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Physics A PHYA5/2B

(Specification 2450)

Unit 5/2B: Medical Physics

Report on the Examination

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

General Comments

The paper was generally well received by candidates and there were plenty of opportunities for students to show their knowledge. All the marking points were used and some candidates gained full marks. There was also no indication that candidates lacked time to complete the examination.

Question 1

The more able candidates successfully negotiated the majority of this question but the less able found many pit-falls.

In part (a) most obtained the first mark but then did not obtain the anti-neutrino.

For part (b) some candidates did not identify the position of P. Position Q was easier for students to identify.

A majority of candidates could balance the number of neutrons in part (c)(i) to obtain the correct answer x = 4. Those that guessed the answer almost always gave the answer x = 3.

Part (c)(ii) was very discriminating. Less able candidates did not know how to balance the energies and only scored marks on the conversion from u to MeV. Some did not go directly from u to MeV and gave many lines of calculation. If correctly performed, they still got the mark for the conversion, but they had many opportunities to show errors and so tended to be less successful and missed the mark.

Question 2

Part (a) was very straightforward for most candidates but less than half could tackle part (b) effectively. Problems were seen at every stage. Some had no idea what was happening at all; some used the wrong charge on the aluminium nucleus and used $27 \times 1.6 \times 10^{-19}$ C; and some even changed the equation given in the question to the Coulomb law of force equation by introducing a squared term for the separation.

Question 3

Part (a) gave a much greater spread of marks than expected. About one third of candidates did not attempt to place a unit on the y-scale and less able candidates also could not recall the correct shape of the graph. At the top end, candidates allowed the graph to fall too steeply as the nucleon number increased and/or they had the peak in the wrong position. Only the more able candidates knew the height of the peak.

In part (b) only the more able candidates could use the idea of 'binding energy' in a coherent manner. Less able candidates did not really make any significant points that were worthy of marks. On a marking point, although the question starts with 'use the graph…', it was possible to score full marks without reference to the graph, as we allowed a reference to high and low nucleon numbers as being equivalent to being either side of the peak.

Question 4

Most candidates performed well in part (a).

In part (b) the less able candidates tended to score only one mark because they could not form the energy balance equation when both changes of temperature and changes of state were taking place.

Part (c) caught a majority of candidates out. Even grade A students were tempted to roll out the usual answer, 'the temperature would be less because heat is lost to the surroundings'. This statement scored no marks.

Question 5

The graph in part (a) was done well by most, but the less able candidates were not careful in reading the temperature scale and did not place the x-axis intercept at absolute zero. In some cases they had drawn a curve that had no intercept on the x-axis.

Parts (c) (d) and (e) were tacked well by more able candidates. The less able could only manage to do part (b) but then started either to substitute the wrong data, eg temperature in °C, or quote incorrect equations in the parts that followed. It was appreciated that not enough space was given to answer.

Part (e) allowed almost all candidates to score some marks, but the scores tended to be grouped in the following way. Less able candidates scored a couple of marks by discussing movement of molecules but did not go any further because of their poor use of physics in using phrases such as, 'the molecules have more energy and so hit each other harder giving more pressure'.

Some candidates started to use Newton's second law more effectively and referred to pressure in a more scientific manner.

The more able candidates could explain how increasing the volume allowed the pressure to remain constant as the temperature increased in terms of molecular motion.

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

General Comments

The paper was accessible to the students and there did not seem to be any problems with allowing themselves enough time to answer this section. It is still the case that the written answers are problematic for many of the candidates who do not express their answers clearly.

It is recommended that all teachers of this option use the support booklet on Medical Physics. It can be downloaded here.

Question 1

The first question was about the eye. Part (a) asked the candidates to complete three ray diagrams to explain long sight. The majority of candidates got the first two diagrams correct however, the third diagram showing the use of the correcting lens was done very poorly. Of those that did score the mark, few showed clearly that after refraction at the correcting lens the rays should appear to be coming from the unaided near point. Only a handful actually produced dotted lines back in line with those rays. It was also noticeable how many candidates did not use a ruler to draw the rays, even though it is clearly stated on the front of the paper that they should have a ruler in the exam.

