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Examiners' Report
January 2009

GCE

GCE Physics (6PH01/01 & 6PH02/01)

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6PH01 Unit 1 Physics on the Go

Multiple Choice Question 1 - 10

Average performance on the multiple choice questions correlated well with performance in section B.

Approximate percentages of correct responses were:

1. 74%
2. 63%
3. 69%
4. 85%
5. 84%
6. 79%
7. 75%
8. 82%
9. 71%
10. 69%

In order of success, the questions and topics were:

4. 85% - derive an equation for power output
5. 84% - vector resolution
8. 82% - viscosity and terminal velocity
6. 79% - Young modulus graph
7. 75% - calculate speed from kinetic energy
1. 74% - identify vector and scalar quantities
9. 71% - dynamics graphs
3. 69% - equivalent units
10. 69% - calculate v using $v^2 = u^2 + 2as$
2. 63% - calculate s using $s = ut + 1/2at^2$

Section B

Question 11

(a) Candidates were nearly always able to find the weight, although some lost credit by using g = 10 N/kg. They did not all go on to find the resultant force correctly. Very few candidates lost credit by not using the extra significant figure required in 'show that' questions.

(b) Candidates applied Newton's second law but a significant minority applied the thrust force rather than the resultant they had calculated in part (a). Occasionally candidates used the units of velocity rather than acceleration.

(c) This part presented few difficulties, although a proportion of candidates attempted to use the acceleration calculated in part (b) in some way, sometimes finding the average of that value and the correct answer to part (c)

(d) A small proportion of candidates gave answers based on fuel consumption or changes in gravitational field strength. A significant proportion attempted to explain this mathematically and without reference to the context of the question by saying simply that acceleration varies so that the average will not be the same as the initial value. Such candidates need to be prepared to look at their previous answers. Here they would have seen that the acceleration was much greater later in the flight and that, since acceleration is resultant force/mass, either resultant force has increased or mass has decreased.

Question 12

(a) Responses in this section demonstrate that there is a need for candidates to learn materials definitions and to be ready to quote them. Candidates usually showed an understanding of proportionality but did not always bring out the 'limit' part.
Descriptions of tensile strength were the weakest responses in this part, with even those who had the idea often referring to force rather than stress. There was a lot of vague wording, such as 'the maximum force it can take', without reference to fracture. Yield point was frequently confused with both of the other terms.

(b) A majority of candidates gained these marks, although some failed to use crosses as instructed. The most frequent error was placing Y past the peak or at the end of the line.

Question 13

(a) The majority of candidates gained these marks, with correct descriptions of turbulent flow outnumbering those for laminar flow where one was incorrect.

(b) A similar pattern was observed for the diagrams, although the quality of the drawing was often poor and this sometimes lost candidates marks for the laminar section where they attempted to draw too many lines and some crossed over or just stopped. The direction of flow was reversed in a small proportion of responses.

(c) This was not very well answered. While a fair proportion identified a reduction in resistive force, very few linked this to the increase in range, apparently ignoring that there were two marks. In a question such as this the candidates are required to identify a possible cause and *explain* its effect, here by reference to work done against the force or a deceleration caused by the force. A misconception seen too frequently was that there would now be a greater force on the ball, increasing its range.

Question 14

Candidates who had learned a quotable form of Newton's laws of motion and were able to apply them answered well in this question.
(a) There was a general understanding that this involved an unbalanced force causing an acceleration, but the expression of both was frequently too vague to allow credit. There was often reference simply to 'a force acting' or a statement about forces being equal. Candidates often referred to a body remaining at rest or at a constant speed without mentioning the direction.

(b)(i) and (ii) Overall, there was usually a difference and a similarity identified, but there were a number of common errors. Candidates did not always separate their answers to (i) and (ii) correctly, so it was not clear if they knew which was a difference and which was a similarity. The same answer sometimes appeared on both lines. Some attempted to answer by giving examples, such as a foot kicking a ball.

For part (b)(i) the most common similarity was magnitude, although usually given as ‘size’ or just ‘equal’. Candidates often said the forces acted on the same body, apparently thinking of a Newton’s first law situation. For (b)(ii) many candidates identified opposite directions, although some just said different. They often thought the forces were of different types.

(b)(iii) A small proportion gave the straightforward restatement of the question with the appropriate points reversed. The most common responses identified the opposite direction, but not that it was exerted by the car on the Earth, and the size, and not the gravitational nature of the force. Many candidates described an upward force on the car from the ground, again describing a Newton’s first law situation.

