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Examiners' report

PHYSICS A

H156

For first teach in 2015

H156/01 Autumn 2020 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 Autumn 2020 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 exam 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.

A full copy of the exam paper and the mark scheme can be downloaded from OCR.

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Paper 1 series overview

H156/01 is one of the two assessed components of AS Physics A. This component is worth 70 marks and is split into two sections. Section A contains 20 multiple choice questions (MCQs) and allows the breadth coverage of the specification. Section B includes short-answer style questions, problem solving, calculations and practical work. The assessment of practical skills, as outlined in Module 1 (Development of practical skills in physics) and Module 2 (Foundations of physics), is an integral part of the paper. The Data, Formulae and Relationships booklet is a valuable resource in examinations and allows candidates to demonstrate their application of physics without the need to rote learn physical data, equations and mathematical relationships. The weighting of this component is 50% and the duration of the exam paper is 1 hour 30 minutes.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• answered most of the MCQs and made good use of the spaces provided to do any rough analysis or calculations • demonstrated good practical skills and awareness of scientific methodology and techniques, e.g. Question **24a** • made judgements and reached conclusions based on experimental data by calculating absolute uncertainty, e.g. Question **22b** • made excellent use of information provided in the Data, Formulae and Relationships booklet when doing calculations, e.g. Questions **23aii**, **23bi**, **24bii**, **27c** and **28bi** • showed all the steps leading to the correct response in 'show' calculations, e.g. Question **22a** • had well-structured solutions with clear manipulation of equations, good substitution and wrote the final answers to appropriate significant figures • demonstrated good use of calculators, especially handling powers of ten • demonstrated good comprehension of command words such as *describe*, *explain*, *show*, etc • wrote numerical and textual responses that were aligned to the number of marks given • correctly used scientific vocabulary and key concepts, e.g. Questions **21b**, **23bii**, **27b** and **28a**.	• showed too much detail when answering numerical MCQs – this was both time-consuming, and unnecessary when most calculations could have been done on calculators • demonstrated poor recall of basic definitions and misunderstood key concepts, e.g. confusing *work function* and *threshold frequency* in the description of the photoelectric effect in **28a** • did not define labels, or letters used in descriptive responses • truncated or rounded numbers prematurely within calculations, which led to incorrect final responses, e.g. Questions **22b** and **23bi** • showed poor recall of prefixes, e.g. nano (n) in Question **28b** • did not underline (or circle) key data and terms in the questions, notably in the MCQs.

Section A overview

There are 20 MCQs in Section A from a range of topics from the four modules of the H156 specification. This section is worth 20 marks and candidates are expected to spend about 25 minutes.

Section B overview

Section B includes short-answer style questions, problem solving, calculations and practical skills. This section is worth 50 marks and candidates are expected to spend about 1 hour 5 minutes. Most of the candidates finished the paper in the allotted time, with about 1 in 10 omitting the last Question **28bii**.

Comments on responses by question type

Multiple choice questions

Some of the questions, such as Question **1** on Kirchhoff's first law and Question **19** on a stress-strain graph for an elastic material, are expected to be done quickly without much reasoning. Other questions, such as Question **12** on *impulse = change in momentum*, requires a bit more thinking and solving time. Each question has ample space for scribbling down key terms or equations – but the bulk of the numerical work is expected to be done on the calculators. It is important for candidates to insert their correct response for each question in the square box provided.

All questions showed a positive discrimination, and the less able candidates could access the easier questions. MCQs require careful inspection. Candidates can annotate text and diagrams if it helps to get to the correct responses. No detailed calculations are expected on the pages, so any shortcuts, or intuitiveness, can be used to get to the correct responses.

Questions **1**, **6**, **13**, **16**, **17** and **19** proved to be particularly straightforward, allowing most of the candidates to demonstrate their knowledge and understanding of physics. At the diametric end, Questions **4** and **14**, were more challenging, and accessible only to the top-end candidates.

Section B questions

In Section B, questions requiring calculations were generally done well, with most candidates using a range of mathematical methods to solve problems. Most solutions were set out clearly and logically and were relatively easy to follow.

There were missed opportunities when answering questions requiring explanations and reasoning. In physics, candidates who learn their definitions and understand physical principles always excel in questions requiring textual answers. It is important to embed scientific vocabulary without contradictions or ambiguity. For example, in Question **28a**, it was important to understand that photoemission cannot take place when the wavelength λ of the incident electromagnetic radiation is greater than λ_0 because the energy of each photon is less than the work function of the metal, or the frequency of the incident radiation is less than the threshold frequency. Treating *threshold frequency* and *work function* as synonyms showed lack of understanding of these key terms.

Common misconceptions

The most common misconceptions and missed opportunities prevalent in the H156/01 November 2020 paper are outlined below.

?	**Misconception**	**Question 23bii** A small number of candidates incorrectly interpreted the velocity–time graph, especially the negatively sloping section of the graph. Instead of deducing that the drone was ***decelerating*** at point **Z**, the most frequent incorrect response was that it was ***accelerating*** at **Z** and still moving upwards.

