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# Principal Examiner Feedback

# January 2014

## IAL Physics

## Unit WPH01 Physics on the go

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## Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
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Section A - Multiple choice items

For the majority of candidates their performance in the multiple choice items correlated well with their performance in section B. Some weaker candidates scored highly on the multiple choice items. However, this often seemed to be at the consequence of completing the whole paper and the questions towards the end were not always answered.

| | Topic covered | Correct response | Most common incorrect response | Percentage of candidates answering correctly |
|---|---|---|---|---|
| 1 | Base quantities | D | B | 84 % |
| 2 | The trajectories of horizontally launched projectiles | D | C | 54 % |
| 3 | Conservation of energy calculation involving a transfer of GPE to KE. | C | A | 69% |
| 4 | Calculation of power | B | A | 76 % |
| 5 | Calculating the acceleration using the gradient of a velocity-time graph | B | C | 90 % |
| 6 | Calculating the displacement using the area under a velocity-time graph | C | D | 65 % |
| 7 | Young modulus | B | D | 69 % |
| 8 | Stiffness of a spring | C | D | 34 % |
| 9 | Work done from the area under a force-extension graph | D | C | 63 % |
| 10 | Stoke's law and the forces on a falling object. | C | B and D | 49 % |

Section B

11 The majority of candidates attempted this question in a quantitative manner. The mark most easily obtained was for calculating the increase in GPE (or total work done against gravity). Some candidates were able to resolve the weight into perpendicular components, but few were able to appreciate that work done had to be calculated in terms of the direction of the applied force. Hence multiplying their value by 365 m and making an incorrect conclusion.

Few candidates managed to score all three marks, often due to incorrect use of trigonometry (cosine rather than sine for the component of force) when calculating the component of weight or distance along the slope. Although many responses included annotated diagrams, which generally tended to help them, candidates were let down by their use of trigonometry and lack of experience of finding the components of a forces parallel to a slope.

Those who realised that the work done would be the same to reach the top, regardless of the side taken, often scored well by realising that the less steep side (25°) would require a lower force. However, many candidates that managed to successfully calculate the correct force and distance and hence the work done when using each slope, failed to appreciate that the work done would be the same. Many candidates looked at the small difference between their values, due to rounding, and assumed that the work would be different, missing the point that the work done would be the same regardless of the route taken.

This question was not intended to be answered quantitatively with only 3 marks for ideally three short points. Firstly that the work done would be the same, regardless of the side take, then a correct statement comparing the force required and the distance along each slope.

12 The context of this question was well understood and responses generally used the information given and the physics of the specification to appropriately explain the shape of each volcano.

Many candidates correctly commented on the relationship between viscosity and temperature, scoring the first marking point. Statements made were often the wrong way round for the context of the question with increasing rather than decreasing temperature.

The majority of candidates managed to score a mark for using the graph to identifying that the viscosity of basalt was lower than that of rhyolite, with many concluding that the basalt would flow at a greater rate. Fewer candidates managed to successfully link this to the shapes of the two volcanoes with many just referring the lava flowing easier so it spreads out and not realising that the cooling of the lave as well as it's viscosity determines the shape of the volcano formed.  Hence the 4$^{th}$ marking point was awarded the least.

13a Question 13 required the candidates to explain how the apparatus given in the diagram could be used to obtain accurate the required measurements for the experiment described in the question. No additional information was required for part (a) with part (b) asking for how the measurements would be used. However, candidates managed to muddle up both parts of this question, often writing their response to (b) in (a) or repeating (a), usually word for word in part b. Many candidates misread the question assuming they were being asked to describe details, taking the method as given and solely focussing on how to carry out the experiment accurately.

Marks were commonly awarded for identifying that the initial length of the spring would have to be measured but few went on to score for a clear description of measuring the length once a mass had been added to the spring. Most frequently candidates referred to measuring the extension of the spring. The third mark required the method of repeating this method for additional masses but again, this was not always included.