Question 15

The most common descriptions involved electromagnets, magnetic gates and timers, or light gates and data loggers and sometimes a confused mixture of the two. Those using the electromagnets and timers tended to score more highly.

Many said they would measure the height and time, or a speed at the end and a time or distance, but the answers tended to be less clear for the latter. Candidates describing the measurement of two speeds and a time between them were the least successful in describing their method.

Too many treated light gate and data logger arrangements as a ‘black box’. They sometimes therefore gained credit for describing the measurement of time and little else. Overall, relatively simple methods which could be fully described gained more credit than complex methods which relied on computers producing an answer without describing the actual inputs and how they were processed.

A common error was not to mention a means to measure distance. This was even when the height of a fall was being used, but especially so with the use of light gates to measure speed where the length of the interrupt card was rarely mentioned.
Candidates usually mentioned repeating measurements, although they did not always say which measurements or what they would do with the repeats.

The descriptions of how to determine g from the measurements were rarely given in sufficient detail. A common error was to use the height of a fall divided by the time as the final speed and to use this divided by the time for their acceleration result. Others stated the equation they would use, but did not make g the subject.

The suggested precautions were often vague and not always about the accuracy of specific measurements, as asked by the question, but about reliability. Repeating and averaging was often given in this part. Some were unrealistic for the laboratory, like carrying out the experiment in a vacuum.

Question 16

(a) Candidates had no difficulty in equating the resistive force with the forward component of the tension and usually completed this part successfully.

(b) The great majority used force x distance but, despite having just worked out the component of the force in the direction of motion, a surprising number of candidates simply calculated tension multiplied by distance.

(c) This was poorly answered, again despite having found the relevant component of force using the cosine of the angle in part (a). Many answers referred to the elastic properties of the rope, thinking that the force would somehow be spread over a larger distance to decrease it. Some candidates said that as work = force x distance, a greater distance (from the longer rope) would result in a lower force.
When candidates identified the smaller angle they did not often go on to connect this with the calculation of work done.

Question 17

(a) Trajectories were often of the correct general shape, although not always with the same initial velocity, but also quite often just continued from the end of the line given with a short curve and drop.

(b) Candidates were most likely to mention the constant horizontal velocity and often discussed the vertical motion, but were often too imprecise with their vertical descriptions. Candidates were rarely explicit about the independence of horizontal and vertical motion, although those who were often did not describe the other two points in any detail.

(c) Weaker candidates failed to identify the significance of air resistance for the motion of the balloon and that is was proportionately much greater. A number referred back to the impetus explanation.

Question 18

(a) The labelled diagram was generally correct, although a number of candidates showed viscous drag acting in the upward direction as if the submarine was falling, perhaps because a falling object is the context in which they met this set of forces. Some used the label ‘gravity’ instead of ‘weight’.

(b) The most common correct response was to show that vertical forces are balanced. Although the submarine is identified as travelling at a constant speed in the direction shown, many candidates state that ‘thrust > drag’, or ‘resultant force = thrust – drag’. Others ignored the instruction to describe relationships between forces acting on the submarine, i.e. those in part (a), and used $W = mg$ and Stokes’ law.

(c) This generally presented few problems, although some candidates calculated mass and were happy to give that as their answer to this ‘show that’ question, ignoring the factor of 10 difference.

(d)(i) Candidates tended to describe compression in some way and didn’t mention or define strain.

(ii) By this stage most candidates had identified that weight = upthrust, they had calculated weight using volume and they had been told that the weight could be varied. It was therefore surprising to encounter a large proportion of candidates whose response to a decrease in volume was to take on water to increase the weight of the submarine! A good proportion did want to release water to decrease the weight or to keep the (average) density the same as the surrounding water.

(iii) Candidates rarely continued the theme of part (d), which was about compression and the volume decreasing. They were also too willing in this part to introduce properties of fibreglass which hadn't been described, rather than using the information they were given regarding the Young modulus. A typical answer would say that fibreglass couldn't withstand the stress because it is brittle. The answers referred to tensile strain by implication far more often than compressive strain, although they rarely used the term 'strain', using 'stress' as a synonym. 'Withstand' was used without reference to the outcome which 'withstanding' would avoid.

Question 19

(a)(i) About half of the candidates answered this question fully. Many just described the shape, linked it to elastic behaviour or described what happened after B.

(ii) About two thirds of the candidates gave a reasonable explanation for CD, although some just described what was happening again.

(b) Probably helped by the 'show that', candidates used the inverse of the gradient, although some did not gain the second mark because they read values from the graph inaccurately. The use of cm on the graph did not cause difficulties.

