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Examiners' report

PHYSICS A

H556

For first teaching in 2015

H556/03 Autumn 2021 series

Version 1

ocr.org.uk/science

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

	Reports for the November 2021 series will provide a broad commentary about candidate performance, with the aim for them to be useful future teaching tools. As an exception for this series they will not contain any questions from the question paper nor examples of candidate responses.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

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Paper 3 overview

H556/03, 'Unified Physics', is the last of the three examination components for the GCE Physics A qualification.

Compared to papers H556/01 and H556/02, a larger proportion of the questions in H556/03 target the higher assessment objectives (AO2 and AO3). For example, they are asked to analyse and interpret experimental data, as in Question 5(b), or to design an experiment in order to test a conclusion, as in Question 2(b). Since this paper is synoptic, candidates must be able to apply their knowledge and understanding in unfamiliar contexts in order to gain high marks.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• clearly showed every step in their calculations • provided clear and well-structured written answers • were confident in using their knowledge in unfamiliar contexts.	• struggled to rearrange formulas correctly • made unnecessary arithmetic errors such as using an incorrect power of ten • did not address all parts of the question.

Spotlight on Question 5(b) as an example

A good illustrative example is the data analysis question, 5(b).

Candidates who did less well on this question often:

Struggled to rearrange the formula $4(l + k) = v/f$ into the correct '$y = mx + c$' form.

Were unable to cope with the horizontal axis being labelled as '$1/f\ /10^{-3}$ s'. Therefore they calculated the gradient with an incorrect power of ten.

Did not address all parts of 5(b)(ii). Having calculated the gradient, they did not go on to calculate v, despite having been told that the gradient = $v/4$.

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Themes in candidate responses

In this paper, candidates frequently answered only part of the question. There seemed to be various reasons for this:

- The question was sometimes misread. For example, 2(a) asked, 'When the LDR is covered, its resistance is 3000 Ω. Calculate the voltmeter reading'. A large proportion of candidates instead answered the question, 'When the LDR is covered, its resistance is 3000 Ω. Calculate the voltage across the LDR'.
- The question was sometimes read too hastily. For example, 1(a)(iii)1 asked, 'Show that output power … is constant at about 4 MW'. Many candidates obviously read this as, 'Show that output power … is about 4 MW' as they did not calculate the power at more than one point.
- Parts of the question were sometimes left unanswered. This was seen most often in the level of response questions, which are discussed below.

	**AfL**	For candidates: read each question through slowly. Highlight or list any information or data you have been given. Then read the question through again, underlining all the key points you should address in your answer.

A good example where this approach would help is for Question 5(a), where many candidates either explained how a stationary wave is produced in general, with no reference to the fundamental frequency or $l = ¼\lambda$, or drew diagrams of several different harmonics, or gave the general equation $l = (2n - 1)/4 \times \lambda$.

Comments on responses by question type

Level of response questions

The two level of response questions in the paper were designed to test different abilities.

The first, Question 2(b), tested the candidates' ability to plan and carry out an experiment they were unlikely to have seen before. Credit was given for addressing <u>each</u> of the four bullet points in the question. However, it was also important to describe the experiment fully, a step which many candidates attempted only sketchily.

	**AfL**	When describing an experiment, it is vital to spell out, step by step, how the experiment is to be carried out. In this particular question: • How will I vary the thickness of paper? • how will I measure the thickness accurately? • how will I measure the current accurately? • What precautions might I need to take to ensure valid results? For example, what other variables would I need to control?

The second level of response question, 4(a), tested the candidates' ability to write a logically structured explanation. Most candidates found this question much more difficult than 2(b) and teachers should note that it is important to give practice in this kind of extended writing.

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The key information given in 4(a) is that the oven is not sealed. This means that N (and n) are not constant. Many students were clearly uncomfortable with this type of situation. Another major problem was that many candidates thought that $E = \frac{3}{2}kT$ (which is given in the data, formulae and relationships booklet) relates to the energy of the whole gas, rather than the energy of a single molecule.

Calculation questions

Most candidates are now setting out their calculations neatly and logically, showing all the steps in their thinking. Here are some points to note from this paper:

- Candidates should be encouraged always to write down the formula they are using as **B** marks are sometimes awarded for this. See for example 1(a)(iii)1.
- Even if candidates go on to calculate the answer incorrectly, compensatory **C** marks are sometimes awarded for writing down the correct formula. See for example 1 (b)(ii), 3(b)(i) and 3(c)(ii)
- In questions that ask candidates to 'show that' a given answer is correct, the formula may include one or more physical constants from the data sheet. If this occurs, candidates must show a full substitution of values, including the value from the data sheet. For example, in 3(b)(i), full marks were only awarded to candidates who substituted 6.67×10^{-11} into the formula instead of simply writing '*G*'.

Common misconceptions

Candidates often struggle to answer questions on circular motion, and Question 6 threw up the usual misconceptions.

	**Misconceptions**	• There is a type of force called the centripetal force that appears when things start to move in a circle. • This centripetal force must be balanced by existing forces. • There exists a force that throws things outwards, called a centrifugal force.

Teachers should make sure that candidates realise that, for circular motion, there must be a force (or combination of forces) that provide a resultant force towards the centre. In Question 6, the two available forces are $R - W$, which acts vertically, and F, which acts horizontally.

Key teaching and learning point

Question 3(b) was a question designed to test candidates' knowledge that gravitational potential energy is always negative. A clue was given in (i), which talked about the magnitude of the gravitational potential energy being 7×10^{11} J. Candidates were also told in (ii) that the kinetic energy was 3.5×10^{11} J. However, when asked to calculate the total energy in (iii), the majority of candidates gave their answer as $(3.5 + 7) \times 10^{11}$ J rather than $(3.5 - 7) \times 10^{11}$ J.

Guidance on using this paper as a mock

The difficulty level increases question by question in this paper. Therefore, if teachers wish to give candidates a valid idea of their ability level, it is important to set this paper as a whole and not 'mix and match' with questions from other papers.

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