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General Certificate of Education

Physics 1450

Specification A

PHYA1 Particles, Quantum Phenomena and Electricity

Report on the Examination

2010 examination - June series

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GCE Physics, Specification A, PHYA1, Particles, Quantum Phenomena and Electricity

General Comments

The paper gave candidates the opportunity to apply their knowledge and understanding effectively and although some of questions proved quite challenging, there was evidence of some careful preparation. The topics that seem to cause candidates the most problems were the explanations of quantum effects such as; the photoelectric effect, the variation of the strong interaction with distance, and the description of an experiment to investigate the variation of the resistance of a thermistor with temperature. Candidates found questions on quark structure and nuclear interactions quite accessible. As in previous series, candidates seemed more confident doing calculations than they were giving explanations – this was particularly noticeable in the questions on electricity. Presentation was good, although a number of answers went over the allotted spaces for questions. The dedicated marks for units and significant figures did not present candidates with too many problems. However, a number of candidates did quote their answers to three significant figures rather than two. Candidates usually showed full working for calculations but this was sometimes poorly set out and this tended to increase the likelihood of careless mistakes.

Question 1

This question was well answered and candidates' demonstrated a clear understanding of quark structure and were able to identify particles as baryons or leptons successfully. The only common error arose when there was confusion between β^- and β^+ decay. This resulted in candidates giving the wrong proton number and also incorrectly identifying an antineutrino as a lepton formed due to the decay. The questions on the quark structure of protons and neutrons and the Feynman diagram for the interaction were answered well by the majority of candidates.

Question 2

Candidates found part (a) quite challenging. The majority recognised that the strong interaction is repulsive at small distances and attractive at larger distances. However, many candidates tended to either not give quantitative answers or quoted distances that were not acceptable. Answers were often muddled making them difficult to interpret. Although many candidates stated the interaction was short range, it was frequently not clear what they understood by this. Responses such as 'the force decreases to a small value' were common.

Part (b) was answered much better and the majority of candidates indentified the nature of the alpha particle, completed the equation correctly and explained what is meant by isotopes.
The final part of the question was quite discriminating and it was clear that the better candidates found the deduction quite straightforward, arriving at a correct answer with the minimum of working.

Question 3

The initial parts of this question caused considerable problems to candidates. They found it very difficult to explain why the kinetic energy of the emitted electrons had a maximum value and also fully explain the link between photon energy, work function and maximum kinetic energy. The idea that some electrons require more energy to be emitted than others did appear to be well understood. Candidates also had a tendency to confuse the photoelectric effect with excitation and ionisation. Evidence from this and previous papers suggests that this is a topic candidates find very difficult and this is particularly true when they are required to explain aspects of the phenomena.

Parts (b) and (c) proved much more accessible and candidates used the various relevant equations confidently. Full marks for calculations were quite common. Part (c) (ii), which assessed *How Science Works*, did confuse some candidates. When this happened, candidates tended to explain the significance of validated evidence in general terms, rather than how it was used to develop the particle model of light.

Question 4

This question was well answered and the majority of candidates appreciated that diffraction is a wavelike property that electrons exhibit. The calculation in part (b) proved to be quite straightforward and full marks were obtained by a pleasing number of candidates.

Question 5

A significant proportion of candidates found part (a) difficult. It seems that many candidates were not familiar with an appropriate experiment that enables the variation of a thermistors resistance with temperature to be investigated. While many drew a correct circuit diagram, few were able to explain suitable techniques for varying the temperature of the thermistor. It was common to see answers that confused this experiment with one that investigated the $I – V$ characteristics of a filament lamp. This led candidates to suggest that it was appropriate to investigate resistance change by using increasing current to change the thermistor resistance. There was also much confusion as to how resistance was to be determined and the use of a graph of current against voltage was a regular response. Candidates incorrectly stated that they would determine the resistance of the thermistor by measuring the gradient of the graph. This would not be an appropriate method as the graph would be a curve and the gradient of the curve is not the resistance. It was extremely rare for water baths to be used for heating the thermistor and also many did not explain how they would measure the temperature of the thermistor. Many candidates did not address the issue of precision in a convincing way and failed to describe how they would make all the measurements needed. It is clear from this paper and from previous papers that candidates find describing experiments difficult and would benefit from some practice of this skill.

In contrast parts (b) and (c) were generally answered well and full marks were frequently seen. Less able candidates found it difficult to explain clearly the effect on the voltmeter reading if the battery did have an appreciable internal resistance. There is some evidence that candidates did not understand the meaning of the term negligible.

Question 6

This question was answered well although a minority stated that non-ohmic conductors did not follow Ohm's Law without explaining the consequence of this. The *I–V* characteristics of the filament lamp seemed to be quite familiar but some answers were spoilt by carelessly drawn graphs that were either horizontal at the end or were not noticeably symmetric in the two quadrants.

The calculation in part (c) was well done but the deduction required for part (c) (ii) proved quite discriminating and only the most able candidates obtained all three marks. Many identified why the power might be 9.0 W, but were unable to explain why, in practice, the power rating is slightly different.

Question 7

Candidates' performance in this question was generally poor and it appears that the effect of internal resistance on terminal pd is not well understood. While many came up with an acceptable definition of emf few were able to explain convincingly the effect on the voltmeter if the switch is closed. A significant proportion of candidates assumed a current was flowing when the switch was open and it was quite common to see statements such as '*when the switch is closed voltage stops flowing through the voltmeter and so its reading decreases',* which supports the view that potential difference in circuits is a concept that many candidates struggle with. Further evidence of this was provided by the explanations given in part (c). Many candidates did not seem to appreciate the reason why a car battery needs to have a low internal resistance.

Mark Ranges and Award of Grades

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