(c)(i) Candidates generally applied a correct method to calculate the energy stored. Some lost a mark by reading the graph incorrectly again.

(ii) Candidates usually approached this via GPE, but some made extra work for themselves and went via kinetic energy and the equations of motion. Candidates who obtained very large or very small answers through errors carried forward blithely quoted them and went on without comment.

(iii) Air resistance was mentioned by many candidates, but not often in the context of energy loss. A number said that they assumed the energy transfer was 100% efficient, but, as they did not define the input or output, they gained no credit. A fair proportion described the chain of energy changes satisfactorily.

(d) Candidates, if somewhat vaguely, generally managed to obtain two marks for the advantage of the video camera, those missing a mark being fairly evenly split between the accuracy point and the description of how it is achieved.

(e) About half got this point, an astonishing number finding that 0.45 m was justified because it was the mode and/or the median of the five results.

6PH02 Unit 2 Physics at Work

Most centres entering candidates for an examination this January chose to enter them for unit 1. The entry for unit 2 was small but having a January examination for unit 2 does mean that centres have the benefit of a paper in their preparation of candidates for the summer examinations.

Centres need to ensure that candidates are aware of the general and mathematics requirements found in appendix 12 of the specification, page 179. It indicates that candidates should be aware of base and derived quantities and their units in SI. Candidates' answers to Q13a and Q15b suggest that some were not familiar of this requirement. Questions on units could appear in all four theory papers.

Each paper will have two or three questions where the quality of written communication will be considered. These questions will score marks for work that is clear and organised in a logical manner using technical wording where appropriate. Candidates need to avoid long rambling sentences and they need to think of as many different physics points as there are marks in that question. In this paper these comments refer to Q14 and Q19.

Multiple Choice Questions 1 – 10

On average, the performance on the multiple choice questions matched the candidates' performance on the rest of the paper. Of course there are some exceptions but in general candidates who did well on the multiple choice questions went on to do well in the remainder of the paper, a similar pattern was seen for the average and below average candidates. The questions that over 75% got correct were 2, 1 and 7. For questions 4, 6, 3, 10 and 9, the % that got them correct varied between 60% and 40% with questions 8 and 5 being the ones that candidates found most difficult with less than 40% giving the correct answer.

Question 11

The question required the candidates to effectively describe e.m.f. as a source of electrical energy and p.d. as a sink of electrical energy. They obviously didn't have to use the words sink and source but that was the idea that was being looked for. The question was poorly answered and for this series, to give some credit, one mark was awarded to candidates who identified the unit of e.m.f and/or p.d. as being a joule/coulomb.

Question 12

This question on a simplified water wave was meant to be straightforward and was testing candidates' ability to understand the graphical representation of a wave. Only the most able were able to score all three marks with two and one being the most common marks. Interestingly many candidates, who correctly identified that the water at Y was moving upwards, went on to put B, the point where the water was at rest at that moment, on the same horizontal line as Y. The other common error was to place A, directly below X at the same displacement but negative i.e. not actually on the graph. This question showed that there were some candidates who cannot actually relate what is physically happening to the point on the graph.

Question 13

The majority of candidates did not score the mark for stating the unit of charge in base unit. Part (b) differentiated well with 0, 1, 2 and 3 all scoring regularly.

Question 14

Most candidates did pick up some marks on this question. However, it was misread by some candidates who ignored the puddle completely and explained how polarisation could be demonstrated with two Polaroid filters. Information was given in the question for candidates to work out that the reflected light was polarised but it was a small number of candidates who realised this. This was a question where the quality of written communication was being considered and there was a requirement that candidates should use the word oscillation/oscillates/vibration/vibrates at least once.

Question 15

The definition of *n* challenges candidates with the most common answers being ‘number of electrons’ or ‘number of charge carriers’. Not knowing the definition of *n* then becomes a handicap in the second part of the question where candidates were asked to show the equivalence of units in an equation (see comment in introduction about this). Candidates need to be prepared for this type of question.

Question 16

Many candidates assumed incorrectly that they had to use all three of the possible answers that were given. Having got the first two statements correct, instead of thinking of the physics, they chose to say that the resistance of lamp A was greater than the resistance of lamp B simply because they hadn’t used that answer. The most common mark for part (a) was 2. Part (b) was poorly done. In questions relating to power, candidates need to select an appropriate equation for the quantity that is remaining constant, in this case the p.d. therefore using $P=V^2/R$. We allowed an e.c.f for incorrect answers to (a) but it was rarely applied because very few candidates gave the correct equation. Common answers were ‘B will be brightest because the current gets there first’ or ‘p.d. is the same for both components so they will be equally bright’.

