GCE

Physics A

Advanced Subsidiary GCE **AS H156**

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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OCR REPORT TO CENTRES

H156/01 Breadth in physics

General comments

This examination paper produced a good range of marks from 2 to 69, with many of the candidates demonstrating good knowledge and application of physics.

There was a marked improvement in answering the multiple-choice questions (MCQs). The space provided on the question paper was used sensibly to carry out rough calculations and then calculators were used efficiently where necessary.

Generally, candidates answered questions on practical skills quite well. Most candidates demonstrated a decent repertoire of practical skills.

Many candidates made good use of the Data, Formulae, and Relationships Booklet. Calculators were used effectively and answers were often quoted to the correct number of significant figures. Candidates are once again reminded, that it is poor practice to round off numbers in the middle of long calculations. In 'show' calculations, it is always a good idea to double-check the analysis and to add as much detail as possible.

The quality of written work remains variable. In some questions, unnecessary additional information often negated previous good physics. In **21(b)** for example, a statement such as '*the trolley has constant speed up to 0.30 s*', was frequently spoilt by the contradictory statement '…*which shows the trolley was accelerating*'. It is best to be brief; use bullet points if necessary. Candidates are encouraged not to use labels (e.g. *A*, *R*, etc.) in their explanations and descriptions - named quantities (e.g. *amplitude*, *total resistance*, etc.) are much better at communicating ideas. There was an improvement in the understanding of the key command terms such as *describe*, *explain*, *show* etc. The legibility of a few candidates' work remains a serious concern.

It is worth reminding candidates again that their scripts are scanned and then marked by examiners. It is therefore important that answers are not written outside the space provided. Fewer questions were omitted and the vast majority of the candidates completed the paper in the scheduled time.

There were some very good scripts with clearly laid out physics and well-presented calculations. The comments that follow tend to relate mainly to the opportunities that were missed by the candidates.

Comments on Individual Questions

Question	Comments
MCQ **1** to **20**	All questions showed a positive discrimination, and the less able candidates could access the easier questions. The questions in Section A require careful inspection. Candidates can underline or circle key information to make the questions accessible. Whilst highlighter pens may be used to identify useful information in the printed question, they must not be used to record any part of the answer as they are not visible when scanned. No detailed calculations are expected on the pages, so any shortcuts, or intuitiveness, can be employed to get to the correct answers. Questions **1**, **4**, **5**, **7**, **10** and **12** proved to be particularly straightforward, allowing most of the candidates to demonstrate their knowledge and understanding of physics. Question **10** tested the learning outcome 4.5.1(e)(i) on LEDs; a good number of candidates successfully rearranged the expression $eV = hc/\lambda$ to get the correct answer **D**. At the other end of the scale, Questions **2**, **8**, **9** and **14**, proved to be more challenging.

	• Question **2** was about the refraction of light through a triangular glass prism. The most popular distractors were **D** and **B**, where the incident and emergent rays were parallel. Perhaps the candidates were thinking about a rectangular block, where such rays are parallel. Only a quarter of the candidates got the correct answer **C**.
	
	• Question **8** was about two resistors in a parallel combination and percentage uncertainty. The correct answer was **A**. The popular distractor was **B** where the candidates simply added the percentage uncertainties for each resistor. The best way of tackling this tough question was to use the equation $1/R = 1/R_1 + 1/R_2$ to calculate either the maximum or the minimum value of the total resistance *R* and then the percentage uncertainty. This question was accessible to only a quarter of the candidates.
	
	• Question **9** was about a potential-divider circuit with an LDR. The resistance of the LDR increases when the intensity of the light is reduced. The smaller current in the circuit would lead to a smaller p.d. across the fixed resistor. The answer had to be **A**. On the back of some erroneous analysis, the most frequent answer was **B**.
	
