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General Certificate of Education

Physics 1451

Specification A

PHYA1 Particles, Quantum Phenomena and Electricity

Report on the Examination

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Dr Michael Cresswell Director General.

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

General Comments

The paper gave candidates the opportunity to apply their knowledge and understanding of the topics in the unit. It was clear that in the majority of cases candidates had benefitted from careful preparation although some aspects of the paper did prove quite challenging. The topics that seem to cause the candidates the most problems were the explanations of quantum effects such as the photoelectric effect and the excitation of mercury atoms in a fluorescent tube. It was also clear that candidates find it difficult to describe experiments in detail and the evidence for this is found in their responses to question 5 (b). Candidates did find question 1 and 7 the most accessible and as has been the case in the past, seemed more confident doing calculations than they were giving explanations. 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 but 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 often poorly set out, frequently resulting in incorrect answers due to unnecessary arithmetical errors.

Question 1

This question was well answered and candidates' responses suggested that the structure of hadrons is well understood. In part (a), less able candidates tended to give specific examples for baryons and mesons rather than their general quark structure. They also stated that the defining property of hadrons was that they were composed of quarks despite the fact that this was stated in the stem of the question.

Responses to part (b) were generally good although some did state that particles and antiparticles had different charges rather than opposite charges.

The table in part (c) did cause a significant proportion of candidates' problems. The most common error was to identify the charge of the antiproton as -1 even though the unit, C, was given in the heading of the table.

Part (d) was answered confidently although a significant proportion of candidates did seem to think that strangeness was conserved in this decay.

Question 2

Part (a) proved to be quite discriminating and less able candidates found it hard to explain the process by which mercury atoms become excited in a fluorescent tube. There was also evidence to suggest that some candidates think that excitation only occurs due to the absorption of photons and seemed unaware that it can also happen by electron collision. Most candidates seemed to appreciate that the mercury atoms emitted photons that were in the ultraviolet part of the spectrum and that the coating changed the frequency of these although there was a tendency to describe these photons as photons of light or coloured light rather than visible light.

Part (b) was answered well and the only common error was a failure to appreciate that the energy levels were in Joules and that the value adjacent to each level needed to be multiplied by 10^{-18}. A minority of candidates either emitted this factor or assumed that the energies were in electron volts and multiplied them by 1.6×10^{-19}.

Question 3

This question was well answered and candidates seemed confident in their understanding of beta decay. They were for the most part well aware of the changes that occur during the decay. The equation for beta decay was only awarded one mark and a few candidates lost this mark due to careless errors such as missing out the bar on the anti-neutrino. There were many impressive explanations of why a neutrino was not produced, providing evidence of a good understanding of the conservation of lepton number.

Part (b)(iii) assessed candidates understanding of how science works and many candidates' responses suggest that they are quite familiar with the concept of validated evidence.

Question 4

Part (a) was not answered well and there was much confusion as to the processes involved in the photoelectric effect. As has been the case in the past, a significant number of candidates confused the effect with excitation and ionisation of atoms. Only a minority of candidates were able to link the energy of a photon to its frequency and there was much confusion between threshold frequency and the work function. It was not unusual to see responses that stated the threshold frequency has to equal the work function. It also seems that some candidates are under the impression that the photoelectric effect involves the emission of photons – presumably due to confusion between excitation and line spectra.

Part (b) proved to be a familiar calculation for the majority of candidates and many competent answers were seen. The only significant misunderstanding occurred in (b)(iii) when candidates assumed that the kinetic energy of the electron is found by using the equation for the energy of a photon.

Question 5

Part (a) proved straightforward and many candidates were able to calculate the resistance of the putty correctly. A minority of candidates did confuse resistance with resistivity and did not rearrange the equation from the data sheet. This question assessed significant figures and it was clear that there are still many candidates who do not appreciate that their final answer should reflect the precision of the data and in this case they should give their answer to two significant figures. The deduction in part (a)(ii) was quite discriminating and the better candidates were able to give convincing explanations as to why the resistance increased by a factor of 16. Less able candidates appreciated the effect of increasing the length but were unable to combine this with the reduction in radius and a factor of 8 was often deduced.

Part (b) assessed quality of written communication and this question proved quite challenging for the majority of candidates. It was extremely rare for candidates to obtain full marks and most answers were either modest and/or limited. The circuit diagrams seen were often penalised for careless errors such as incorrect symbols or the wrong positioning of meters.

It was rare for candidates to include a means of obtaining more than one result such as varying the length of the putty or using a variable resistor. Descriptions were often vague and hard to follow. 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.

Question 6

The majority of candidates seemed to approach this question with confidence and set out their working well. Many did not appreciate the effect of connecting the two identical cells in parallel and it was quite common to see them using the combination of parallel resistors formula to combine the emfs of the two cells. This was something that was not confined to the less able candidates but was seen across the full ability range. This was not a heavy penalty as subsequent answers received full credit whatever value candidates had deduced for the total emf.

Part (a)(iv) assessed the unit for charge and the majority of candidates had no problems with this.

The deduction required for part (b) proved quite discriminating and only the very best candidates obtained all three marks. The first mark for identifying cells C and D proved quite straightforward but the explanation less so. Many candidates appreciated that the greater current in the cells in series was significant but were unable to take this to the next step and link this with the rate of energy dissipation.

Question 7

This was the most accessible question in the paper and candidates are clearly familiar with the use of an oscilloscope and the idea of peak and rms voltages. The only consistent error was the failure to convert the time period to seconds when calculating the frequency.

Mark Ranges and Award of Grades

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