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General Certificate of Education

Physics 2450

Specification A

PHYA5/2D Turning Points in Physics

Report on the Examination

2010 examination - June series

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GCE Physics, Specification A, PHYA5/2D, Section A, Nuclear and Thermal Physics

General Comments

The exam was very accessible to candidates and many good scripts were seen, some with full marks. The overall standard of writing was very good and the paper as a whole did not produce many scripts with scores in single figures. The majority of candidates had prepared well for the exam. The main difficulties for candidates were expressing their ideas clearly in the descriptive questions.

Question 1

Almost all candidates knew which equation to use in part (a) and only a small minority used the wrong temperature change.

In part (b) most candidates obtained full marks.

Part (c) turned out to be a very good discriminator. About one third of candidates were not using the heat energy released by the lead, as it cooled, in their calculation. These candidates either used their answer to (a) or (b) or the sum of the two. In addition another 10% calculated the incorrect temperature change.

Part (d) was answered well on the whole. The most common error by candidates was to not say where the heat energy might go in their answer. Candidates simply said that heat is lost.

Question 2

This question was a good discriminator. Most candidates, in part (a), knew how the core of the reactor functions. Some candidates too readily used the wording of the question as their answer. Others did not refer to neutrons even though this was asked for in the question. One example of a phrase given by candidates that did not quite answer the question but sounded reasonable was, ‘the power levels were kept constant by keeping a constant rate of fission using control rods’. This offers much of what was in the question itself and it does not refer to neutrons. The quality of the writing was generally good.

Again question (b) was a good discriminator. The majority of candidates were aware that fission products are normally unstable because they tend to be neutron rich or that they release beta and gamma rays. Less able candidates thought used fuel meant that they had undergone alpha emission.

Question 3

Less than half the candidates could explain the meaning of the decay constant. By contrast almost all candidates could find the half-life in part (b) and a majority could answer part (c). Some candidates did not gain credit because they conveniently removed 10^{12} in their calculation without showing the division. So lines like, $1.15 \times 10^{12}\,\text{Bq} = 1.15\,\text{Bq}$, were seen.

Most candidates who tackled part (d) using the exponential decay of the activity equation got full marks. Only a few candidates could not rearrange the equation. By contrast almost all candidates who tried to use the exponential decay in the number of nuclei got confused. Most had numbers of nuclei on one side of the equation but activity on the other.

Part (e) did discriminate but only between scoring zero marks or one mark. Very few candidates attempted two reasons. Most acceptable answers to this question were difficult for the candidate to express. For example, in question (d) it states that the decay rate due to carbon-14 is 0.65 Bq, indicating it is a corrected count rate. So an answer to part (e) like, 'the background can effect the result', is not acceptable. This is not the same as saying it is difficult to obtain the results for the sample activity because the background activity is high in comparison. This example is also ambiguous in that it suggests the surroundings can influence the rate of decay. Another answer that was not acceptable was, 'radioactive decay is random so it's bound to give false values'. To gain a mark following this line of thought it was necessary to refer to its effect on the statistics. The most common answers that candidates found easy to express included the following; the tree died well before the boat was made; or the boat was repaired later in its life with fresh wood; or that carbon based microbes died in the wood when the boat was rotting at the end of its useful life.

Question 4

Part (a) proved difficult for less able candidates. Some drew straight lines and others tried to force the curve to intercept the volume axis. The less able candidates sometimes marked correct points on the grid but did not draw a line. It seemed that some less able candidates followed the wrong order in tackling this part. They drew the curve before they marked points on the grid. As a result the points were just randomly placed on the curve they had drawn.

Part (b) (i) was done well by most. Candidates who used the alternative equation $PV = nRT$ often stopped when they had found the number of moles of gas. Part (b) (ii) was much more discriminating with less than 50% of candidates obtaining the correct answer. Many candidates did not have a clue whereas others could find the mean kinetic energy but then did not follow this up by finding the total kinetic energy.

