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Examiners' Report January 2008

GCE

GCE Physics (8540/9540) International Supplement

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6735 Unit Test PHY1

This paper worked well in most parts, though in a couple of places even candidates of evident ability were apt to squander marks through cursory reading or a failure to appreciate the detail of the question. Most candidates were able to access all questions, though the quality of answers in descriptive parts was sometimes limited by the confusion of ideas or a failure to appreciate that the context of the question had shifted from that applicable in an earlier phase.

Question 1

Part (a) was a straightforward exercise based firmly on fundamental understanding of circuit behaviour. The great majority had no difficulty recognising that the potential difference across the resistor was the key to the solution. A minority attempted to evaluate an overall circuit resistance, while a few missed the second mark by stopping at the intermediate stage of finding the 4V across the resistor.

Parts (b) and (c) were straightforward exercises, providing the majority with opportunity to harvest marks for standard calculations. Complacency with the developing pattern of the question was the undoing of many at (d) however, since the routine circumstances of charging or charge sharing without there being a resistor in the circuit were not applicable. Only the most alert spotted that the presence of the resistor meant that the battery was transferring energy at a much greater rate than it was being stored on the capacitor, the different p.d. values being overlooked by most when finding the product 'QV'. For much the same reason, the energy value difference at (e) was usually attributed vaguely to heating in wires or in the circuit resistance, rather than being specifically linked to work being done in the 200kΩ resistor.

Question 2

The calculation at part (a) allowed many to demonstrate appreciation of the essential physics behind the particle acceleration process, taking the standard equation for the electron case and modifying it appropriately to reflect the context shift from electron to proton. A minority fell prey to carelessness at the early arithmetic hurdle where the speed value needed to be squared to find the kinetic energy. This robbed them of credit they could easily have earned. A few well-drilled candidates, finding themselves on what they believed was familiar ground, inadvertently substituted the mass of an electron here rather than that of a proton. They were thus solving a problem other than the one set, limiting the credit they could achieve.

In parts (b) and (c) (i) there were too many candidates whose lack of thought or care over the drawing of the proton and alpha particle paths left their answers unclear or contradictory. The mark allocations indicated that these two paths deserved together around 4 minutes of each candidate's time to consider and draw. Answers very rarely reflected this. Centres could usefully emphasise to students the need for careful drawing to allow the detail of their understanding to be reliably conveyed.

Surprisingly few appreciated that the proton path at B would run, throughout its length, equidistant from that at A, affected to an identical extent by the uniform field between the plates and equally unaffected beyond them. A popular misapprehension was that the closer proximity of B to the positively charged plate would result in a path of greater curvature for the proton entering there.

Most candidates appreciated that the bending of the alpha particle's path at A would also be upwards, since it too carries a positive charge. However, almost all showed stronger deviation, failing to take into account the offsetting factor of increased mass. This was reflected in the explanation offered at (c) (ii), the double positive charge commonly being cited, but very rarely the quadrupled mass. Perhaps the most surprising feature here was that many candidates started their argument with a specific statement that the alpha particle's speed would be either greater than or less than that of the proton, despite the explicit detail in the question stem. A worrying minority believed that the alpha particle was uncharged.

Question 3

The first part of this question was poorly answered. The majority of suggestions were merely word descriptions of obvious features of the diagram, rather than deductions of their significance. At the opposite extreme were supposed deductions that were simply known facts linked to the context, neither proved nor disproved by the evidence on the diagram. Contradictory pairings were also not uncommon, such as adjacent statements to the effect that the field was both uniform and radial.

Part (b) was found to be quite straightforward by many, the twin keys to success being careful reading of the question and an understanding of the significance of the MJ kg^{-1} unit of potential. Only a few overlooked the need to arrive at an answer at least one significant figure more precise than the approximation given. A minority embarked on ambitious solutions that involved the standard expression for gravitational potential, despite it not being on the specification and redundant here with the data given. The given figure of 11 km s^{-1} itself rang a bell in the minds of others, who moved as a result to produce a variation on the derivation of the Earth's escape velocity, effectively turning the question on its head.

Solutions to part (c) were often pleasingly thorough, efficient and convincing. In a good many more cases the basic structure of the argument was apparent, with the destination obviously a familiar one, even if the algebraic steps towards it were halting. A common poor start, strategically, was to use the same letter 'r' for both distances, a move that introduced unnecessary ambiguity. Equally unhelpful was the decision to make one distance 'r' and the other 'R-r', introducing unnecessary complexity in the later stages, usually more than the candidate was able to resolve. A single mark penalty was levied on those who skipped the prescribed starting point and started with expressions for gravitational field strength. Rather more was lost by those who tried to find the distances from the Earth and Moon where their respective field strengths were 9.81 N kg^{-1}. The ratio of these distance values did yield the factor of 9 they sought, but this was not a valid approach. No credit at all was earned by those who gave a speculative single statement of Newton's Law of gravitation, but with the product of the masses of Earth and Moon in the one numerator.

