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Specification B: Physics in Context

PHYB5 Energy under the Microscope

Report on the Examination

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Dr Michael Cresswell Director General.

GCE Physics, Specification B: Physics in Context, PHYB5, Energy under the Microscope

General Comments

There was a small entry for this paper and most of the candidates had prepared themselves well for the challenges presented by this paper. Candidates had no time difficulties when completing the paper with most candidates making a very pleasing attempt at the questions based on the short paragraph in question 6.

Question 1

A majority of the candidates appreciated what was required in part (a) (i). Some misunderstood and referred to the combustion of fuel in this part. Credit for doing this was given in part (a) (ii). A number of answers referred to the change as an isothermal indicating that they had not yet fully understood this term.

There were many correct answers to part (a) (ii). Some referred only to combustion without further detail.

It was anticipated that part (a) (iii) would be well known but only 40% gave the correct response.

There were many correct responses to part (b) (i) but some referred only to internal energy and not change in internal energy.

About three quarters of the candidates identified *Q* in part (b) (ii).

Most who gained credit in part (b) (iii) referred to no heat transfer but relatively few commented on the rapidity of the change not allowing time for the transfer to take place.

All candidates completed part (c) (i) successfully.

Whilst the majority made some progress with part (c) (ii), most of these associated the temperature of 313 K with T_H in the equation. Some could not handle the 27% correctly.

About 44% of candidates were successful in part (c) (iii). Less able candidates did not appreciate the process and/or data required here. The conversion to cm^3 from litres also caused difficulty for some candidates.

Part (c) (iv) required some careful thought and pleasingly 44% obtained the correct answer. Some forgot to include the four cylinders. There were a fairly high proportion of non-attempts at this challenging question.

Part (v) was well done by those who had persevered with the previous two parts.

Question 2

Surprisingly, less than half the candidates could successfully apply the left hand rule to the situation in part (a) (i).

Part (a) (ii) was done very well. The vast majority completed it successfully and most made very good progress with the problem.

Part (a) (iii) was successfully completed. Whilst appreciating that $E = V/d$, many were unable to progress because they were unable to determine *E.*

It was clear from responses to part (a) (iv) that many were unfamiliar with the idea of using crossed fields as a velocity selector. Candidates were allowed error carried forward from (a) (i) but a number of candidates suggested connecting the pd so that it produced a force in the same direction as that in (i) with a supporting statement to this effect.

35% successfully completed part (b) (i) and a further 25% arrived at the radius of the orbit but neglected to double it. Some did no more than quote the formula.

Almost half of the candidates made some progress with part (b) (ii) and many of these gave a sound analysis. However, a majority of the candidates did not appreciate what was required.

There were many correct responses to part (c). Most made some progress but errors of arithmetic or algebra led to incorrect answers.

Question 3

A majority showed the correct curvature in part (a) but many did not show the curve that was shown acceptably asymptotic to 2.8 V.

In part (b) (i), only half the candidates made any progress with this routine calculation and only 30% of the candidates were completely successful. Apart from power of 10 problems, some candidates used the resistor in the charging circuit instead of capacitance when calculating *CR*.

There were only a small proportion of correct answers to part (b) (ii). Some used one or other of 2.5 V or 3.0 V to find a charge using $Q=CV$ and some found a charge assuming that I remained constant at the initial discharge rate.

Candidates generally found part (b) (iii) difficult. The concept of the A-h was not well understood and there were relatively few correct answers seen.

Answers to part (c) were generally poor with no reference to how time constant can be used to determine pulse rates. The majority who attempted the part only referred loosely to capacitors affecting heartbeat.

Question 4

In part (a) (i), the use as a tracer was given by relatively few.

Responses to part (a) (ii), which was direct recall, were usually disappointingly poor.

The vast majority gained some credit in part (a) (iii) and most of these gave completely correct answers.

Part (b) (i) was generally done well. How to work with hours and seconds was problematic for some candidates.

Most candidates successfully completed part (b) (ii).

