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Physics A PHYA5/2D

(Specification 2450)

Unit 5/2D: Turning Points in Physics

Report on the Examination

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

General Comments

There was no evidence to suggest that candidates lacked time to complete this examination. It is recommended that all teachers of this option use the support booklet on Turning Points in Physics. It can be downloaded here.

Question 1

In part (a) most candidates named the process correctly in part (i) and demonstrated some knowledge of the process in the subsequent parts of the question. In (ii), many candidates knew that electrons with different speeds would not diffract in the same directions although some candidates did not mention that this is because they would have different wavelengths.

Many correct calculations were seen in part (b)(i) and most candidates scored the unit mark. Some candidates lost marks through careless numerical errors.

In (b)(ii), most candidates knew that the speed would increase and therefore the wavelength would be decrease. However, some candidates thought that this would cause more diffraction or that the resolution would be poorer. Candidates gained no marks if they gave an incorrect physical reason such as a greater number of electrons in the beam.

Question 2

In part (a)(i), many candidates knew the correct expression for the weight in terms of the droplet radius and equated it to the Stokes' law expression for the upward force, but they often did not identify the nature of the upward force as a viscous force.

Most candidates knew in (a)(ii) that the mass could be calculated from the product of the oil density and the droplet volume and were able to give the correct formula for the droplet volume in terms of its radius. Those candidates who did not know the volume formula were unable to gain this mark. Some candidates obtained the mark by showing the droplet mass could be calculated by dividing the viscous force expression by g.

Some candidates lost marks in part (b) because they used the symbol *e* instead of *Q* or *q* for the droplet charge or they gave their answer to three or more significant figures.

In part (b)(ii), candidates were often unclear about what the quantum of charge is or they stated that the charge of a droplet is a factor rather than a multiple of the charge of the electron.

Question 3

Many candidates did not score the mark in (a)(i) because they gave general statements which could apply to a comparison of any two individuals rather than referring to Newton's greater scientific reputation.

In part (a)(ii), most candidates knew that light travels slower in water than in air but many lost a mark because they only gave the correct prediction of one of the two theories.

Although considerable variation was seen in the depth of knowledge and understanding of candidates in part (b), many candidates were able to express their ideas adequately. Relatively few candidates were hampered by very poor quality of written communication. Most candidates gained some credit for knowing the light from the two slits produced an interference pattern and were able to give a simple explanation of why bright and dark fringes were formed. Many candidates knew that bright fringes were formed where the light waves were in phase but a significant number of candidates did not indicate the exact phase difference for the formation of a dark fringe and merely stated that the waves needed to be out of phase. Few candidates were able to state the correct path difference for a bright fringe or for a dark fringe, often referring to 'phase' difference in wavelengths or stating the path difference for a bright fringe as one wavelength instead of a whole number of wavelengths. The key explanation of why there are more than two bright fringes was often absent or too vague to gain any credit. The more able candidates wrote clearly that bright fringes are formed where the path difference is a whole number of wavelengths and that because the light is diffracted at each slit, there will be several positions where the path difference condition for a bright fringe is fulfilled.

Question 4

Most candidates scored the mark in (a)(i) and many went on to successfully complete (a)(ii). However, careless arithmetic errors were not uncommon in (a)(ii) and some candidates used an incorrect formula.

Some excellent answers were seen in part (b) which demonstrated a very good understanding of the topic and a first-rate grasp of algebra. The more able candidates usually worked through several lines of algebra and successfully reduced the ratio to an expression in terms of v/c only then completed the calculation in a single line. Most candidates started with calculations of either rest energy or relativistic mass or the total energy. Many candidates demonstrated they knew how to calculate the relativistic mass of the proton at the given speed. However, many candidates did not gain more than two marks because they attempted to calculate the kinetic energy using ½ mv^2 rather than $mc^2 - m_o c^2$, even when they had calculated the correct values of mc^2 and $m_o c^2$.

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