?	**Misconception**	**Question 26c** The intensity of a progressive wave is directly proportional to amplitude^2. The most common incorrect response here was 2.4, the ratio of the amplitudes. The correct response of $2.4^2 = 5.76$ was often spoilt by writing $\frac{144}{25}$ on the answer line. Candidates are reminded that fractional responses in Physics A are unacceptable.

?	**Misconception**	**Question 28bii** The most frequent error here was to divide the power of the laser beam by 1.60×10^{-19} J instead of the energy of a single photon 4.06×10^{-19} J.

Key teaching and learning points – comments on improving performance

Improving techniques for multiple choice questions:

Many candidates write too much when answering numerical questions; this is unnecessary and time-consuming. Some questions just require basic knowledge of physics or definitions. The specific comments on the two questions below outline possible strategies when tackling MCQs. These comments can be generalised and applied to other comparable questions in this paper.

Question 3 is all about a ball of scrunched-up paper falling towards the ground. *Terminal velocity* is mentioned in the question so that the candidates can start thinking about the forces acting on the falling ball – weight and air resistance. The air resistance acting on the ball will increase as the speed increases. Therefore, the resultant force on the ball will decreases with time. Since acceleration is directly proportional to the resultant force, the only graph that matches with the correct physics is **C**. All the other graphs show either an increasing acceleration or a constant acceleration. In fact, the question can be answered by eliminating the incorrect responses – the acceleration cannot increase or remain constant for a falling object. This would imply that **A**, **B** and **D** are all incorrect. The question is not assessing any elaborate physics; just explicit understanding of an object falling through the air. About two-thirds of the candidates got the correct response. Some MCQs will be testing basic knowledge and application of physics, and any gaps will lead to unnecessary guessing of answers. The important lesson here is to learn your basic physics.

Question 4 is all about two key ideas: KE = $\frac{1}{2}mv^2$ and energy gained by the electron = Ve. Scribbling down these two expressions would be a good starting point. Immediately, **A** can be ruled out as a response because the electron must have gained speed. The **increase** in the kinetic energy of the

electron is 250 eV, this would make the **final** kinetic energy 350 eV. The kinetic energy has increased by a factor of 3.5, therefore with $v \propto \sqrt{\mathrm{KE}}$, this would imply the electron has a final speed of

$$\sqrt{3.5} \times 5.9 \times 10^6 = 1.1 \times 10^7 \text{ m s}^{-1}.$$

The response must be **D**. Identifying the key physics, and avoiding detailed calculations are both important when tackling numerical MCQs. The same technique can be employed in Questions **9**, **12**, **13**, **15** and **18**.

Improving techniques for descriptive questions:

Learning definitions and scientific terms are important aspects of answering questions with command terms such as *describe* and *explain*. Candidates often write too much, and occasionally contradict earlier correct statements. This can be avoided by writing responses using short sentences or in bullet points. The specific comments on the two questions below outline how performance may be improved. These comments can be generalised and applied to other comparable questions in this paper.

Question 21b is all about the principle of conservation of momentum. The three available marks imply that examiners are looking for at least three discrete physical ideas. The person moving to the left would score a mark, as would any description of the principle of conservation of momentum or Newton's third law of motion. The final mark was for either appreciating that the total momentum remains zero, or that the speed of the person would be smaller than that of the ball. The question can be answered either in short sentences or in bullet points. The key thing is not to miss anything or to add a statement that contradicts earlier good physics. The most common error here was that the total momentum of the system is equal to the final momentum of the ball. It is best not to write too much - keep the physics clear and succinct.

Question 27b is all about superposition of radio waves and explanation of the maxima and minima. The correct response can be either in terms of path difference or phase difference or just mentioning constructive and destructive interference. This is where underlining or circling the key terms **maxima** and **minima** would have been helpful. A significant number of candidates correctly described constructive and destructive interferences, without linking them specifically to the maxima and minima. Scrutinising questions, and reflecting before writing, are all important aspect of examination work - these skills can be learnt through practise.

Guidance on using this paper as a mock

This H156/01 paper can be used by Centres as a mock paper. This paper has gone through all the OCR quality and scrutiny processes and is aligned in terms of structure and depth to previous papers. This examination paper can provide candidates the opportunity to do the following:

- improve knowledge of chucks of physics across the breadth of the AS specification
- improve time-management skills when tackling the whole paper in 1 hour 30 minutes
- improve understanding of scientific vocabulary of physics
- understand the expectations of command terms such as *state*, *describe*, *explain*, etc.
- improve mathematical and algebraic skills
- improve presentation of numerical responses, and learn the benefit of using calculators to carry through values from intermediate calculations
- improve practical skills, including calculation of absolute uncertainty
- improve interpretation, analysis and evaluation of data presented either in text, or in graphical form
- learn how the mark scheme can be used to maximise marks from any missed opportunities.

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