	• Question **14** was about the de Broglie wavelength of an electron when the accelerating p.d. is doubled. Less than a third of the candidates got the correct answer **B**. All the other distractors were equally popular. The logical way to tackle this would have been as follows:
	  o $KE = e \times V$; doubling the p.d. *V* will double the kinetic energy of the electron.
	  o $KE = ½mv^2$; the speed *v* of the electron will increase by a factor of $\sqrt{2}$.
	  o $\lambda p = h$; the wavelength λ will decrease by a factor of $\sqrt{2}$.

21(a)	Most of the candidates answered this opening question extremely well, with the majority picking up the mark. The two most popular errors were omitting to square the speed of the trolley and using 900 g instead of 0.900 kg.
21(b)	Most candidates gained two or more marks. Answers were often longer than required, but most candidates managed to analyse the displacement-time graph of the trolley extremely well. A few candidates lost marks for incorrect physics such as '*the trolley decelerates at a constant speed between 0.3 s and 0.8 s*'. The top-end candidates scored full marks for their descriptions and recognised that the velocity was equal to the gradient. A small number of candidates spoilt their answers by suggesting that the trolley '*bounced back*'.
21(c)	Most candidates were aware of what equation to use but only about half managed to gain one or two marks for their calculation. The simplest answers occupied a single line and the complex ones recalculated the initial velocity of the trolley from the graph and then used the equation $v^2 = u^2 + 2as$. There were no marks for using incorrect values for the time, or the displacement, during the deceleration stage. A significant number of candidates took the time for stopping to be either 0.80 s or 1.0 s.
22(a)	Most candidates effortlessly applied the principle of moments to calculate the vertical force at the pillar. A few candidates took moments about the pillar, determined the force on the platform at the wall and then calculated the force *F* at the pillar using 'net vertical force = 0'. Although this was a longer route, it was still worthy of two marks. About a quarter of the candidates scored nothing. The common errors were quoting the moment of the weight about the wall (22750 Nm) as the force *F* and using 5.0 m instead of 3.5 m in the calculations.
22(b)	This was a notable success for most of the candidates. Examiners were pleased to see a range of techniques being used to get to the correct answer of 1.8×10^{-5} m. Most of

	the answers were well-structured and showed good use of calculators. A small number of candidates correctly calculated the strain but then struggled to rearrange the expression for strain to determine the compression.
23(a)	This question on the principle of conservation of momentum was not answered well. Only a small number of exceptional candidates recognised that momentum of the Earth-ball system was conserved which meant that the Earth must have momentum equal to that of the falling ball but in the *opposite* direction. Most of the candidates thought either air resistance had a role to play, or that momentum was conserved only when the ball collided with the ground. A small number of candidates thought that the conservation of momentum was intrinsically linked with the principle of conservation of energy. This prompted incorrect physics such as '*momentum transferred to KE and then GPE after impact with the ground*'.
23(b)(i)	Some of the answers were quite brief but most of the candidates knew that force was equal to the rate of change of momentum. The correct answer of 20 N appeared on numerous scripts. A few candidates used Δt = 2.0 s rather than Δt = 0.20 s.
23(b)(ii)	This was a good discriminator with many of the top-end candidates scoring full marks. A good number of candidates had the momentum of **Y** constant at 8.0 kg m s^{-1} up to 0.40 s, but then instead of the momentum increasing uniformly with time between t = 0.40 s and t = 0.60 s, the momentum decreased. This showed poor understanding of the principle of conservation of momentum. The total momentum of the two balls had to remain constant at 18 kg m s^{-1}. A very small number of candidates drew wobbly freehand lines. This was not penalised, but in future, candidates are reminded to draw straight lines using rulers.
24(a)(i)	Almost all candidates were familiar with the equation $I = Anev$. The modal score here was two marks. Most scripts had well-structured answers. The final answer was often quoted to the correct number of significant figures and written in standard form. A very small number of candidates incorrectly calculated the current using 'current = VR = 3.0 × 100 = 300 A'; this scored zero because of incorrect physics.
24(a)(ii)	This question on the heating of a thermistor favoured the top-end candidates. Most candidates recognised that the resistance of the NTC thermistor decreased as its temperature was increased. The explanation of why the current increased lacked robustness. Some correctly gave the explanation as '*increased number density of free electrons'* or successfully showed that current was inversely proportional to the resistance. The fate of the voltmeter reading baffled many candidates. The answer was simple, the voltmeter reading remained unchanged because the battery had no internal resistance. For many, the voltmeter reading increased because '*p.d. was proportional to the current*'.
24(b)(i)	This question required careful examination of a series circuit. The answer was very much dependent on knowing that 1.2 V was the p.d. across the 2.0 Ω **and** half of the resistance wire. Using total resistance other than 10.0 Ω led to incorrect value for the internal resistance. Less than about a third of the candidates secured full marks. Some of the most frequent difficulties were: • Assuming the p.d. across the 2.0 Ω resistor was 1.2 V. • Using 1.5 V as the terminal p.d. rather than 1.2 V. • Experiencing problems rearranging the equation $E = V + Ir$.
24(b)(ii)	The question required an explanation in terms of the current in the circuit as the distance d increased. Many candidates realised that the increase in the length of the resistance wire meant an increase in the total resistance of the circuit and hence, a

