A-LEVEL
PHYSICS

7408/2 Paper 2
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

The number of students entering the exam was 308. This extremely low number in itself shows that this series is exceptional compared with a normal summer series. The ability profile of the students was much lower than we would expect to see in a normal series.

Comments on Individual Questions

Section A

Question 1

01.1 Fewer than 10% of students answered this question correctly by making clear reference to the material between the electrodes of a capacitor. Other responses often referred wrongly to charge, to energy or to voltage changes.

01.2 The forces acting on the charges of the polar molecules were mentioned by many, but few went on to discuss molecular alignment. The equation $C = \frac{Q}{V}$ was often quoted, but the last mark was missed because few students recognised that the charge is constant for an isolated capacitor.

01.3 About half of the students could calculate the initial stored energy from the standard equation but the majority failed to calculate the final stored energy correctly. Most did not realise that the capacitance increases by a factor of 6 and chose to increase either the charge or the energy by this factor.

01.4 Most attempts at drawing the sketch were reasonable and showed a general shape, but students failed to gain marks through lack of care and through failing to draw straight lines.

01.5 Most students did not respond to the words '*Explain with numerical detail*'. They appeared to think that just stating the value of the change would gain the marks. This was the reason why marks were low for this question part.

Question 2

02.1 About half of the students successfully completed the task. Most of the others either did not choose an acceptable starting point or became confused in their algebra.

02.2 A majority of students tackled this question successfully. A common fault by the minority was the failure to realise that they should begin with the equation provided in the previous section.

02.3 Students commonly thought that the deciding factor was launch height. Even those choosing location **Z** thought that the diameter of the Earth was greatest at this point. When explaining the height advantage, only a handful of students referred to the reduced difference in gravitational potential energy required to place the satellite in orbit. A minority of students referred to the spin of the earth.

02.4 Students often calculated gravitational potential rather than gravitational potential energy. Some reverted to simplistic physics by quoting GPE $= mgh$. Only a minority correctly gave a negative answer, further reducing the success rate on this question.

02.5 A few able students justified the statement that the linear speed is smaller for higher orbits which they worked out either from the equation given in part 02.1 or from first principles. A majority thought the linear speed was greater, often justifying this by incorrectly taking the angular velocity to be constant.

Question 3

03.1 In the main, students thought it was sufficient to explain that in a vacuum a collision would not occur. Only about a fifth of them went on to explain how collisions might affect the speed distribution of the atoms emerging from the oven.

03.2 Half of the students sailed easily through this question. There was a significant number, however, who failed to identify the time and then could not make any progress.

03.3 A significant number of students went wrong at an early stage by not knowing the difference between mass and molar mass. In general, the students who could evaluate the mass of a single atom had no difficulty in completing the whole question.

03.4 Almost all students made reference to having fewer atoms in the oven. Several different types of errors then occurred:

- a number of students failed to discuss any kinetic motion, instead these students chose to rely incorrectly on the gas laws;
- a failure to discuss the rate of collision with the oven wall even when it was these collisions that were recognised to be of importance;
- poor use of technical language. It was not always clear whether described momentum changes referred to single atoms or the whole ensemble. The first of these should be described as being, on average, constant whereas the total momentum change would decrease.

03.5 A majority of students did not have enough knowledge or experience of the gas equations to make any progress. Most attempted an answer using inappropriate equations.

03.6 Most students understood the situation but many did not always describe the motion of the atoms with sufficient clarity in writing about the new detector. A number thought the detector would darken more because it was hit harder and did not focus on the number of colliding atoms.

Question 4

04.1 The question was answered well by most students. Those who had difficulties fell into two groups. The first group misread the graph and did not choose the correct location on the x-axis. The other group quoted an equation for the flux linkage that involved a $\cos\theta$ term. This in itself is not an issue, but most could not continue because they did not realise that θ is zero in this case.

04.2 Few students stated that the emf was linked to the rate of change of flux linkage. Instead they linked the emf directly with the flux. Some did quote Faraday's law in equation form but failed to apply it properly to the situation. Often **Figure 8** was taken to be the variation of magnetic flux density with time rather than distance, so the second marking point was rarely given.

04.3 The misinterpretation of **Figure 8** persisted here and very few students could determine the variation of magnetic flux density with time. Even fewer students realised that the question involved finding the maximum gradient of the graph within a distance range at $x = 0.10\ \text{m}$.

Question 5

05.1 Generally students did not explain the direction in which the force acts in a clear way. Only a few could identify the magnetic force as centripetal.

05.2 Only a quarter of students determined the correct answer. Others settled at random on various energy equations to attempt an answer.

05.3 About a fifth of the students completed the task in a straightforward way. Others did not seem to know how to start; some of these gained a mark when they had established some clear workable equations in the first place. However, just writing *BeV* does not constitute a working equation unless there is some appropriate supporting evidence provided by the student.

05.4 Only a minority of students scored highly in this question, with very few attempting the cost calculation. Most could not get beyond the first mark. They could often make headway in calculating the kinetic energy of one cyclotron but then stopped. When it came to the cost calculation, most ignored the power law and simply used a linear relationship between kinetic energy and cost.

Question 6

06.1 A large number of students did not address the question and spent much of the time explaining binding energy. Most students knew that energy was released in fusion but got the change in binding energy the wrong way round. They often suggested that binding energy is a quantity that can be physically exchanged.

06.2 This was a question on which most students easily scored at least one mark. Some made it much more difficult for themselves by converting each mass separately instead of just converting the final mass difference.

06.3 Most students struggled to find a correct equation. Coulomb's force equation was often quoted and even when the correct electric potential energy equation was used, candidates added the charges or omitted the electronic-charge factor.

06.4 Students often determined the difference in nucleon number and charge of the nuclei involved but did not go on to discuss the effect this has on the rate of fusion reaction. Some simply discussed the stability of the final fusion product. Answers rarely gave a sense that the reaction takes place in a star where the nuclei move around at various speeds. Few gained marks, therefore, for stating that a particular fusion only occurs at greater kinetic energy or higher pressure. Finally, students frequently confused rate of fusion reaction with the speed of the fusion event.

Section B

Questions 7 – 31

The success rate on almost all the multiple-choice questions was between 25% and 55%. Questions that were noticeably more straightforward than this were B7, B14, B19 and B29. Only questions B22 and B23 proved to be accessible to less than 25% of students.

Concluding Remarks

The exceptional circumstances that students found themselves in for this series is very evident when comparing their performance with those who took exams in 2019. For example, **Section B** which was of a similar standard to the earlier series had a reduction in total score of 27%. In a similar way, some of the **Section A** questions appeared not to be accessible to many 2021 students because of their lack of experience and knowledge.

Mark Ranges and Award of Grades

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