Question 4

This should have been a straightforward question in which the majority scored full marks, but almost all candidates made an unforced error by using the wrong length value at part (a) (ii). Despite being told that the region inside the solenoid corresponded to distance AB, they took the length of the solenoid either to be the full 100 cm of PQ, or the smaller value they had just obtained for the uniform field region.

All but a handful suggested correctly that the current direction in the solenoid was the key factor in determining the field's polarity in (b), though a few tried to correlate the cell's polarity with the field's, apparently blurring the distinction between their very different natures.

Question 5

From the outset this question proved difficult for many, instinct leading them to conclude incorrectly that position 2 would be the one where electromagnetic induction produced the greatest effect, rather than the least as a consequence of zero net flux cutting. Even those who were able to discern that the generation of emf was only occurring in frame side QR at position 1 and only in side PS at position 3 were not always able to employ Fleming's Right Hand Rule correctly.

The calculation stage at part (a) (ii) saw a good few successful attempts, though additional factors of 2 to allow perhaps for two flux-cutting frame edges were quite commonly seen. Another flawed approach sprang from belief that the area of the frame itself was an ingredient in the calculation. The need to find a current value prompted too many to start with an inappropriate equation from the list of formulae and data, attracted to it simply because it featured both the 'B' for magnetic flux density and the 'I' for current. There was no merit in this at all. Many students whose flawed application of Faraday's Law led to an incorrect value for the induced emf at the intermediate stage of the calculation process were able to salvage the final two marks for the subsequent stage of current calculation. This compensated them for employing the right physics principles, even if they had stumbled over the detail in the early stages.

In part (b) the shift in circumstances from steady speed to acceleration was not reflected at all in a lot of answers. Many simply elaborated the thinking they had used in part (a). A proposed pattern of current variation that saw it rise in position 2 and then fall again in position 3 was thus quite common. Also prevalent was the notion that the flux density itself was changing. Even those that did earn full marks for this exercise were apt to use up a great deal of the available answer space in an extensive but aimless preamble, only focusing in on the key points in the last couple of lines. The best answers were given by those who saw from the outset that the net rate of flux cutting was the issue at the heart of the problem. They produced neat and succinct summaries that addressed the important details in a logical order, quickly earning full credit.

6735/2A Practical Unit Test PHY5

Overall the responses to the paper were rather disappointing. The test contained some very straightforward questions about simple practical skills and basic physics concepts with which candidates at the A2 level would be expected to be very familiar. In particular, the failure to take an adequate number of readings and the poor quality of the graph drawing caused many candidates to lose what should have been easy marks.

In Question A, many of the measurements of the width and thickness of the rule lacked accuracy and were often not repeated. Supervisors are reminded that it is essential that they supply data, as requested, *for each candidate individually*; it was apparent that some Supervisors did not do this and a number of candidates may well have lost marks as a result of this.

Many candidates did not make it clear that the lengths should be recorded to the centres of mass when taking moments. Few candidates indicated how this was done, for example by recording the position of both edges of the 50 g mass. In general, the experimental work on moments did not show the degree of accuracy and care expected at this level. Density values were often quoted to too many significant figures or given the wrong unit.

In part (b), a significant number of candidates did not read the meter correctly, the commonest error being to give the current as 145 mA instead of 0.145 mA. Most candidates got two easy marks for taking three readings for the time, but then lost a mark for giving the capacitance to too many (usually 4) significant figures. Again, a pleasing number of candidates drew a reasonable sketch of the decay curve, putting in the relevant data, but often got only two of the three marks as they did not put in the origin.

For Question B, candidates were expected to state that they found the extension by the difference between the original length and the length of the spring when loaded and to *show* their readings for this. Very few did. Likewise, very few candidates timed an adequate number of oscillations. The time period was very short (usually less than a second) and the oscillations only lightly damped and so 20 oscillations, repeated, should have been easily obtainable in the time available. Several candidates lost a lot of marks as they only timed 10 oscillations and then forgot to divide by 10 to find the period.

Graph work tended to be untidy, often with poor scales, inaccurate plots and lines that were not of best fit. As a result of this, and poor data, very few candidates got a value for g that was within the tolerance allowed. Only the more able candidates were able to find the percentage difference between their value and the accepted value correctly by using 9.8(1) as the denominator. Fewer still candidates were able to comment on this difference quantitatively in terms of at least one estimated experimental uncertainty.

In Question C, very few candidates were able to explain that the oscilloscope would be connected *across the 47 ohm resistor* and then this value of potential difference would be divided by 47 ohms to find the current.

Candidates were more successful in determining the frequency of the oscilloscope signal and the peak voltage, although in the latter case a number of the answers lacked the necessary accuracy.

Most candidates got a mark for saying that the capacitors would be connected in parallel combinations, with the stronger candidates giving an example, e.g. 320 μF could be obtained by connecting the 100 μF and 220 μF capacitors in parallel.