	smaller current in the circuit. Some went one step further and correctly concluded that *V* increases as the p.d. across the internal resistance decreases. A significant number of candidates either described the variation *V* with *d* without any explanation or guessed the physics. No credit could be given for answers such as '*the graph gets less steep*' and '*the current changes because the electrons have to travel a longer length*'.
25(a)(i)	Almost all scripts had the correct answer of 4.0 cm for the wavelength.
25(a)(ii)	About half of the candidates scored one or more marks for their explanations. A fair number of candidates realised that the amplitude decreased and this led to a decrease in intensity because *intensity* $\propto$ *amplitude*^{2}. No credit was given to candidates who stated that the '*intensity decreased because of the inverse square law'*. The intensity of circular waves spreading out on the surface of water does not obey this law. A significant number of candidates incorrectly stated that the '*intensity and power decreased because of heat losses or friction*'.
25(b)(i)	Most candidates gave vague answers for interference. Answers such as '*this is when waves interact or collide*' were prevalent. Interference is the superposition of coherent waves.
25(b)(ii)	This was another question that favoured the top-end candidates. The question required a clear understanding of path difference. Credit could only be given if the distances of 10.5 cm and 15.0 cm were used to answer the question. Destructive interference occurred at **C** because the path difference is **1.5**λ. A significant number of candidates struggled to get their physics across. Path difference was confused with phase difference and '*cycles'* was used to imply wavelength. Many candidates incorrectly concluded that the path difference was **0.5**λ. Weaker candidates referred to *nodes* and *antinodes* in their descriptions.
26(a)	The proof for the homogeneity required careful progression and no omission of any key step. About half of the candidates showed sufficient rigour to score the mark. Those who lost the mark, invariably did so because of the poor manipulation of m divided by m^{-1}.
26(b)	About half the candidates scored two or more marks for this practical based question. It is good to report that many candidates were familiar with the idea of measuring mass using a balance and using a ruler to measure length. A good number of candidates mentioned plotting a graph of mass against length of wire and determining the gradient or μ. In this instance examiners ignored the incorrect use of the terms *precise* and *accurate*. A significant number of candidates spoilt their answers by referring to *weight* being measured by a balance. Alternative approaches describing the analysis of measured values of tension *T* and speed *v* were allowed if the physics was correct.
26(c)	Full marks were rarely scored but many top-end candidates did manage to score two marks for recognising that the wavelength was inversely proportional to frequency and that the speed of the progressive wave was constant. A significant number of candidates recognised that the separation between adjacent nodes was half a wavelength, but then spoilt their answers by mentioning '*wavelength = 0.5*λ *for the first harmonic and wavelength = 1.5*λ *for the third harmonic*'. The answers from weaker candidates were confused with statements such as '20 Hz = 0.5λ'.
27(a)	To gain the one mark for the threshold frequency candidates had to mention *electromagnetic waves* or *photon* and *minimum frequency* for the removal of electrons.