Many candidates picked up on the requirement for a description of a measure taken that would increase the accuracy of the measured data. Most candidates were awarded the mark for a reference to measuring at eye level or to using a set square to make sure the ruler was vertical. References to just reducing parallax or use a set square did not tell us how they would make the measurements more accurate and were insufficient to score the $4^{th}$ marking point.

13(b) 3 marks were frequently awarded for a good description of a suitable graph. Usually a force-extension graph was suggested then a reference to use of the gradient to calculate the spring constant. Some candidates suggested using $F = kx$ to find $k$ and averaging over all the values of $k$ calculated. This would have just scored a maximum of one mark as the question required a reliable value of $k$ and a graphical method would be the most reliable.

13 (c) Many candidates confused the limit of proportionality with the elastic limit and referred to the plasticity of the spring and not to k. Therefore responses such as 'the spring would not return to its original length' or 'the spring could not be re-used' were common.

The question was asking for the importance of exceeding this limit, responses re-wording or explaining the question such as 'the force will no longer be proportional to the extension' were also frequently seen. Such responses did not explain the importance within the context of the experiment of exceeding this limit. This experiment relied on using Hooke’s Law and a linear relationship between the variables in order to calculate $k$ is assumed.

14(a)(i) Many responses assumed that the archer would be using the traditional method of firing their arrows upwards rather than reading the question which clearly states that the arrow is fired horizontally. A large number of candidates drew a straight line from the archer to the target rather than a parabolic curve downwards. In projectile questions candidates should be aware that the initial direction should not be taken as given and look within the text for additional information.

14(a)(ii) Candidates answered this question well, selecting the correct equation using the horizontal data to calculate the time of flight of the arrow. The correct answer of 0.417 s was occasionally truncated to 0.41 s preventing the candidate from obtaining the final answer mark. If an answer is truncated and is not equal to, when rounded to the same number of significant figures as the final answer quoted in the mark scheme, then the final answer mark will not be awarded. Therefore, candidates that gave 0.41 s and not 0.42 s (as written in the mark scheme) lost the mark.

14(a)(iii) The majority of candidates were able to successfully select the correct equation of motion and substitute in the relevant vertical data to find the displacement. Most of these candidates realised that to obtain the height above the ground, the calculated displacement needed to be subtracted from 1.5 m.

Some candidates failed to realise that the initial vertical velocity was 0 and proceeded to mix the vertical and horizontal components, substituting in the horizontal velocity of 36 m $s^{-1}$ for *u*. A small number tried to use the entire trajectory to the ground, calculating the total time and then the distance.

14(b) This response was answered very well with the majority of candidates working logically through and describing all the changes to the relevant variables for the archer standing closer to the target.  Therefore most candidates described how the time of flight would be reduced, the vertical displacement would therefore decrease and hence the height above the ground would increase. Marks were mainly lost due to a lack of clarity when describing the distance, as some statements seen were ambiguous as there three distances involved and the candidate had to be clear as to which one they were referring for the final mark.

15(a) Nearly all responses labelled weight correctly. Far fewer responses labelled the upwards arrow successfully and there generally seemed a lack of experience and understanding of the reaction force, especially when upwards arrows were labelled as resultant force. Some responses contained additional forces such as drag, air resistance, illustrating that the context of the question was not grasped by all.

15(b)(i) Compared to previous lift questions, this calculation was answered well by most candidates with 48 % scoring all three marks. The majority of students realised that a difference in the mass reading was required in order to calculate the resultant force. Most of these candidates could then successfully use resultant force = mass x acceleration to calculate the initial acceleration of the lift. Some candidates assumed that the mass of the accelerating lift was 73 kg, just scoring a maximum of  2 marks whilst weaker candidates occasionally used 73g = 60a, scoring just 1 mark for use of $F = ma$ without an understanding of the physics of the accelerating lift.

