A LEVEL
PHYSICS

7408/3BD TURNING POINTS IN PHYSICS OPTION
Report on the Examination

7408
November 2020

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General Introduction to the November Series

This has been an 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

With only 250 students taking this examination, the entry was significantly lower than the typical summer entry of about 6000.

It was very clear that the student outcomes were much lower than in a typical series. The mean mark was only 30%, whereas for the 2019 entry it was 50%. There is no reason to believe that the standards of the two papers were significantly different, however. Despite the fact that students were able to pick up marks on every question, the highest mark was only 25/35. In a typical series we would expect to see students obtain marks across the full mark range.

In the 2019 examination all question parts were attempted by at least 95% of the students. In this examination, there were only 4 of the 14 question parts that were attempted at a similar level. Even these answers suggested that many students had little of the specialist knowledge and understanding required to perform well in this option.

All of this information suggests that these students found this examination much more challenging than did students in the past.

Comments on Individual Questions

Question 1

This question required students to be familiar with JJ Thomson's work and the discovery of the electron. In 01.1, many students could not explain how the cathode rays were produced in Thomson's experiment; a description of thermionic emission was a common incorrect answer. Despite 01.2 and 01.3 requiring little more than knowledge from the core physics specification, answers that demonstrated an understanding of the processes involved were rare. By contrast, 01.4 was well answered with over 40% of students obtaining both marks. A common error here was to reverse the relative magnitude of the specific charge for the proton and electron.

Question 2

This question was about the development of quantum theory. 02.1 was the poorest performing question on the paper. Many incorrect answers attempted to explain the nature of a black-body rather than to answer the question as written. It was clear from some answers that a significant number of students were unfamiliar with the term. Despite not being answered by over 15% of the students, 02.2 did yield a good spread of marks. It was common to see evidence of some

familiarity with the ultra-violet catastrophe. Many students made no attempt to annotate the graph despite the explicit prompt to do so. Answers to 02.3 suggested that many students were unable to express clearly Max Planck's contribution to quantum theory. Vague and incomplete answers were common. 02.4 had a maximum of 6 marks and, in common with previous series, the level of response mark scheme discriminated very well, with answers seen across the full mark range. Students whose knowledge of the photoelectric effect was limited to what is on the core specification were still able to pick up some marks. In the best answers, students made it very clear whether a point referred to an observation, a failure of classical theory, or to Einstein's solution. Answers scoring low marks were usually too vague and incomplete.

Question 3

This question required knowledge and understanding of quantum tunnelling, a specialist area of this Option. It was rare to see an answer that suggested the student had any familiarity with the process or its application in the scanning tunnelling microscope (STM). In particular, few students demonstrated an appreciation of the role that probability or wave-particle duality plays in the STM. In 03.3, many students were able to obtain a value for the de Broglie wavelength of the electrons but few managed to make a correct judgement linking this value to the size of an atom. Again it should be noted that the de Broglie wavelength equation is part of the core specification. A surprisingly common error was the use of the speed of light for the speed of the electron.

Question 4

This question dealt with special relativity and the behaviour of muons. It was disappointing to see how many students attempted to answer 04.1 without any reference to relativity at all. Many of the students who made use of the correct equation unfortunately confused L_0 and L. Similarly, answers to 04.2 indicated that many students were not familiar with the muon-decay experiment, with answers frequently suggesting that the speed or the time taken were measured directly. Many answers to 04.3 either made no reference to relativity or suggested that the muons were decelerating so that the theory of relativity no longer applied. The best answers focused on one frame of reference, either the muon or the observer, and made a clear argument in terms of length contraction or time dilation. A common error was the suggestion that the half-life of the muons changed.

Concluding Remarks

In terms of difficulty, this paper was broadly similar to previous papers on this option. It is worth pointing out, however, that there may have been a greater emphasis on contexts unique to this Option, with less overlap with core physics than there has been in the past. This means that, for example, specific knowledge was expected on Thomson's experiment, black-body radiation and quantum tunnelling. Whilst the questions were not in themselves more difficult, the need for a better understanding of some of the detail specific to the Option may have made the paper less accessible to many of these students.

In common with previous series, question parts that assessed AO3 and required students to make a judgement were generally answered less well. The AO1 question part on the significance of Thomson's discovery and the AO2 question part that required the calculation of a relativistic length proved to be the most accessible.

Mark Ranges and Award of Grades

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