	Less than a third of the candidates gave an adequate definition. Poorer answers confused *threshold frequency* with *work function* of the metal.
27(b)(i)	About a third of the candidates showed how Einstein's photoelectric equation led to the expression $\phi = hf_0$. The key in securing a mark was stating that the kinetic energy of the electrons is zero at the threshold frequency. Some candidates lost the mark for careless work such as writing $h\boldsymbol{f_0} = \phi + KE_{max}$.
27(b)(ii)	Most candidates picked up the mark for plotting the data point and drawing a best fit line. Examiners were a lenient with the marking of the line of best fit. Candidates must use rulers and ensure an equal spread of data plots about their best fit lines.
27(b)(iii)	The determination of Planck constant *h* from the gradient of the best fit line was impeccably undertaken by the top-end candidates. A large triangle was used to determine the gradient of the best fit line. More than half of the candidates correctly converted the eV to J. The most common errors here were: • Using **1.0** $\times 10^{-19}$, rather than **1.6** $\times 10^{-19}$ to convert eV to J. • Calculating the gradient using eV values. • Omitting the 10^{14} factor for the frequency.
27(b)(iv)	About one in ten candidates omitted this question. Many candidates realised that a worst-fit line had to be draw, with or without error bars, and then its gradient used to determine the percentage uncertainty in the experimental value for *h*. A significant number of candidates gave answers in terms of percentage **difference** between their experimental value and the accepted value for Planck constant.

H156/02 Depth in physics

General Comments:

This summer was the second paper of the new AS physics specification. The paper was accessible to candidates and very few questions were omitted. There is little evidence to suggest that the candidates ran out of time although the answer to the last part of the final question did appear to be rushed. There is a good range of marks for the paper ranging from 0 to 68.

Candidates again answered questions on practical skills quite well indicating that they are developing their practical skills. Candidates struggled with analysing and interpreting graphs in practical contexts. This was evident in both **2 (d)** and **3 (b)** where candidates were expected to identify the gradient from a graph.

Candidates clearly made good use of the Data, Formulae and Relationships Booklet. There were some very good mathematical skills demonstrated by candidates. To ensure full credit candidates should be encouraged to demonstrate clearly their methods when carrying out calculations. In particular, candidates should avoid rounding intermediate numbers in long calculations and there was also evidence of rounding final answers to one significant figure. This year candidates answered 'show' questions much better. The unknown should be the subject of any equation – credit is not given for using the "show" value. Clear demonstration of the method and final answer is needed. For example, in question **4 (a)** an answer of 15.1 was expected, an answer of 15.2 was incorrect.

The quality of written work was variable. A significant number of candidates could have gained more marks by stating definitions correctly, for example, in **2 (e)** and **4 (a) (iii),**and carefully answering the questions set. It is important for all candidates to understand key command terms such as state, describe, define, etc. When answering 'explain' questions candidates must be precise in the use of terms and quantities, for example, in **4 (c) (ii)**, candidates often did not explain which resistance or potential difference they were discussing. The problem was often further compounded by candidates using symbols which were not defined.

It is worth reminding candidates that their scripts are scanned and then electronically marked by examiners. It is therefore important that answers are not written outside the space provided for the answers. The legibility of some candidates' work remains a concern.

The two level of response questions, **3 (b)** and **6 (b)** were generally better answered this year and again gave the opportunity for candidates to demonstrate their knowledge and understanding of physics. Good candidates structure their answers well and clearly explain their reasoning. In **6 (b)** the good candidates determined the speed of sound in air and showed that it was the same for different harmonics. Good candidates also clearly indicated the harmonics and stated how the length of the tube was related to the wavelength.