Many candidates missed the point in part (b) (iii). They did not appreciate the statement in the question about the ‘rapid sequence of images’ and that the question was about recording the movement of the body part as opposed to a snapshot. They were required to recognise that initially the gamma ray intensity would be high enough for an image to be formed and recorded rapidly and that a new image of the moving body part could then be recorded a short time later. As the activity decreased it would take longer to build up a satisfactory image so that photographing a moving body part would result in a blurred image but the image could be built up over time for a part of the body that does not move. Many focussed on the moving parts of the body reducing the amount of technetium quicker because of activity and secretion than parts of the body that were stationary. Reference to biological half life was however given credit.

Question 5

Disappointingly, a quarter of the candidates did not score the mark in part (a) (i).

Most of the candidates correctly answered part (a) (ii).

Part (a) (iii) discriminated well, with candidates making various degrees of progress. Most gained at least one, usually for the conversion of MeV to J or the correct binding energy for one deuteron. A common error was failing to notice that three deuterons were required in the process, the tritium and helium-5 being intermediate nuclei.

There were several relevant points that were creditworthy in part (b) (i) and half the candidates identified three or more of these and only a few scored no marks.

Less able candidates tended to write superficially in part (b) (ii), but almost all were able to give at least one relevant point. Vague answers included statements to the effect that more energy is available from fusion than fission without any qualification about ‘fuel’ mass. Water as the ‘fuel’ for fusion was another vague comment.

Question 6

In part (a) (i), candidates either scored all the marks or were unable to extract the relevant data form the passage or identify an appropriate process. The 70% of the candidates obtained full marks.

Regrettably there was an error in part (a) (ii) which was not noticed before the examination date. The time recorded in the proton’s moving frame of reference must be lower than that recoded in the stationary reference frame. The question should have read, ‘Show that in the proton’s frame of reference it will take about 1.3 μs to travel around the LHC.’

When applying the formula on the formula sheet, t_o is the time in the moving frame of reference. The time taken in the stationary frame of reference (9.0×10^{-5} s) is reduced to 1.27×10^{-6} s (ie by a factor of $(1-0.9999^2)^{0.5}$).

This is consistent with length contraction in which, in the proton’s frame of reference, the distance travelled (at speed *c*) is only 381 m and not the 27 km circumference of the LHC as measured by a stationary observer.

Candidates who attempted the question began by quoting the appropriate equation. Any attempt to use substitute data in the equation was rewarded. Those who made no attempt to use it, however, gained no credit. Those who did a substitution invariably supposed (as did the question) that t_o was the time in the stationary frame of reference and proceeded to obtain or try to obtain *t.* If a candidate completed the working successfully then full credit was awarded. In the processing some omitted one of the squared quantities when substituting and others made algebraic or arithmetical errors. No candidate was seen who used the equation correctly. If they had, then they would, of course, have been awarded full credit.

The majority made a sensible comment in part (b), relating to the additional energy available or to a loss of energy due to momentum considerations. Relative few however, discussed why this extra energy was an advantage.

The number of candidates omitting part (c) (i) was disappointing. The location of the data in the passage needed for use in $pV = NkT$ was clearly identified for them in the question. Many of those who did make progress with the question ran into difficulties with the conversion of cm^3 to m^3 or vice versa.

There were fewer omissions in part (c) (ii) than in (c) (i) and a good proportion of correct or partially correct answers were seen. The conversion between units was also a problem here.

In part (d), most gained one mark for identifying the initial decrease in resistance with temperature but only a fifth of the candidates identified what happed in a superconductor at the critical temperature. Even when a critical temperature was mentioned the sudden fall to zero resistance was rarely specified.

Only the more able candidates clearly addressed how pressure was produced in part (e) and why reducing pressure and evacuation affected the pressure in terms of the number and speed of the molecules in the gas. Less able candidates tended to offer only partial explanations. They included superficial statements about energy or momentum and they often wrote about collisions between molecules. A description of the kinetic theory view of how pressure arises was the logical starting point for the explanation.

Mark Ranges and Award of Grades

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