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Principal Examiner Feedback

Summer 2013

GCE Physics (6PH01)
Paper 01R: Physics on the go

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For the first time this year, due to timing problems, different examination papers are being taken at centres based in the U.K. to those based overseas. This paper is being taken by candidates based overseas. It is intended to be exactly the same standard and style as the home paper and special care has been taken to ensure that the marking and grading are done to the same level.

Overall, the paper was answered well by the candidates. The questions may have been a little more mathematical in approach than many of the previous Unit 1 examinations, but some very good responses were seen, both in complex mathematical calculations and in the descriptive answers. The careless use of scientific wording was less apparent that might have been the case in the past. There were some common errors though where candidates put themselves at a disadvantage by imprecise use of scientific language, such as in question 15(a) where they might discuss the "speed" at which the viscosity was changing, even though "speed" in scientific terms clearly relates to time, not temperature. Also in question 14(b) where the correct wording of "resultant force" was often replaced with "external force", the candidates not realising that they had different meanings.

The questions involving Newton's laws were quite well answered this time, with candidates understanding well which laws applied to the given situations. However, a number of answers would have gained more marks had they been complete. For example in question 18(c)(i) the first statement should be "the bird exerts a force down on the ground", but we often saw the word "ground" left out, or just "there is a force down on the ground", or the question answered just in terms of body A and body B. It is important that students are taught to write answers that give the full description required, and not to leave out words which, though they might be implied by the response, have to be filled in by the examiner.

In calculations, numerical answers were often slightly wrong due to rounding at an earlier stage of the calculation. Although examiners try not to penalise rounding errors of this type, it is a pity that such errors creep in. The candidates should always work to a higher precision than required by the question so that the final rounding of the candidates' choice will give the correct answer. On a very positive note, numerical answers with the unit missing were very rare in this exam.

Questions 1 to 10

Question	1	2	3	4	5	6	7	8	9	10
Mean mark (max 1)	0.96	0.78	0.81	0.79	0.78	0.71	0.95	0.82	0.74	0.95

These multiple choice question were very well answered, only questions 2, 5, 6 and 9 showing a significant number of mistakes.

Question 2: It is always harder to pick out the statement that is **not** correct than the one that is right. A few candidates read it as asking for the correct statement, and so gave A as the first correct statement they read.

Question 5: To determine velocity from the graph the most common incorrect response was B, using velocity as displacement divided by total time rather than the gradient.

Question 9: In calculating the ratio of extensions some made the understandable error of inverting the values and choosing response A (2.0) rather than the correct response C (0.50).

Question 11: (mean mark 4.0, max 5)
This was a straightforward question on flotation, answered very well by the great majority of candidates. Remember that in A-level papers using a value of g = 10ms^{-1} is likely to be penalised. In part (b) they were asked to "state the weight of the cork", which most did (0.49N) but a few lost a mark by just saying "*The weight is equal to the weight of water displaced*" but not giving a value. In addition, the statement just quoted was not sufficient to justify the answer for the second mark. In such questions candidates need to show how the laws of physics are being applied, and for this context it was essential to describe how the upthrust on the cork was involved. The mark scheme allowed either a statement that the upthrust was equal to the weight of water displaced (Archimedes) or that the upthrust was equal to the weight of the cork (Law of flotation).

Question 12: (mean mark 2.7, max 6)
For part (a), which is really about describing terms that have a well defined meaning, there was a full spread of marks. Those who had learnt what the terms meant did well, but others, who were trying to write a description from the generally accepted meaning of the words, did not. For instance in (ii) spring constant is not a good term to apply to a wire in place of the Young Modulus; also in (ii) "*Hard to change its original shape*" and "*The resistance of material to plastic deformation*" were examples seen of insufficient or incorrect answers; in (iii), strength was confused with toughness, and also a description of the large force required to give a plastic deformation, rather than fracture. It is important, as scientists, that students learn the precise scientific meaning of words such as these.
For part (b), the great majority of candidates missed the point that the wires in a piano are constantly under tension. They attributed the force to the hammers striking the strings. This misunderstanding made it difficult to give a complete explanation, but the mark scheme was arranged so that they could still achieve two marks.

