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General Certificate of Education (A-level)
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Physics A PHYA1

(Specification 2450)

Unit 1: Particles, quantum phenomena and electricity

Report on the Examination

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

General Comments

A significant number of candidates took the opportunity this examination provided to produce confident responses to questions. An impressive proportion of candidates scored high marks. The mean mark for the paper increased markedly from summer 2010, providing further evidence of the accessibility of the paper. The topic that seemed to cause the candidates the most problems was the understanding of the effect of internal resistance of cells on their terminal pd. There was also evidence that the process of electron capture is not understood well.

Candidates were able to effectively demonstrate their knowledge of particles and found the question on excitation and line spectra more accessible than previous descriptive questions on quantum effects such as the photoelectric effect. Presentation was generally good and space used well. The dedicated marks for significant figures did not present candidates with too many problems and the two unit marks were well answered. The marks for the quality of written communication were generally higher than has previously been the case due to fewer instances of candidates mixing up different quantum effects.

Question 1

This question was answered well and provided limited discrimination between candidates. Most were able to successfully identify two baryons and also deduce the quark structure of the pion, π^+. Less able candidates found it hard to indentify which of the K^+ decays in part (b)(ii) were possible and they provided explanations that were not convincing.

Part (c) was answered very well with the majority able to identify the weak interaction and correctly apply charge and baryon conservation. Most candidates were well aware that the proton is the most stable baryon.

Question 2

This question was more discriminating. The majority of candidates were able to state what is meant by isotopes. However, less able candidates found it hard to complete the equation for alpha decay and the calculation for specific charge of the alpha particle also caused them problems.

A significant number of poor responses were seen to part (iv), these were mainly the result of the alpha particle being considered in isolation rather than describing the short range of the strong interaction and linking this to the effect of the nucleus, Y, on the alpha particle.

Question 3

Part (a) required candidates to complete the equation for positron decay and the majority were able to do this successfully. The only common error was the inclusion of an antineutrino rather than neutrino and confusion with β^- decay.

Parts (b)(i) and (ii) caused far more problems and the majority of candidates did not identify the decay as electron capture and were then unable to explain where the electron came from – most seeming to think that it was a free electron. The remainder of this question was answered well and many candidates were able to explain the conservation of lepton number and to successfully complete the Feynman diagram. However, there was sometimes confusion over the exchange boson and some candidates did omit arrows from the lines representing the products of the decay.

Question 4

Descriptive questions on quantum phenomena have caused candidates major problems in previous papers. Therefore, it was good to see so many confident answers to this question. Candidates seemed much more confident explaining excitation and line spectra than they are describing aspects of the photoelectric effect. Far less confusion was evident and a number of answers were awarded marks in the top band – a significant increase on previous questions that assessed the quality of written communication. Some less able candidates incorrectly tried to include a discussion of threshold frequency but this was comparatively rare. The correct use of technical terms such as ionisation and excitation were seen frequently and there was strong evidence that this aspect of quantum phenomena is more widely understood that is the case in other related areas of the specification.

Part (b) was generally answered well, although a minority of candidates incorrectly related the ionisation energy of hydrogen to a mole of hydrogen atoms. The conversion of electron volts to joules caused few problems and the majority of candidates appreciated that their answer should be quoted to three significant figures.

Question 5

Previous papers have suggested that the majority of candidates have a good understanding of the use of an oscilloscope as a voltmeter and this proved to be the case here too. The vast majority were able to successfully complete both parts of the question and only a few confused peak to peak with peak voltage. Most candidates provided evidence that they understood why a vertical line is produced if an alternating voltage is applied when the time base is switched off. However, some answers were spoilt by a lack of precision in explanations of how the voltage was varying – references to alternating currents rather than voltages were common.

Question 6

Part (a) of this question generated some of the poorest responses in the paper with over three quarters of the candidates obtaining no marks. The evidence suggests that candidates find the concept of internal resistance and its relationship with terminal pd quite challenging and were unable to convincingly explain what was happening in this circuit as the current increased. A significant number of candidates assumed that the terminal pd decreased because the internal resistance was increasing due to an increase in temperature of the cell. There was also a lack of precision in answers making it hard to determine which resistance was being referred to in many explanations.

In part (b), the majority were able to find the emf of the cell correctly but the determination of internal resistance, r, proved to be much more discriminating. The more able candidates appreciated that the gradient of the graph was equal in magnitude to r and those who did, for the most part, produced acceptable answers. Alternative solutions using the equation, $\varepsilon = IR + Ir$, were less successful as there were often careless mistakes made when this approach was used – an example being the calculation of R using terminal pd and current and then using this value with a different value of current to find r.

Part (c) required candidates to add lines to the existing graph. Most appreciated that these two lines had the same intercept as the original line and a significant number realised that the line for the cell with double the internal resistance would have a gradient double in magnitude. The line for the cell with zero internal resistance caused more problems and less than half the candidates drew horizontal lines.

Part (d) produced some mixed responses. The calculation of charge was successfully answered by the majority and the unit for charge is clearly well known. However, the calculation of energy dissipated in the internal resistance per second caused far more problems and over half the candidates did not score any marks in this section – many applied the wrong equation and this resulted in them either multiplying the terminal pd or the emf of the cell by the given current.

Question 7

This question proved to be very discriminating with only the high performing candidates able to score high marks. The calculations involved in part (a) proved to be straightforward and the majority of candidates realised that this was 5.0 Ω. Part (a)(ii) caused more problems and there were many answers in which the calculation of the resistance of the parallel component was spoilt by poor setting out – equating
½ to 2 Ω was a common occurrence.

Part (b) required candidates to calculate currents in the parallel branches of the circuit. Many tried to do this by ratio and got the currents the wrong way round, ie quoting a value of 0.67 A instead of the correct 1.3 A. A more successful approach, used by more able candidates, involved the calculation the pd across the series resistor and hence the deduction of the pd across Y. Once this was known the current in Y could be correctly calculated. This approach also enabled candidates to give the correct pd across W because they realised it was half the value of the pd they had already calculated for Y.

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