(a) that $2^8 = 256$ (or $\log_2(256) = 8$) was the relevant equation to identify the number of levels, but only the best answers pointed out that pixel values of 1 to 255 should have the value for 0 added to give the number of levels needed. In part (b), candidates who showed carefully their scaling in terms of pixels/km often gained marks, even where there was a subsequent error. In (c), not all candidates appreciated that noise removal commonly gave rise to the loss of information, whereas most appreciated that the noisy pixels represented lost data that could only be guessed at using a statistical approach. Many candidates chose to describe the sort of median -smoothing technique used, which was not what the question asked. Part (d) was well done by nearly all candidates, with the most common error being to quote the answer as 47.8 s instead of 48 s.

Section 6 (Question 8)

8 (Trolley collision experiment)

This section is intended to assess skills related to data analysis, so candidates should expect to look critically at the numbers they are given in the question: in part (a)(i), few stated both measuring and timing percentage uncertainties to justify the fact that the second was negligible, and in (b)(ii) and (b)(iii) calculations of the values of momentum and kinetic energy before and after the collision were often missing or incorrectly done. In (a)(ii) only the very best candidates rounded the uncertainty to one significant figure and then rounded the mean speed to the same number of decimal places.

Part (c), being the last question in the paper, was often rushed or omitted. A common misconception was that it would be an improvement of the method to measure the velocities at a number of different places. The best candidates:

- Understood that having the initial velocities the same enable results to be compared and anomalous results to be eliminated;
- Realised the problem with the timing was not the light gates but the card – cutting it more accurately, making the card longer and putting the trolleys on tracks to ensure the card cut the light beam at right angles were all sensible suggestions on ways to improve the timing;
- The most common suggestions on how to ensure the same initial velocity was to use a pair of ramps or spring-loaded trolleys. Both had their merits. The best candidates also include detail such as the constant starting positions and angles where ramps had been used.

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