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General Certificate of Education

Physics 2450

Specification A

PHYA5/2B Medical Physics

Report on the Examination

2010 examination - June series

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GCE Physics, Specification A, PHYA5/2B, 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, PHYA5/2B, Section B, Medical Physics

General Comments

This was the first time that the option had been examined as a split paper with the compulsory part of Unit 5. The overall standard of the answers was disappointing with few candidates consistently producing written answers which were well expressed.

Question 1

Question 1 on lenses and defects of vision was expected to provide a straight forward introduction to the paper, but this was not the case for the majority of candidates. The ray diagram was completed correctly by a minority of candidates, many drawing the ray diagram for a converging lens. Most candidates were able to define the power of a lens and realised that a diverging lens was used to correct myopia or short-sight.

The lens calculation in part (c) (ii) was answered poorly. Candidates still find these eye defect calculations difficult, and correct answers were in the minority. Candidates can struggle to decide which is u and which is v in the lens formula, and many candidates had no idea the image was virtual and thus needed a negative value in the formula. However most candidates gave their answers to the correct number of significant figures and were awarded the maximum mark.

In part (d) most candidates gave the answer *'*use cylindrical lenses'. This response did not answer the question correctly. Candidates needed to refer to 'the format of the prescription' ie the power and the axis of correction for the lens.

Question 2

Part (a) was about the structure of the ear. In (a) (i) most candidates wrote about the ear drum vibrating and then passing a vibration through the bones to the oval window. Very few candidates talked about pressure waves for the sound at the start or the end. Of the candidates who did talk about pressure waves in the cochlea very few mentioned that it was in a liquid. Many candidates did not appreciate the importance of saying the ear drum vibrates in order to transmit mechanical vibrations, not sound or pressure waves, through the middle ear.

In part (a) (ii) very few candidates said that the **force** was increased by the bones of the middle ear, and some who did lost the mark by saying the force was amplified by 50%. A significant number of candidates talked about the ear bones amplifying sound or pressure not force. The realisation that the oval window was much smaller than the tympanic membrane was the source of the majority of marks awarded for this part of the question.

In part (b) it was unfortunate that the value of I_0, the threshold of hearing, was not given in the question. However, this was not a problem for many candidates who were able to quote the value and score full marks. There were quite a few candidates who could not solve the log part of the equation and a minority who did not know the difference between log base 10 and log base e.

Many candidates were awarded a mark for stating what was meant by the dBA scale in part (c), but a correct deduction about the frequency of the sound being tested was rarely seen.

Question 3

Part (a) was about the action potential of a nerve, but a significant number of candidates sketched the ecg trace, and a small number sketched the action potential of the heart. If the correct shape was drawn, then most candidates were able to score the marks for labelling the axes with the correct scale and unit.

In part (b) there were quite a few candidates who used about three quarters of the space available talking about the sodium potassium pump getting the muscle into equilibrium and then tried to squeeze the action potential into two lines at the end. There were some good descriptions of the ion movements, but the majority of candidates answers fell within the middle strand as shown in the mark scheme. The main faults were not using specific physics terms such as depolarisation, reverse polarisation and repolarisation, or not relating the ion movement with specified changes of potential.

Question 4

Question 4 concerned the new part of the specification.

In part (a) most candidates had an idea of how the MR scanner worked but did not include enough detail. Things missed were the strength of the magnetic field, talking about the effects on hydrogen **nuclei** rather than atoms or molecules, and that the radio pulses emitted on relaxation had to be detected before they were passed on to be processed by a computer.

Part (b) was answered well on the whole with many candidates talking about safety issues to gain credit and some talking about the better detail produced in picturing soft tissues. The candidates who just stated 'cheaper' or 'easier to use' may have been running out of time on the last question. Quite a few candidates incorrectly seemed to think that MR scanning was less claustrophobic than CT scanning.

Mark Ranges and Award of Grades

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