In part (b) there were less than a quarter of the candidates who gained full marks, the majority of the candidates only scoring one mark for expressing their final answer to the correct number of significant figures. It had been hoped that the third diagram in part (a) would have given the candidates the clue that the object was real and the image was virtual, but many candidates thought that both were real, using positive values in the equation, whilst a noticeable number of candidates used values suggesting that the image was real and the object was virtual.

In part (c) the use of the term 'flicker fusion' was common, but a direct explanation of persistence of vision was very rare. The second mark for stating a practical situation where it is important was well answered with most candidates mentioning cinema or television.

Question 2

Part (a) asked for a clear definition of I_0, but the majority of candidates did not include either the fact that this was for a person with normal hearing or that it was at a frequency of 1 kHz resulting in no marks being scored by over half of the candidates. This was disappointing as it is a standard definition.

In (b), the line for part (i) had to show an increasing loss with increasing frequency which was lost with careless drawing. There were a noticeable number of candidates who drew a new line parallel to the original line clearly not understanding the idea involved. The line for part (ii) should have shown an increase in loss followed by a decrease in loss as the frequency increased, with maximum loss at 4 kHz. Many candidates gained the first mark, but few drew a line which showed the maximum loss at 4 kHz. There were quite a number of candidates who tried to relate a loss of hearing with a new line drawn underneath the given line.

Question 3

This proved to be the easiest question, with nearly all candidates producing some correct facts and over half the candidates scoring four or five marks. In part (a), the majority of the marks were lost by candidates not answering both parts relating to fibre arrangement and use.

In part (b), most candidates got the equation and therefore the answer right, but some candidates lost the mark when they did not give their numeric answer correctly rounded to the number of significant figures which they wished to quote. This was not a penalty on significant figures, but on the rounding procedure.

Question 4

In part (a), much of what was written did not answer the question clearly. The impression often given was that this topic had been learnt parrot-fashion from a revision guide, or dictated notes, because candidates who clearly did not understand what was being measured could often quote 'high gain, large input impedance, low noise' impeccably, without relating it to an amplifier, often just to the 'sensors', or just the ECG machine. Many candidates, presumably confused by the use of a gel, were drawn into describing some features of an ultrasound scan. Coupling gel was often used to reduce impedance, matching that of the skin, and sometimes an A scan was received on the oscilloscope. Generally, answers were so mixed up with actual features of an ECG scan that it was difficult to be sure what was being described. Features that seemed to have registered well were the shaving of the chest and the absolute requirement not to use the right leg. Sometimes it was clear from the answer that the candidate thought that the electrodes were being used to supply a voltage to the patient – which is why the leads needed to be screened so as not to shock or electrocute them. 'Low noise' was a giveaway to the poor understanding of other candidates when it was clear that it was being related to sound. The ECG machine had to be quiet, the room had not to be noisy either otherwise it would 'spoil the trace'.

In (b)(i) many candidates gained the unit mark, mV, but the scale mark was often lost by either placing the zero in the wrong place or by confusing it with that for the nerve action potential.

In (b)(ii) the scale was generally well known, but sometimes it was drawn looking non-uniform because candidates were trying to relate peaks on the graph to remembered values.

In (b)(iii) there were many answers which gained full marks. Those that lost marks did so because they did not give the electrical events, but described the resulting movements of the heart.

Question 5

Part (a) highlighted the inability of many candidates to state their answers clearly and so marks were often lost by omission; omission to state the **atoms** of the target anode were excited or ionised, rather than just the target; omission to mention the **inner** electron shell is involved in this process if X-rays are produced; omission to relate the specific energy of the X-ray photon to the specific **difference in energy** due to the specific levels of the excited/de-excited atom.

Part (b) produced some good answers, but there was quite a lot of confusion between the intensifying cassette and the intensifier tube; some candidates had X-rays producing light photons then electrons drawn to an anode and a second fluorescent layer which they thought might be the rear intensifying screen. The point that the screens being in close contact with the film mean that the film is exposed by the light in the same place as it would have been exposed by the X-ray was missed by nearly all candidates.

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