AQA

A-LEVEL
PHYSICS

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

7408
June 2018

Version: 1.0

General Comments

Apart from question 3, most parts of each question proved to be accessible to many/most students. Apart from part 03.1, which was answered quite well, a majority of the students had insufficient understanding of the experimental arrangement in question 3 to deal successfully with the questions asked. The question is dealt with in more detail below. The other part that presented particular difficulties was the 6-mark question, 04.1, in which relatively few students were able to give a convincing discussion that was worthy of a mark in Level 3. The other parts that were answered surprisingly poorly were 04.2 and 04.3 where the statements of the postulates were frequently incorrect or incomplete.

Question 1

01.1 Most students made some progress with this question (69.6% of students scored at least two marks). Those failing to be awarded the first marking point made no mention of the electrical heating *due to the current* in the filament. Many simply restated the stem, stating that electrons were emitted, without further detail. Thermionic emission was frequently mentioned in the response. Weak answers referred to electrons being “dragged” out of the filament by the positive anode.

01.2 Presentation of the derivation was often very poor, with the space for the response being occupied by a jumble of equations that were unrelated. Over half of the students scored both marks, however. Whilst giving one correct equation with v as the subject was treated generously, students needed to produce an unambiguous and acceptable structured response to gain full credit. Questions of this type are common and it is expected that students should derive the given equation from more basic equations. It was **not** acceptable to substitute data in the given equation to produce a value that agreed with the accepted value for *e/m.* This was tested in part 01.3.

01.3 Students needed to show all data substituted to gain full marks. Most appreciated that the answer needed to be given to two significant figures for consistency with the significant figures in the data used. 58.8% of students were awarded both marks.

01.4 Weaker answers to this part referred to the greater specific charge for the electron meaning it was *smaller* rather than it having a lower mass. There was a high proportion of completely correct responses (54.4%) and nearly 80% of students scored at least one mark.

Question 2

02.1 There were two particular reasons why students failed to gain marks in this question. The first was that the amplitude cannot be negative, and the second was a failure to include any scale on the angle axis. Sketches were often quite poor, but these were treated generously providing the important features were shown. Some attempt to show curvature was expected to gain the final mark. Full marks were awarded to 42.5% of students.

02.2 The straightforward substitution of data and computation gained the first mark. Substitution of the data was expected. The second mark was less frequently awarded (28.9% of students). The fact that Maxwell's result agreed with a measured or experimental value was essential. That Maxwell's equation for the speed gave a value that agreed with the 'accepted value' was insufficient.

Question 3

03.1 All parts of question 3 exposed misunderstanding about the photoelectric effect. Part 03.1 tested application of the photoelectric equation. Firstly, to determine the wavelength, data in eV had to be converted to Joule somewhere in the response. The 0.50 V was the stopping voltage which relates to the maximum KE of an emitted electron in eV. This, added to the work function, gave the energy of the photon which produced this electron in eV. Then the equation $\lambda = hc/E_k$, with E_k in J, gave the answer. There was a good proportion (over 40%) of correct answers. The most common incorrect response used the work function alone to determine the wavelength with various other combinations of the energies in eV or J. Some made incorrect attempts to convert eV to J.

03.2 A large number of students seemed not to have read this question carefully enough – there were relatively few convincing responses. Many responses explained why the photon model could explain why there is threshold frequency, which is not what was asked. In this question, there is no change to the incoming radiation other than intensity. Some students commented that as intensity increased there would be more photons arriving, so the number of photoelectrons produced would increase, so current would increase. However, what determines the current is not the number of electrons that are emitted but the number that can reach T. As the photon energy is fixed, students needed to appreciate that current could only increase if more electrons could reach T. As the maximum KE of the photons is the same, even though there are more of them, none can reach T so the current is unchanged. A high intensity wave could transfer, resulting in electrons with more KE, so these could reach T, producing a higher current. Over half of the students failed to score on this question.

03.3 Just over a fifth of the students were able to make a comment that gave access to the first mark in the marking scheme, but very few of these referred to the current depending on the rate at which electrons reached T. In this part, the key knowledge of the photoelectric effect is that electrons are emitted with a range of kinetic energies. Students needed to appreciate that initially a current exists because, as there is no stopping voltage, all emitted electrons can reach T. As T becomes increasingly negative with respect to the metal surface, more and more electrons with KE less than the maximum KE cannot reach T. Nearly 70% of students made no headway at all with this question.

03.4 40% of the students identified the correct response.

Question 4

04.1 Students needed to demonstrate a clear understanding of the prediction, the experiment itself and the conclusions, as outlined in the bullet points in the question. Even the better students rarely addressed the first bullet point in the question with any conviction, so were limited to a mark in the middle level. Many responses showed only a superficial understanding of the experiment, with many appreciating no more than that rotating the apparatus was expected to produce a fringe shift and as there wasn't one, there is no ether.

Those who had more knowledge of the experiment itself often failed to provide adequate detail in their responses, particularly the detail relating to anticipated effect of the ether, the change in times of travel for the light waves, and the expected changes in phase difference when the apparatus was rotated. Responses from many students indicated a lack of understanding of how fringes were formed and no appreciation that there would be fringes seen whatever the orientation of the apparatus.
For full notes on the experiment see:
http://filestore.aqa.org.uk/resources/physics/AQA-7407-7408-TG-TPIP.PDF

04.2 Those who failed to gain the mark (72% of students) usually did not state the speed invariant *in free space*.

04.3 Approximately 30% gave an acceptable form of the other postulate.

04.4 This was answered well, with just over 50% of students gaining three or four marks. Both approaches attracted roughly equal numbers of students. A read-off from the graph was adequate for the final step, but many did correct but unnecessary calculations of the number left. There was a significant minority of students who gave the number that decayed as their final answer having correctly determined the number remaining.

Mark Ranges and Award of Grades

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