GCE

Physics

PHYA1 – Particles, quantum phenomena and electricity
Report on the Examination

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General Comments

The performance of candidates in this unit was generally good and in some cases extremely impressive. In previous series there has been a tendency for candidates' responses in the Particle Physics questions to be stronger than they are in questions on Quantum Phenomena and Electricity. It was noticeable in this exam however, that the questions on electricity were answered with much more confidence and it was only really question 5 (c) on the oscilloscope that caused significant difficulty with just over 10% of candidates managing to score full marks.

Other questions that proved to be quite challenging were 1 (iii), which involved specific charge and 4 (a) which concerned the photoelectric effect. Candidates did particularly well in question 3 on particles which included the assessment of the quality of written communication.

Evidence from scripts suggests that they were far more confident writing extended answers involving Particle Physics than is usually the case with questions on the photoelectric effect or line spectra. Presentation was good and candidates for the most part showed their working in a logical way that was easy to follow; the only common exception to this being 1 (iii) where candidates often ignored the mass of the electrons. The assessment of a unit and significant figures did not cause candidates problems but there was tendency for candidates to leave answers as fractions or in surd form without calculating a final answer.

Question 1

This question required a knowledge of atomic structure and specific charge and part (i) was unsurprisingly, extremely well answered.

Part (ii) caused more problems with a significant proportion of candidates either giving a charge equivalent to 20*e* or 18*e*. The calculation of specific charge has often proved to be quite discriminating with the specific charge of an ion causing candidates the most problems. On this occasion candidates performed slightly better partly due to them having been asked for the charge in part (ii) and not being penalised when carrying their answer into part (iii).

A significant proportion of candidates completely ignored the mass of the electrons and although their mass does not significantly alter the specific charge they were required to include it or to justify it being disregarded.

Question 2

Feynman diagrams often prove to be somewhat discriminating and in line with this, performance in question 2 was quite patchy. On this occasion candidates were not required to draw or complete a diagram and this tends to make the question more accessible.

In practice less than 50% of candidates were able to correctly identify the particles with the commonest errors being the identification of the positron and the neutrino – confusion with β^- decay being the most frequent mistake.

Parts (b) (i) and (ii) were very well answered but this was not the case with (b) (iii). Less than 40% of candidates were able to give a difference between the exchange particle and a photon or gave one word answers such as charge or mass. Their responses were required to be completely clear, matching a stated property with the relevant exchange particle or photon.

Most candidates were able to state two other conserved quantities in part (c) but the demonstration of conservation were often less convincing. As with part (b) (iii) there was often a lack of clarity with things such as lepton number, charge or baryon number not being related to particular particles.

Question 3

This question on particle classification generated some very impressive responses. Many candidates proved to be quite confident in their extended writing and top band answers were seen more frequently than has been the case in the past, particularly when questions refer to the photoelectric effect or line spectra

The main confusion that weaker candidates seem to have was an appreciation of which groups are affected by the strong nuclear force – a significant proportion seemed to think that this was only baryons

The most common omission in good answers was the identification of a similarity between hadrons and leptons. Overall however, the question worked well and candidates clearly enjoy this aspect of the specification and evidence for this is found in the confidence shown in many of the answers.

Question 4

This question was concerned with aspects of the photoelectric effect and this is a topic which has caused candidates real problems in previous series. This also proved to be the case in this exam.

Part (a) was not well answered and only about 5% of candidates scored full marks. In a significant proportion of scripts confusion with excitation was apparent and this restricted candidates to the first mark. Another common error was to assume that the photons had a range of energies and this led to a range of kinetic energies.

Part (b) was more quantitative in nature and as has been the case in the past, candidates performed better with a much higher proportion of candidates scoring full marks.

Part (c) was less well done and only the more able candidates were able to explain convincingly the effects of decreasing frequency and increasing intensity on electron emission. It was common to see answers which discussed threshold frequency rather than giving more general answers which covered the reduction in frequency above this limit.

Question 5

This question on alternating currents was generally very well done. There were few major problems with part (a) although a minority did leave the rms voltage in surd form thus not completing the calculation.

Part (b) was also well answered and most candidates drew their line with care, using a ruler.

Part (c) however, was answered poorly and it is apparent that a significant proportion of candidates were not clear on how to use an oscilloscope. Reference to the time base was seen more often than reference to *y - gain* or *y – sensitivity* but frequently neither of these was mentioned. It was also quite common for candidates to assume that the vertical scale only needed to cover the peak voltage and not the peak to peak voltage i.e. eight divisions covered 64 V rather than 128 V.

On the other hand a far greater proportion was able to deduce that each horizontal division needed to represent 2.0 ms.

Question 6

Part (a) was highly structured and led candidates through a full circuit calculation in stages. This approach appeared to have helped them and more successful solutions were seen than has been the case in the past with this type of circuit.

The part that caused the most problems was (a) (ii) with a significant proportion of candidates not appreciating that the pd across the 2.0 Ω resistor was the same as that across resistor R. Candidates were however, not penalized when they carried their incorrect answer to subsequent parts and consequently the remaining calculations were often carried out successfully.

Part (b) proved to be much more demanding and only about half the candidates managed to complete the table for the rate of energy dissipation successfully.

The demonstration of energy conservation in part (b) (ii) provided an even greater challenge and only about a third of candidates provided a convincing analysis of energy conservation in the circuit. A fifth of candidates made no attempt at this part of the question.

Question 7

This question on a potential divider circuit was a mixture of qualitative and quantitative. As is often the case with questions involving electric circuits, candidates coped better with quantitative parts. This was particularly true in part (a) where the calculation involved more than one stage.

Part (b) was not well done and only the strongest candidates manage to relate the changing light intensity to the voltmeter reading. A significant proportion of candidates were under the impression that increasing the light intensity increases the ldr resistance.

Part (c) did involve a calculation but this was much more challenging than part (a) because there were no intermediate stages. Only a third of candidates were able to calculate a correct value for the resistance of the variable resistor. The majority of those who were successful calculated the value using a ratio method rather than calculating the current and then using this value with the correct pd to find the resistance.

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