The questions that candidates found most difficult were **1 (b) (iii)**, **2 (f)**, **3 (a) (iii)**, **5 (c) (i)** and **5 (c) (ii)**.

There were some very good scripts with clearly laid out physics and well-presented calculations. The comments that follow tend to relate mainly to the opportunities that were missed by the candidates.

Comments on Individual Questions:

1(a)	The first question was incorrectly answered by a large number of candidates. The common error was only referring to braking distance.
1(b)(i)	This question was the first 'show' question of the paper. It is important that candidates show clearly their working. In this case it was expected to see 61 multiplied by 1000 and divided by 3600. Most candidates came up with an answer of 16.9.
1(b)(ii)1	Most candidates were able to correctly write down the equation for kinetic energy and substitute the numbers into it. Where mistakes were made, it was normally with candidates not squaring the speed. It was hoped that candidates would use a speed of 17 $m\,s^{-1}$ from the previous part.
1(b)(ii)2	Good candidates clearly indicated which equation they were going to use and then clearly showed the substitution of the numbers, with the acceleration as the subject of the formula. Some candidates attempted to determine the time taken for the train to stop. Often when this method was attempted, candidates incorrectly assumed that the speed of 17 $m\,s^{-1}$ was the average speed and not the initial speed. A few candidates round their answer inappropriately to one significant figure.
1(b)(ii)3	Candidates answered this question in a number of different ways. The majority of the candidates substituted in their answer to the previous part into $F = m\,a$. Other candidates either used their answer for kinetic energy and the distance travelled or determined the time for the train to stop and used force equals the rate of change of momentum.
1(b)(iii)	Candidates found this question requiring an explanation tough. There were many vague answers referring to "gravity" as opposed to the "force due to gravity" or "weight". Candidates should be encouraged to use correct scientific terms. There was also occasional reference to "faster" deceleration. Some candidates correctly answer this question in terms of the kinetic energy being transferred to an increase in gravitational potential energy. Few candidates were precise in discussing the component of the weight parallel to the incline.
2(a)	A surprisingly number of candidates either did not include the heading in the table or wrote "0.9" or "1" to one significant figure rather than "1.0".
2(b)	The graph was drawn well with most candidates labelling the axis and using a simple scale which covered more than half the *y*-axis. Occasionally candidates lost a mark because of a miss-plot.
2(c)	This question was well answered. It was pleasing to see that the majority of the candidates clearly indicated the points on their line used to determine the gradient.
2(d)	In this question candidates were required to use the gradient value to determine a value for the spring constant. Many candidates did not realise that the spring constant was the inverse of the gradient value. A common error was determining *k* and then dividing it by two. This question also required candidates to include a suitable unit and give the answer to an appropriate number of significant figures. Some candidates made a power of ten error by not converting centimetres to metres; other candidates either gave the answer to one significant figure or four or five significant figures.
2(e)	A good number of candidates quoted Hooke's law; candidates should be encouraged to define any symbols used. Many candidates stated that to prove a directly proportional relationship a straight line should be produced but omitted to state that the straight line should pass through the origin.
2(f)	Candidates found this part difficult; it was often omitted and where candidates did attempt it they ended up with the inverse ratio of 1.5.
3(a)(i)	Most candidates were able to suggest the use of a micrometer or caliper. A significant number of candidates did not state that they would repeat readings in different directions and calculate the mean value.
3(a)(ii)	Candidates were able to use the formula for a volume of a sphere and rearrange the equation for density. Some candidates were confused with the power of tens. Again, clear working was needed for the award of both marks.

