A-LEVEL
PHYSICS

7408/3BD Turning Points in Physics
Report on the Examination

7408
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Question 1

01.1 Although many students could identify the importance of the momentum carried by the particles in this question, not all went on to the explain that this momentum was transferred to the paddle wheel. A good number of students identified that the direction of travel of the cathode rays from cathode to anode was indicated by the direction of rotation of the paddle. Most students scored one of the two available marks, but few scored both.

01.2 This question was not well answered by significant numbers of students. Common mistakes included describing the processes of thermionic emission and photon emission following de-excitation. A small number of students recalled, to a high level of detail, the process of ionisation and subsequent role of the positive ions in generating the electrons that go on to become cathode rays. A good number of students were able to describe the acceleration of the electrons toward the anode as an important factor in generating cathode rays.

01.3 Responses to this question were good. Most students were able to explain how the lower number of air molecules would either reduce the electrons available to generate cathode rays, or result in the cathode rays present having more energy. Some students did not fully develop the latter argument to the point where cathode rays carried more energy, but were given some credit if they explained that collisions with air molecules would be reduced. A significant number of responses were limited to ideas about air resistance, which was not accepted.

Question 2

02.1 Although many responses were detailed and showed understanding of Fizeau's experiment, few students explained with sufficient precision observations A and B. For observation A, a response explaining that light returned through the same gap was expected, while for observation B the correct response was that the light was blocked by the adjacent tooth.

02.2 Few students had trouble with what proved to be a straightforward calculation. An explicit value for the accepted speed of light, to at least two significant figures, was expected, along with a statement of comparison to the calculated value. A large number of students failed to work with this level of care and attention to detail.

02.3 An answer that was based on recall was not accepted as a deduction. Only a small fraction of students were able to construct a convincing deduction, although a good number were able to give the correct value for the frequency of rotation. The minimum expected as a deduction was that the light would be blocked at the next tooth.

02.4 A good proportion of responses were well rehearsed to form a clear chain of logic between Maxwell's predicated speed for EM waves, congruence with Fizeau's result, and the implication that light is an EM wave. Some students went only as far as stating that Maxwell's theory predicted a value for the speed of light, meaning that the argument could not be completed. Another common mistake was to focus on various experimental results that show the wave nature of light or other electromagnetic waves.

Question 3

03.1 A very high proportion of students scored this simple recall mark.

03.2 The calculation was done well by many students. Some students used an energy argument rather than the more straightforward direct substitution from the formula sheet. Where students did follow an energy argument, a common mistake was to confuse potential difference with velocity. Students in general were reasonably successful in arguing whether the electrons could resolve atoms. Few students were able to recall and use the approximate size of an atom and compare their value for the de Broglie wavelength with this; for those who did make some progress in this regard, a common mistake was to confuse the dimensions of the atom and nucleus.

03.3 This question produced a wide range of levels of performance. Many students used the diagram provided to help structure their response to how the image was formed, and could support their answer with some detail about how the quality of the image was affected by the speed of the electrons. This meant that most responses fell into the middle band of performance, which was encouraging. The best responses named and described the function of three lenses well and went on to explain how resolution depended on the speed, and hence de Broglie wavelength, of the electrons. Some students were also able to detail how speed varied due to sample thickness and thermionic emission. Very few students explained sufficiently well how the electrons that travel through the centre of the TEM are unaffected by the lenses.

Question 4

04.1 A significant number of answers to this question scored full marks. Some students neglected the instruction to support their answer with a time-dilation calculation. In addition, where students' strategy was sound but marks were lost, this tended to be for not fully answering the question which required a judgement on both aspects of the student's prediction, i.e. the time being longer and the magnitude of several days.

04.2 The answers given often showed a sound level of knowledge and understanding. Many students identified that the spacecraft would be accelerating, and a requirement of Special Relativity is that the frames of reference are not accelerating. Other students who scored full credit stated that the spacecraft is not an inertial frame of reference, and inertial reference frames are a requirement for Special Relativity. A commonly seen answer that scored partial credit explained what an inertial reference frame was, but did not go on to explicitly state that this was a requirement for the application of Special Relativity.

Question 5

Nearly all students were able to convert the energy given in eV into J. A good number of students went on to complete the calculation successfully. A common error was the incorrect use of the $E_K = mc^2 - m_oc^2$ equation.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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