Question 13: (mean mark 2.6, max 5)
Part (a) was answered reasonably well. The candidates were expected to take the measurement from the tape to the nearest millimetre (mm), which was not difficult for the well defined dots on the exam paper. They could either take the distance between the two final dots (2.2cm) or the total distance (14.6cm). If they did the latter, there was a very common error in which the candidate counted the number of dots for the time (giving 0.28s) rather than correctly the number of spaces (giving 0.26s). This error was only penalised once if repeated in (ii).
For part (b), a good response seen was "*It's more accurate because it won't affect the motion of the object while the ticker tape timer may produce a drag to the car which may reduce the speed*". This candidate has understood the real problem with use of the ticker tape, which is the extra friction introduced. However candidates who said that the student did not have to calculate the velocity, a much more common answer, were also awarded the mark. They should, however, have realised that the velocity did still have to be calculated by the computer, so a response such as "the velocity is read out directly" did not get the credit. Many produced the standard responses which may not be relevant to the case in hand, such as greater precision, no reaction time, no human error, and very commonly "plots a graph automatically", even though no graph was required here. Candidates should think about the situation being examined when answering questions of this type.

Question 14: (mean mark 4.7, max 7)
For part (a) the calculations were generally tackled well, the main problem being with those candidates who did not realise the energy in part (i) was transferred to kinetic energy so that 1/2 mv^2 could be used to find the velocity. These candidates often wasted considerable time trying to use equations of motion and F=ma. For (iii) we were looking for a simple statement about friction or energy dissipation, but many marks were lost for incomplete statements. For instance the word "friction" alone was not enough. Friction always acts between two objects and we want to know what those are in this application, so "friction between the car and the track" would get the mark.
For part (b) many marks were lost for poor understanding of Newton's first law, and for careless use of scientific language. A good and concise response seen was "*If the resultant force acting on an object is zero, its velocity will remain constant. The resultant force is zero, so the car can not change its direction. Then it leaves the track at the corner*". Many thought an extra force would be needed to remove the car from the track at the corner, e.g. *"At high speed there will be a resultant force causing an acceleration*", and others, instead of continuing in a straight line, said it would continue in the forward direction, although the car would still be moving forwards if it went round the bend in the track. Often the word "external" was incorrectly used in place of "resultant", and occasionally there was a confused reference to centripetal force.

Question 15: (mean mark 5.5, max 10)
(a) There were 2 marks. The first mark was for a very simple description of the trend shown by the graph, i.e. that the viscosity decreased as the temperature increased, and this mark was almost invariably scored. The second mark was rarely scored and was for a more detailed description, e.g. "at a decreasing rate". "Non-linearly" is clearly insufficient and "inversely proportional" is clearly wrong, although both were seen quite often. Incorrect use of the words which normally relate specifically to time, such as "quicker" and "slower" was not credited.
(b) For the units question (i) we were expecting to see the units N (or kg m s^{-2}), m, m s^{-1}, and N m^{-2} clearly delineated. The algebra also needs to be in terms of units and not variables. For part (ii) there were few errors, the most common mistake being to substitute the viscosity as 1.12 rather than 1.12×10^{-3}.
(c) Although the question itself was clear, many responses indicated that candidates had not really understood what was being asked, and they need to be told to read the stem of the question fully to get a clear idea of the context to which their response needs to be addressed. In this case we need a replacement for diesel and would like that replacement to be biodiesel. However, that is not suitable but a blend might be, and they are asked to explain why these blends are being researched. In the response the candidate therefore needs to tell us why biodiesel cannot be used alone, and how a blend might help. One good candidate wrote "*Biodiesel has a much higher viscosity than diesel and also has a much higher freezing point*", immediately gaining the first two marks. This candidate then went on to describe how adding ethanol with low viscosity and freezing point could reduce the viscosity of the biodiesel, so gaining the third mark. However, too many candidates just picked out a few points from the table without applying them to the problem with which the question was concerned. Others described the benefits of using renewable fuels, which gained no credit. Many answers, though not incorrect statements were too vague to award a mark, examples being: "*The viscosity of the blends is not too high or too low*", and "*By combining, the blend will have a suitable viscosity*", neither of which described what viscosity was required.