15(b)(ii) This question was answered correctly by most candidates. Most substituted in *u* and *v* the correct way round, with many correctly removing the minus sign when quoting their final answer for the deceleration. The second mark, if not awarded was due to the omission or an error when quoting the unit.

15(c) For the most part some good attempts had been made by the candidates who had thought carefully about the air flow. There were some clear representations of laminar and turbulent air flow however, not all candidates managed to apply it to the situation.

The transition from laminar to turbulent was often missing with candidates leaving voids with no air flow at all. Additionally, some candidates drew their lines representing air flow for laminar right into the building and made no attempt to curve them around the building or give a transition into what would be turbulent flow. The given lines were intended to start the candidate off but many chose to start their own flow lines for laminar, usually nearer the building. The question clearly asked for the air flow around the building i.e. a continuous flow therefore laminar lines ending abruptly or even going across the building did not demonstrate a good understanding of the context.

The question specifically asked for the regions to be labelled and some, very accurately drawn diagrams failed to score as they contained no labels.

16(a)(i) Candidates found brittle and ductile easiest to identify with many more identifying that graph C, copper, was the least stiff material. Candidates frequently assumed that material B was the strongest, identifying the greatest strain on failure rather than the greatest stress as a measure of strength.

16(a)(ii) This question was answered correctly by many candidates and the majority of incorrect responses had the graphs for steel and copper the wrong way round. Given the varied responses seen for part (c) of this question where few candidates were able to identify the yield point and even fewer could correctly explain its significance, it would appear as though the graph for steel is less familiar to many students than that for copper.

16(b) Many properties of steel make it suitable for use in the production and use of paper clips. This question required the candidate to identify and explain one of these properties and then correctly explain how the selected property makes it suitable for that aspect of the life/use of a paper clip. The vast majority of students managed to identify at least one property of steel and many also managed to explain a behaviour of the paper clip that is required for its use or manufacture. The question had asked the candidates to explain why steel was suitable for this item and therefore the property and the required behaviour had to be linked to obtain the third mark. Candidates found that difficult, with most of the candidates that scored all 3 marks simply stating 'it is ductile because the steel can be drawn into wires'. Attempts at explaining other properties of steel were not as easy and rarely scored the third mark.

16(c) There appeared to be some confusion for many candidates between the limit of proportionality, the elastic limit and the yield point. Although point 'X' was clearly positioned just before the dip in the graph, the majority of candidates believed 'X' to be the elastic limit. The few candidates that could identify that was the yield point did, for the most part, not understand its significance, instead assuming that the material would begin to exhibit plastic behaviour beyond this point. The few responses seen that attempted to describe the true behaviour beyond this point were often poorly worded, usually omitting the 'increase' for stress It would be better for candidates to understand the significance of these points rather than learn definitions by rote as the omission of a key word can significantly change the meaning of a statement.

17(a)(i) The calculation of the gradient was generally well done. Some candidates appeared to be unnecessarily selective as to the values chose so that the final answer would equate to exactly 0.06, most good attempts managed to calculate a value within the given range. Few candidates misread the scale compared to similar questions on previous papers and very few attempted to find the gradient of the wrong part of the curve. Students should be encouraged to leave evidence on the graph of the tangent and right angle triangle they have created to cleanly show the origins of the numbers used in the answer space for the gradient calculation.

17(a)(ii) The graphs seen produced a wide range of marks, some fully understanding the question, others not remembering that the ball was running at a constant speed (and producing curves). The majority of candidates managed to score at least the second marking point for a straight, diagonal line of increasing displacement starting from s = 0, therefore identifying the constant speed nature of this section of the marble’s journey. Many more identified that the displacement would not exceed 0.20 m (MP 3). Some appreciated that the displacement of the marble would decrease as the direction changed, hence, producing the triangular shape commonly seen. Only the best candidates thought about the turns on the right side of the track and the effect these would have on the displacement managing to produce a dip at the maximum displacement of their graph.

