AQA

A-LEVEL
PHYSICS

7408/3A

Report on the Examination

7408

Autumn 2021

Version: 1.0

General Introduction to the Autumn Series

This has been another unusual exam series in many ways. Entry patterns have been very different from those normally seen in the summer, and students had a very different experience in preparation for these exams. It is therefore more difficult to make meaningful comparisons between the range of student responses seen in this series and those seen in a normal summer series. The smaller entry also means that there is less evidence available for examiners to comment on.

In this report, senior examiners will summarise the performance of students in this series in a way that is as helpful as possible to teachers preparing future cohorts while taking into account the unusual circumstances and limited evidence available.

Overview of Entry

Just over 300 students were entered for this exceptional series, compared with about 20 000 in June 2019 which was the most recent normal summer series.
On average, each part of this 2021 paper was not attempted by 10% of students; in 2019 the corresponding figure was 2.5%. The incidence of non-attempted parts was highest in question 3, but question 1 was not far behind. 1% of the scripts scored zero which, in the history of this paper, is unprecedented.

There is nothing to suggest that the accessibility of the 2021 paper was different from those set before. Compared with previous mark distributions, the peak for the 2021 component occurs where we usually find D/E grade students. The general shape of the distribution confirms that higher-achieving students were under-represented, although not completely absent.

Comments on Individual Questions

Question 1

The question was set in the context of Required Practical Activity 12.

The demand of question 01.2 was not much beyond GCSE so it was unsurprising that the mean mark (75% of the maximum) was much higher than for any other part.

In question 01.3 we asked students to explain whether the data indicate an inverse-square relationship. It was encouraging that 75% could suggest calculations that would lead to a conclusion. However, in rejecting the prediction, only 6% of students earned full credit by providing more than the obvious comment that their '$R_C \times d^2$ values are different.'

In the 2019 paper the students were told that the sealed source depicted emitted three types of radiation. This meant that for α and β radiation the source could be thought of as directional. Later in that question, an aluminium absorber was placed in front of the open end of the source so that only γ radiation could be detected. However this radiation is emitted in all directions regardless of which way the open end of the source is pointing. It seemed that in the 2021 paper many students overlooked this when answering question 01.4. We expected them to state that the detector would be moved towards the source (about 40% did), but less than 15% explained that this maximised the distance between themselves and the source. This question discriminated in favour of those with direct experience of using a sealed source.

In question 01.6, only 30% of students gave the analysis ($\log R_C = -2 \log d + \log k$) that was the gateway to further progress in this straightforward question.

In question 01.8, about 40% referred to the random nature of radioactive decay, scoring the first mark, although some thought that the question concerned exponential decay. Some of the attempts to explain why all 100 photons would not be detected were tortuous to read.

Question 2

This question was about the light emitted from different LEDs but included general ideas about the use of diffraction gratings, as used in Required Practical Activity 2.

In question 02.1 students had to make an easy read-off from Figure 3 and then apply an equation available in the *Formulae and Data booklet*. Despite the low demand of the question, fewer than a third of the students were able to obtain full credit.

Question 02.2 is one of several in the paper where those suggesting simple practically-based explanations were most likely to score. About 40% of students mentioned some relevant characteristic of the 5th maximum to score the available mark.

It was clear that some did not understand what we wanted them to do in question 02.3 and many showed no evidence of working on **Figure 4**.

In question 02.4 only 3% of the students successfully used data about both LEDs; some engineered an answer that duplicated the value in the *Formulae and Data booklet*. All students realised that c is the speed of light but not all recognised that e is the electronic charge and used 2.718 in their calculation.

Question 02.5 was the least accessible part and only 10% of students used **Figure 4** to determine the voltage drop across the LED before going on to deduce the minimum value of R.

Question 3

This question was set in the context of Required Practical Activity 9.

In question 03.1 more students chose the distractor 13.5 than the correct value of 2.7, suggesting that many did not appreciate the distinction between 'more sensitive' and 'less sensitive'.

Question 03.2 is a question used in an earlier series. Some students improvised answers such as 'the mirror was used to illuminate the scale to eliminate human error'. Only 10% could supply a completely correct answer.

Question 03.3 was poorly answered in comparison with similar examples in previous papers, with many failing to halve the range before calculating the percentage uncertainty.

In question 03.5 most found that the space provided was adequate for them to complete their answer; those who needed supplementary pages usually included information already provided in the question. Many could suggest something sensible about meter protection, checking that C was discharged being the most popular idea. Some recognised the advantage of timing for longer but suggested impractical ideas such as 'measure the time for C to fully discharge' or 'add a resistor to the circuit'. Few could state how they would test for any relationship between range and time constant. Weaker students wrote that they would check whether the half life was $2.5\ \mathrm{s}$.

More than half were able to score one mark in question 03.6 by making at least one relevant observation about the values of V in **Table 2**, although finding an explanation to back up their observation was a harder proposition.

In question 03.7 at least 30% knew how to find the voltmeter resistance (as per page 116 of the physics practical handbook). However, half of the students, despite often obtaining relevant data from Figure 8, then failed to make enough progress to score.

In question 03.8 it was surprising to find that many, having correctly read relevant information from **Figure 8**, then attempted to calculate the current using $\dfrac{\ln V_{10}}{16\times10^{3}}$.

Concluding Remarks

The demands of this paper were no greater than in 2019.

Besides demonstrating knowledge and understanding of the required practical activities, students must show that they can apply their core understanding of practical work in new and unfamiliar contexts. Some will not have seen an analogue meter and we would not expect any to have heard about the dead time of a radiation detector, but this would not have affected their ability to tackle the questions we set.

Question 1 revisited Required Practical Activity 12 which featured in 2019 and this will have benefited those who looked at past papers and schemes. Specification coverage of theory leading up to Required Practical Activities 12 and 9 (see question 3) would normally take place later in the course, so both of these should have been fresh in students' memory. However this assumes that students will have had uninterrupted study and this clearly will not be true in every case.

The impression gained was that students felt more comfortable writing about capacitor discharge than about the inverse-square law. Where possible they should be given direct experience of using equipment relevant in each of the practical activities, including the safe manipulation of a sealed radioactive source.

As might be expected, work at grade A was in very short supply, but a handful of capable students submitted answers and some of them found innovative variations on the expected approaches to question 03.7.

At the other end of the spectrum we saw evidence of calculators set to read angles in radians (in question 02.1) and misguided attempts to use the Boltzmann constant (in question 01.3). Aside from questions 01.2, 01.3, 02.1 and 03.3, students at about the E boundary found marks difficult to obtain.

Some of the work seen in questions 01.1 and 03.2 show that, while students know about parallax error, they are not always aware of techniques used to limit its effect. This is an area we will continue to test and the best way to acquire knowledge of such techniques is by direct practical experience.

Work seen in question 01.4 suggests that some students wrongly assume that sealed sources emit γ radiation only through the open end of the source.

Students should be made aware of the expectations behind the different command words used in the questions. When we use 'Explain' we expect a reasoned justification to be included and when, as in question 01.3, they are basing a decision based on a numerical outcome, the justification should be quantitative, eg a percentage-difference calculation.

There is always scope in this paper to test the Maths Skills listed in section 6 of the specification. Question 01.6 exposed weak understanding about the use of logarithmic plots to test power law variations (MS3.11).

Relevant opportunities for skills development are identified in the main body of the specification.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.