Question 16: (mean mark 5.7 max 9)
This question was well answered, with many candidates showing a very good understanding of the use of some quite complicated mathematics in the solution of a physics problem.
In part (a) there were many approaches to the problem, but the most common was to calculate the time taken to reach the maximum height and then double that to give the total time of flight. The best candidates put the total displacement at zero and then solved the quadratic equation to find the time. A common problem was to ignore the fact that if the initial velocity is 2.8 m s^{-1} then the value of *g* is −9.8 m s^{-2}. Ignoring the negative lost a mark.
In part (b) some tried to combine the horizontal and vertical velocities when calculating the horizontal distance travelled.
Part (c) was a demanding calculation aimed at testing the strongest candidates. However, a pleasing number of responses gained full credit. Again there were many possible approaches to the question, but the best substituted the new vertical displacement of −0.50 m into $s = u\,t + ½\,a\,t^2$ and solved the quadratic for the total time.

Question 17: (mean mark 8.2, max 13)
The context of this question was a pile driver used for driving posts deep into the ground. The candidates are not expected to have met the device before and need to be able to understand how it operates by reading the stem of the question. They are then asked questions about the physics behind the operation of the device, and although the marks are for the individual physics principles, the candidates are unlikely to score highly if they have not understood the mode of operation.
Part (a) is about energy transfers. Very few made any mistake in part (i), but part (ii) caused difficulty because a large proportion of the candidates thought that the wasted energy (60%) was being used against the resistive force of the ground, rather than the correct 40%.
In part (b) the calculations of compression and energy stored were done well, but the written response required for part (iii) generally scored fewer marks. Most candidates recognised that plastic compression was taking place, but then did not go on to give a good reason why that meant the cushion would have to be replaced. A response such as "it will no longer work" is too vague. "It would lose ability to absorb any force" is better, but still does not give a reason. A good answer was "*The wooden cushion will undergo plastic deformation after a few hundred impacts, and will no longer be able to be compressed ….*". To explain why the temperature of the cushion would rise, it was not sufficient just to say that energy is transferred to heat. Some description of the hysteresis shown on the graph was necessary, although probably not using that word.

Question 18: (mean mark 6.6, max 15)
Part (a) is about drawing laminar and turbulent flow of air past the bird's wings. As the candidates are told where the air is laminar and where it is turbulent, the question is really about recognising what these types of flow look like. Any turbulent flow under the wing is likely to lose both the marks for the question.
For part (b)(i)the correct calculation is mg / cos 20°, but an approximately equal number of candidates used mg × cos 20°, losing two marks. This error was, however, carried forward to part (ii) so that full credit could be obtained there for calculating the acceleration.
For part (c) we are looking for a response like "By Newton's third law, if the bird pushes down on the ground, the ground pushes up on the bird. There is therefore a resultant force on the bird, so Newton's first law tells us the bird must accelerate". The candidates were expected to specify the laws they use and to apply them to the bird. Some gave a detailed description of Newton's third law, for instance, but did not apply it to the bird, just left it as "body A" and "body B".

“External force” is not a good substitute for “resultant force” as, for instance, the weight is an external force that is always acting. Many candidates only discussed the third law giving the force on the bird without moving on to the acceleration, and so just giving half the answer. The calculation in part (c)(ii) more often than not missed out the effect of the weight and assumed the only force acting was the force obtained from the graph.

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