3(a)(iii)	Candidates found this question difficult. Many candidates gained one mark either for determining the weight of the sphere or for determining the upthrust correctly. Few candidates realised they needed to find the difference between the upthrust and the weight of the sphere.
3(b)	This question was the first level of response question on the paper. It involved candidates planning an investigation into the variation of terminal velocity and the radius of a sphere. Candidates were expected to draw a labelled diagram and there were many tubes with elastic bands drawn. To gain the highest marks candidates were expected to explain carefully how they would measure the terminal velocity and to include how they would check that the terminal velocity had been achieved. Candidates were also expected to explain how their results could be used to give to determine the constant K. Good candidates suggested an appropriate graph that should be plotted and explained how K could be determined from the gradient. In general answers were better this year than last year.
4(a)(i)	This question asked candidates to show that the resistance of one of the heaters was 15 Ohms. Some candidates divided 3500 W by 230 V which gave an answer of 15.2 A which was the current. If these candidates then divided 230 V by 15.2 A they still gained the mark.
4(a)(ii)	It was pleasing to see many good answers to the determination of the length of the wire. Candidates showed clearly how they determined the area and then substituted correctly into the rearranged equation for resistivity. Some candidates round their answer to one significant figure.
4(a)(iii)	Candidates often scored a mark for stating Ohm's law; candidates should define any symbols used. Candidates often did not refer to any temperature change in the heater. Vague answers referring to "heating" did not score.
4(b)	A surprising number of candidates did not correctly determine the cost of electricity. Many candidates did not use three heaters or seven days. For the award of the intermediate mark, clear working needed to be shown.
4(c)(i)	Candidates who use the potential divider equation invariably gained the correct answer of 0.71 V. Alternatively, some candidates correctly determined the current and then determined the voltmeter reading.
4(c)(ii)	Candidates were expected to explain how the voltmeter reading would change as the temperature of the thermistor increased. Good answers used a step-by-step approach. Candidates needed to explain how the potential difference of across the fixed resistor would change. It was essential that clearly defined terms were used – often candidates referred to V_1, R_2, or p.d. and resistance without indicating explicitly the meaning of V_1, R_2, or explaining which p.d. or resistance was being referred to.
5(a)	Many candidates found it difficult to define phase difference although coherence was usually correctly defined.
5(b)(i)	It was expected that candidates would describe the path difference in terms of the wavelength. Candidates often realised that the bright line would have a path difference of an integer number of wavelengths, this was often written as $n\lambda$. To explain the dark line many candidates struggled with the appropriate relationship in terms of λ or did not state an odd number of half wavelengths.
5(b)(ii)1	Although candidates correctly identified the correct equation, a large number of candidates did not determine the fringe spacing correctly. Some candidates used 42.2 cm, others divided 42.2 cm by 11, 15 or 20. Furthermore, some candidates did not convert the slit separation from millimetres to metres. Candidates were able to identify the equation from the Data, Formulae and Relationships Booklet.
5(b)(ii)2	Most candidates were able to determine at least one percentage uncertainty for the individual quantities correctly. Mistakes were made either on determining the other quantities or adding the percentage uncertainties. Some candidates attempted a maximum/minimum method – the common error with this method was not dividing maximum by minimum or minimum by maximum.
5(c)(i)	Candidates found this question difficult. Many could not determine the energy of a

	photon correctly – an error carried forward was allowed from **5(b)(ii)1**. The question also required candidates to realise that 50.0 mW is equivalent to 50.0 mJ s^{-1}. A common error was to divide the power by the charge on an electron.
5(c)(ii)	To explain whether photoelectrons will be emitted, candidates needed to convert the work function measured in electron volt to joule. A clear conclusion was needed.
6(a)	Most candidates answered the difference between stationary and progressive waves in terms of energy considerations.
6(b)	The second level of response question required candidates to explain the results of an experiment investigating stationary waves in a closed and open hollow tubes. Good candidates demonstrated their knowledge and understanding by explaining how the standing wave was formed, where nodes and antinodes were positioned and how the wavelength of the stationary wave could be determined. Many candidates drew additional diagrams showing the harmonics in both open and closed tubes. To gain the highest marks, it was expected that candidates would determine the speed of sound correctly for more than one tube.

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