Question 17

This question was generally very well answered although surprisingly it was the direction of arrows Y and Z that seemed to contain the most errors.

Question 18

Generally well answered. Some candidates lost a mark because in trying to identify three points (to fit the mark allocation), they said same frequency, same wavelength and 180° out of phase, not realising the equivalence of referring to frequency and wavelength. Some candidates also lost a mark because they used phrases such as ‘approximately the same amplitude’ or about ‘180° out of phase’. Also in part (b) it was not sufficient for candidates to say that the engine noise was continuous or constant, a reference to the frequency or wavelength was required. Many candidates assumed that because they were first introduced to cancel engine noise they worked better at that particular frequency and not so well for speech because speech had a different frequency to engines.

Question 19

From the candidates who did attempt the question many were unable to work out 5% of 60 W. This question is based on point 70 of the specification and help was given to the candidates by telling them the formula for the area involved. However very few candidates were able to arrive at the correct answer.

Part (b) was also not well answered with many candidates talking about filament lamps and why they were so bad, rather than focusing on the fluorescent bulb. Quite a few candidates used the word effective rather than efficient and many wrote statements about saving the planet. A lot of data was given but very few candidates used this data to back up their argument.

Question 20

This question only required candidates to use distance = speed × time and to realise that the distance travelled is half the measurement required. The diagram had the path of the ultrasound drawn to direct the candidates in the right direction. This was the most common mistake, closely followed by a failure to covert milliseconds to seconds. Part (b) was generally well done but where candidates went wrong was in trying to explain what ultrasound is, what longitudinal waves are or just saying to avoid interference without saying with what.

Question 21

Quite a few candidates scored full marks for this question. I suspect the candidates who gave answers such as violet or blue hadn't actually read the question. Candidates who did get part (a) wrong could still get full marks for part (b). Some, not being to sure, went for the safe option of calculating all three and choosing the lowest value. This is fine if the arithmetic is correct and they scored full marks but they did also lose time in doing the extra calculations. Answers in Joules were expected but answers in electron volts were also accepted, although this extra calculation was not required. A significant number of candidates having found the answer in Joules weren't sure if it was Joules or electron volts and so omitted a unit. Candidates who did this automatically lost the last mark as there was no unit. Candidates should attempt a unit rather than leaving it out.

Question 22

This question was a good discriminator over the whole range of candidates with the weaker candidates scoring some marks and the most able gaining nearly full marks. There are a few points than can be made however. The first is that having correctly plotted the points on the graph, some candidates do not realise that a best fit line can be curved, as far too many tried to draw a straight best fit line. Most candidates could calculate power and even the e.m.f. explanation usually managed to draw out at least one mark. However, the internal resistance calculation was not answered very well, even by the more able candidates. Although the specification does not specify $E = V + Ir$ or $E = I(R + r)$, these are two statements that apply Ohm's Law to the whole circuit and if candidates are to define and use e.m.f. and internal resistance, as specified in the specification, they need to be able to do this type of calculation. Part (c) was not very well answered, a few candidates left it out, possibly because they did not read the question properly and because there were no answer lines at the bottom and thought they had finished. We allowed an e.c.f from their first graph but many candidates who had drawn a straight line through the points they had plotted, then drew their second graph with a positive gradient through the origin. Very few candidates who drew the first graph correctly were able to pick up both points for the second graph.

Question 23

Generally candidates either had a full grip of what was necessary for this question or they had no idea. There were some mixed statements such as ‘photon energy is below the threshold frequency’. Quite a few candidates left part (b) blank and others left the first box blank and put a number in the second box. It appeared there was a lack of confidence about writing zero, perhaps they hoped that the examiners would take a blank box to mean zero. Negative indices also caused a problem, some candidates worked out that the current was 20×10^{-12} A and changed it to 2×10^{-13} A.

Part (c) was difficult. However, in order to make some of the marks accessible to the weaker candidates, it was split into two parts with the first part asking candidates to convert electron volts into Joules. Candidates could score one mark for identifying that the process required the use of 1.6×10^{-19}. The stumbling block to the last part of the question was the rearranging of equations which was poorly done. We saw $hf = \Phi + \frac{1}{2} mv^2$ rearranged as $2hf - \Phi = mv^2$ and even candidates who managed to correctly work out the kinetic energy were then unable to rearrange the kinetic energy equation to find the speed of the photoelectrons. A few candidates were happy with an answer greater than the speed of light.

Grade boundaries

6PH01

Grade	Max. Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	54	48	42	36	30

6PH02

Grade	Max. Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	54	48	42	37	32

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