17(a)(iii) Just 13 % of candidates realised that the average horizontal velocity of the ball was zero. The fact that there was just one mark, combined with the request that the candidates 'state' the velocity should have clued in the candidates that no further calculations were required.

17(b) Candidates scored well with the majority scoring two or three marks, usually for two relevant points taken from the 'max 2' section of the mark scheme. Although the first marking point was frequently awarded, comments made on accuracy or the precision rarely were explicit to the measurements to be taken.

Many incorrect references to parallax were seen and candidates should be aware that, depending upon the position of the camera relative to where distance measurements are to be taken from the ruler, this can be as much of an issue using a video camera as with a ruler and stop watch.

18(a)(i) The vast majority of candidates managed to score at least one mark, usually for identifying the upthrust. 'Reaction' and 'normal reaction' were the most common incorrect responses for upthrust. Candidates struggled in naming the force pulling the iceberg along, using 'pull' or 'force' as the label. If a force is unknown then a candidate will usually score the mark for identifying the source of the force and the object on which it acts, therefore as response such as 'the force/pull of the boat on the iceberg' would score the mark.

18(a)(ii) Use of trigonometry to calculate the components of vector quantities is a skill that only the middle ability or better candidates manage to successfully use. Some candidates forgot to halve the given angle using cos 30° whilst other candidates unsuccessfully attempted to find the component of the drag force in the direction of the tension in the ropes using $T = 3.3 \times 10^{5}(\sin 30°)$.

Whilst most candidates realised that to find the tension in each rope a component of the tension in the direction of motion would have to be calculated, weaker candidates realised that drag/2 gave a value close to the 'show that' value and did not attempt to find the component of the tension.

18(a)(iii) Most candidates managed to score a mark for use of work done = force x distance however there was a lot of confusion as to which force to use, many candidates choosing their calculated value of tension from part (i). Some candidates did not realise that the work was done by the boat against drag, choosing instead to re-work their tension force calculated in part (ii) and find the total tension acting in the direction of motion i.e. a very long way round and not always successfully carried out.

18(a)(iv) Many candidates worked logically through some of the consequences of using longer tow ropes. Most could identify that the angle of the ropes would be lower and then about 20% correctly identified that the tension in each rope would be less. Most candidates then went on to conclude that there would be less work done. Few realised that because the power of the tug is the same the work done would be the same, so although the tension would be lower for a smaller angle, the motion would remain unchanged.

18(b) The attempts at constructing the vector diagram were better than seen previously for similar questions. Parallelograms were the most successful constructed diagrams, often scoring both of the diagram marks. Candidates attempting to draw triangular vector diagrams did not always draw their forces head to tail and so the resultant was then in the wrong direction. Some candidates chose to use different scales for the two forces, preventing them from scoring the second marking point and others did not know west from east.

Although the question asked for the drawing of a scaled vector diagram to determine the velocity, most candidates drew the diagram and then went on to calculate the magnitude of the velocity. Although using this method was not penalised for the final answer, most forgot to include a direction hence usually scored only 1 mark for an attempt at the vector diagram. After spending time working out the correct magnitudes and directions some good candidates lost the third mark choosing to use $m\ s^{-1}$ rather than the given $km\ h^{-1}$.

18(c) Most candidates managed to score a mark for realising that the required ratio could be found by dividing the given densities. However, the question asked the candidates to show how to obtain this value so we needed to see that they understood the physics behind the ratio. Therefore as a starting point, as with any upthrust question you had to identify that the upthrust is equal to the weight of water displaced. The candidate could then use a variety of methods using upthrust or weight = $\rho Vg$ to either the volume or a statement in terms of the unknown volume for the weight and upthrust which would then lead to a ratio being calculated for the third marking point.

18(d) Over half of the candidates managed to score a mark usually for identifying that the sea temperature increased and then for identifying a decrease in viscosity or density due to the warmer water. Although candidates could often successfully link the decrease in density of the water to the fact the iceberg would be in a lower position, some responses were expressed ambiguously and candidates missed out on a second mark.

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