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Physics A PHYA1

(Specification 2450)

Unit 1: Particles, quantum phenomena and electricity

Report on the Examination

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General Comments

The paper allowed students to apply their knowledge and understanding effectively in most topics in the unit. However, it is fair to say that a significant proportion of students found the questions involving electric circuits more challenging than other topics assessed. Nevertheless, the performance of students overall does provide evidence that in the majority of cases students had benefitted from careful preparation.

The topics that caused the students most problems were detailed circuit analysis and the prediction of changes that occur in circuits when one of the components has a change in electrical properties. This was particularly true of question 6 in which parts (b) and (c) proved to be the least accessible questions on the paper. To balance this, students were more confident describing an electrical experiment than has sometimes been the case in the past and the evidence for this is found in their responses to question 5 (b).

Students did find questions 1 and 4 the most accessible, although the explanation of excitation by photon absorption was often not convincing with a significant proportion of students confusing this with the photoelectric effect. Presentation was good, and there seemed to be fewer examples of answers exceeding the allotted space. The dedicated marks for units and significant figures did not present students with too many problems. Students usually showed full working for calculations and this seemed to help them arrive at the correct answer or allowed for consequential error marks to be awarded.

Question 1

Previous papers have indicated that students have a good understanding of the quark structure of hadrons and this was certainly the case in this examination. The table in part (a) was completed well and full marks were frequent. The remainder of the question was also answered well and students now seem well aware that a similarity between particles and their corresponding antiparticle is rest mass.

Question 2

Part (a) was answered well and the evidence suggests that specific charge is a topic that is now much better understood. It has often been found in previous papers that explanations which go beyond standard definitions usually produce considerable discrimination.

This was certainly the case in part (b) (i) and it was quite common for less able students to write confused and contradictory answers. A common mistake was to assume that X and Y were isotopes. Some students also thought that the question was about ions rather than nuclei.

Part (b) (ii) produced better responses although the route to a candidate's final answer was sometimes difficult to follow. A significant number of students gave answers with no working which is bad practice; especially for a question allocated four marks.

Question 3

This question was generally answered well although, while students explained the basics of pair production, it was quite rare for them to mention the necessity for the photon to interact with a nucleus. Momentum was referred to by some of the more able students, but this was more often related to the particle and antiparticle after production, rather than the initial photon.

The remainder of this question was answered well, with students confidently explaining why the frequency of the photon must not be below a certain value. They also were able to select appropriate quantities that need to be conserved during the process of pair production.

Question 4

Many students were able to distinguish between excitation and ionisation successfully and also to define the ground state. They clearly found the structured format of this question helpful. However, students were not so good at explaining the process of excitation of atoms by the absorption of photons. It was common to see muddled answers that confused the photoelectric effect with excitation. The term *work function* was often used incorrectly in candidate responses as was threshold frequency. A significant minority focused on the photon released after excitation rather than the incident photon.

The calculation in part (c) was generally done well and most students gave answers to the correct number of significant figures. A common error by some students was to fail to convert electron volts to joules, this mistake limited them to a maximum of two marks.

Question 5

Part (a) (i) required students to draw a suitable arrangement for investigating the variation in resistance of a piece of wire with temperature. Many students drew an appropriate circuit and misplaced voltmeters were far less in evidence in circuit diagrams. However, the majority did not show how the temperature of the wire was to be varied, in spite of being given the hint that the temperature range should be varied between 0°C and 100°C.

The description of the experiment required in part (a) (ii) was answered better than has previously been the case. Nevertheless, a significant proportion of students did not provide suitable methods for temperature variation. Suggestions such as 'vary the temperature using a thermistor' or 'direct use of a Bunsen burner' were not uncommon. It was clear that some students did not appreciate that the wire could be safely placed in a water bath.

Part (b) on critical temperature was answered well.

Question 6

With the exception of part (a), students found this question particularly challenging.

The calculations in part (b) were very structured but this did not seem make the analysis of the circuit straightforward. In part (b) (i), less than half the students were able to calculate the pd across the resistor correctly with many not appreciating that the pd across the a parallel network was the same as the pd across lamp X. Part (b) (ii) produced better answers, although a significant proportion of students did not appreciate that they simply needed to add together the two currents calculated in part (a).

Part (b) (iii) was answered well, although many students benefited from being allowed to use incorrect answers from parts (b) (i) and (ii). The remainder of the circuit analysis did cause problems due to many students not realising that the pd across R_2 was simply the difference in the pd's across the lamps or that the current through R_2 was the same as the current in lamp Y.

Part (c) required students to consider the effect of lamp X ceasing to conduct. In part (c) (i) they had to explain the effect on the voltmeter reading. This was not answered well with a significant proportion of students thinking the voltmeter reading would increase. This was mainly due to the mistaken assumption that the current in the circuit would increase. Part (c) (ii) generated more correct responses because many students stated that the current through lamp Y would increase, although it was clear from their answers many thought that this was due to the current from lamp X now going through lamp Y. It was not commonly appreciated that although the overall current in the circuit had decreased, the current through R_2 and lamp Y was higher than it had been when lamp X was conducting.

Question 7

Students fared better in the circuit analysis involved in this question than they did in question 6. Parts (a) (i), (ii) and (iii) were answered well with a significant proportion of students able to correctly find the total circuit resistance. The calculation of the parallel network was done correctly by the majority of students, although the working shown by many was sometimes not set out properly with the reciprocal of total resistance being equated to the total resistance. This was in part due to the combined resistance being equal to 1 Ω.

Part (a) (iv), in which students had to calculate the energy transformed by the battery in 5.0 minutes, was not answered as well. A significant proportion of students did not appreciate that this was found by multiplying the emf of the battery by the appropriate time. Part (a) (v) caused students even more problems and only a minority of the more able students were able to correctly calculate the energy dissipated in the internal resistance of the battery.

The final part of this question was well answered with most students giving sensible suggestions. However, one out of two marks was quite common due to students mixing up an explanation with a reason; an example being ‘has a higher terminal pd’ and ‘provides large current’.

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