Although part (c) looks like a basic question it did discriminate well. It was only the more able candidates who scored full marks. Many did not know what the question was getting at and guessed. Sometimes these candidates did score the mark associated with molecules moving in random motion. In other cases candidates did not complete their statements fully. For example, stating 'atoms travel in straight lines', rather than, 'atoms travel in straight lines between collisions'.

GCE Physics, Specification A, PHYA5/2D, Section B, Turning Points in Physics

General Comments

This was the first examination on the new specification, essentially the same option as the old specification. The questions appeared accessible to the candidates, with few blank sections seen. However, candidates often wrote carelessly or did not put over their point clearly. The Quality of Written Communication question produced very low marks and the candidates need to consider their approach to this type of question. The numerical questions also posed more problems than expected for many candidates.

Question 1

In (a) (i) most candidates understood the heating effect of an electric current, realising the beam would become more intense due to the release of more electrons, but struggled for a precise and rigorous explanation. Many thought the electrons were emitted with increased speed and a significant number of candidates did not explain the effect on the beam, as asked in the question, and simply said more electrons were emitted. In (a) (ii) most candidates identified that the electrons would be travelling at greater speed but again struggled for a complete explanation.

In (b) (i) most candidates scored one mark for identifying that the force on the electrons acted at right angles to their direction of motion. More able candidates identified the fact that the force does no work on the electrons and hence their speed remains constant. Very few candidates could go on to say that the force is always at right angles to their direction of motion and hence is centripetal.

The calculation in (b) (ii) should have been a straightforward exercise but less than a quarter of the candidates scored all four marks. The necessary equation is on the data sheet or candidates could equate the centripetal force to the force on an electron in a magnetic field. However many candidates did not know what was meant by specific charge and simply worked out the charge on an electron. A significant number of candidates used values of e or m or both from the data sheet in arriving at their value of e/m. This approach received no marks. The significant figure and unit marks were independent. Although the unit of specific charge was widely known (on the *Data and Formulae Booklet*) a large number of candidates gave their answer to three significant figures even though all the data was presented to two significant figures.

In (b) (iii) the candidates that had worked out e in (ii) went on to talk about quantisation of charge and Millikan's experiment for which they gained no credit. This question is a crucial part of the turning points option and as such was poorly answered. Very few candidates could clearly say that the specific charge of an electron was much greater than that of the H ion which could have been due to either a much greater charge or a much smaller mass of the electron.

Question 2

In (a) the calculation was considered straightforward. Even though the photoelectric equation is written on the data sheet candidates need to be aware what each symbol represents. In (i) many tried to use the photoelectric equation before realising that this part involved the stopping potential only. Others worked out the work function here and again in (ii). For the able candidates who correctly worked out the maximum ke of the photoelectrons in (i) they invariably scored full marks in (ii) as well.

In (b) many candidates knew the correct physics in this situation but the majority of answers lacked detail and a logical argument was not presented. Most candidates were content in (i) with just saying that the work function of Y was greater than the work function of X. In (b)(ii) very few candidates could clearly make a statement that the wave theory of light predicts that any incident light would cause the emission of electrons. Most picked up a mark for saying the wave theory of light could not predict the instantaneous emission of electrons.

Question 3

In (a) most candidates found it difficult to score high marks. Only about a quarter of candidates reached the high or intermediate levels and about a quarter of the candidates scored zero marks. The main reason was that the candidates did not say or realise that the essential point of this answer was that the electrons were behaving as waves. Very few realised the significance of the pd many saying that a high pd is required to pull the electrons across the gap.

In part (b), the majority of candidates could score one mark by saying that the current decreases as the gap between the probe and surface widens, but did not go on and link it to probability or tunnelling.

Question 4

In (a) many candidates were able to explain the statement by referring to the relative motion of the source or observer. Some candidates had learnt standard responses such as the speed of light is the same in all frames of reference which was insufficient to score the mark here.

In (b) there was a full range of answers. There were some blanks, there were some pages of numbers and equations getting nowhere and there were some excellent well argued four mark answers. However, the most common response was a two mark answer that found the time in the rest frame of the detectors and knew that this was two half-lives. Many candidates were unable to substitute the correct values or use the relevant equations with sufficient care.

Mark Ranges and Award of Grades

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