The graph drawing was particularly poor in this question and well below the standard expected at A-level. Candidates should be familiar with the shape of a resonance curve and so were expected to draw a smooth resonance curve through the points. This should have peaked at slightly less than the plotted 470 μF point. Poor candidates simply drew two straight lines, whilst the better candidates attempted a curve but usually forced it through the 470 μF point, thereby distorting its shape.

In part (d), candidates invariably lost a mark for saying that resonance occurred at 470 μF and often lost the second mark for suggesting extra measurements between values of capacitance that were *not in the table*. Candidates must learn to the question carefully. However, most candidates redeemed themselves in the last part by correctly stating that the 4700 μF and 470 μF capacitors would be connected in series, giving a value of 427 μF.

6736 Unit Test PHY6

This Synoptic paper offered a wide variety of question types, not always asking for a 'standard' response. In this sense the paper was quite challenging, giving too many candidates an opportunity to answer a question of their own making or to cross out their first attempt and try again – sometimes on a separate sheet of paper. There was some evidence that time constraints were leading to scrappy or unfinished attempts at the last question. As 'You may be awarded a mark for the clarity of your answer' came up twice, relevant physics was needed, though for clarity both the use of bullet points and the inclusion of mathematical expressions were as usual credited.

Question 1

Apart from parts (a), (c)(i) and possibly (ii) there was nothing where a straight quote from the passage was available as an answer. In part (b) a noticeable minority took the speed of ultrasonic waves to be 3×10^8 m s^{-1}, though many of these still calculated λ to be 15 mm. The drawing in part (d)(i) were generally careless but the calculation in (ii) was fine. Very few understood in tackling (iv) how any stationary wave in the nickel rod would have antinodes at both ends. As usual, showing that a graph is exponential – part (e)(i) – produced an encouraging variety of correct methods, together of course with 'proofs' relevant to inverse and inverse square laws, and in (ii) the control of units was sound. In part (f) many candidates described the *result* of a diffraction experiment rather than the experiment itself, and a two-slit arrangement was not uncommon. The Doppler question, part (g), was surprisingly badly answered: the shifts were said to be those of planets or, more often, the Universe; light waves were sometimes sent off to an object from which they were reflected; arguments about Hubble almost always assumed that the distance to a star or a galaxy was known or could be found from a knowledge of H, leading to a circular argument, and even the qowc mark was often lost.

Question 2

Only 50% of candidates could explain that the current and the electrons' movement were in opposite directions – part (a)(i), but a much greater proportion were able to deal with the algebra needed in (ii). Diagrams to 'illustrate this statement' in part (iv) showed a reasonable understanding, the odd mark often being lost for incomplete labelling. Labelling the cyclotron diagram given for part (b)(i) showed that a high proportion of candidates knew of the need for a (high voltage) a.c. supply; failing to label the magnet's poles was unfortunately a common omission. There was plenty of opportunity for mistakes in (ii) with the calculation, and some candidates attempted to use relativistic relationships. As so often in this paper, the square in $c^2\Delta m$ was sometimes omitted and the request for a comment too often failed to elicit a quantitative statement.

Question 3

Part (a) generally went well, though the use of lots of fuel in a ‘long flight’ was missed by many who then tried unconvincingly to discuss air resistance and friction. As with other diagrams in this paper, the forces arrows demanded in part (b)(i) were highly inadequate – often obviously leaving the plane with a resultant force. In (ii) the unfortunate use of the word ‘any’ led to some explanations of what produces aerodynamic lift, but apart from a vague nod in the direction of Newton’s 3rd law very few candidates could *explain* the forward thrust force. The calculation in part (c) was testing. Two starting points were possible: either $pV = nRT$ or $p = \frac{1}{3}\rho \langle c^2 \rangle$, the latter having the advantage of containing the density ρ. The question would have worked better had the candidates been told to make a clear distinction between symbols representing the conditions at take-off and cruising respectively.

Question 4

Candidates who, in part (a)(i) failed to estimate the charge but used the product *RC* were credited with only half marks. Besides these, the business of finding the area under a current-time graph was quite well done. The need to state that the capacitor is initially uncharged was usually omitted in (ii). A large number of candidates simply drew the values from their table in (iv), producing a graph that looked exactly like that in the stem of the question. Part (b)(ii) produced many values for *C* and *R* but little working, so the Examiners assumed that the product *CR* had been used if the values matched the candidate’s delay time.

Grade boundaries

The raw mark obtained in each Unit is converted into a standardised mark on a uniform mark scale, and the uniform marks are then aggregated into a total for the subject. The tables show the boundaries at which the raw marks are converted into uniform marks. Raw marks within each grade are scaled appropriately within the equivalent range of uniform marks.

Units converted to 90 uniform marks

Unit	**Maximum mark**	**Grade**				
		A	**B**	**C**	**D**	**E**
	Uniform marks 90	72	63	54	45	36
PHY 5	*Raw marks* 60	68	61	54	47	40

Units converted to 120 uniform marks

Unit	**Maximum mark**	**Grade**				
		A	**B**	**C**	**D**	**E**
	Uniform marks 120	96	84	72	60	48
PHY 6	*Raw marks* 96	54	48	42	36	30

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