Examiners' Report
Principal Examiner Feedback

October 2017

Pearson Edexcel International Advanced Level

Physics (WPH01)

Unit 1: Physics on the Go

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General introduction

This paper enabled students of all abilities to apply their knowledge to a variety of styles of examination questions. The questions on this paper were more context based than has been seen in previous WPH01 papers. It was good to see that, on the whole, the students were able to apply the physics they had learnt to these real and unfamiliar situations even though they had not studied them directly. However, it was often the simpler contexts or conceptual questions that prevented students form scoring such as straightforward definitions and practical that should be familiar to most. Timing was an issue for some students and questions 19(c)(i) and (c)(ii) were left blank by a fair number of students.

The quality of open response style questions was good, with students giving clear descriptions of the physics involved, within the context of the question, in a clear and logical manner. One area highlighted by the responses seen is the subtlety of the command word used in a question. Whereas 'explain' may required a candidate to apply their knowledge of a concept to the context of the question, 'describe' requires the candidate to almost just state what they can see in a graph, or as in this case in question 17(a), in a photograph. An explanation of the forces involved was not required as that would have been an explanation of the observations. The subtlety of the wording of the question was also evident in question 13(a) and 13(b) where the question specifically askes for 'a' property. Many students identified the correct property but then continued to list and explain additional properties. This could perhaps be brought to the attention of the students when completing past papers in preparation for the exam.

The shorter calculations were successfully answered by many as were the longer calculations. For some questions the calculations were performed more successfully than is usually seen, in particular question 18(a), for the strain in the ribbon, however the context for question 19(b) and 19(c) appeared to be more challenging and students did not perform as expected. This was particularly evident in 19(b)(ii) where the incorrect resultant force was frequently used in $F = ma$ and in 19(c)(ii) where very few students identified that the pump would have to transfer sufficient power to the water to supply both kinetic energy and gravitational potential energy to lift the flyer to lift them above the water.

Section A – Multiple Choice

While most of the multiple choice items were answered very well and, as anticipated, with increasing numbers of correct responses as the ability of students increased, a few were not answered as expected. The mean score for questions Q1 to Q10 across all students was 6.2. With A grade students typically scoring 8 and E grade students typically scoring 6.

	Subject	Percentage of students who answered correctly	Common incorrect response	Comment
1	Units and vector quantities	78	C	The first question is often answered in haste and many students, by selecting C forgot that $m\ s^{-1}$ is the unit for both speed and velocity.
2	Displacemen	62	C	30π is the distance travelled i.e. half the circumference of the inner diameter whereas the displacement is the shortest distance from start to finish i.e. 2 × the radius.
3	Kinetic energy	84	–	High scoring correct response
4	Graph of projectile motion	22	D	Graph D would be that of velocity against time for an object in free-fall as $v \propto t$. Using either the equation of motion $v^2 = u^2 + 2as$ to show $v^2 \propto s$ or $\frac{1}{2}mv^2 = mgh$ to show $v^2 \propto h$, the graph is that of a quadratic, plotted the other way around to the way students should be familiar with.
5	Stoke's law and terminal velocity	50	B	As weight of raindrop = drag force at constant velocity, i.e. $\rho Vg = 6\pi\eta rv$, the only quantity from A to D not considered is C. The viscosity in the equation is that of the air as the raindrop is moving through the air.
6	Properties of materials	63	D	Sea shells have all of the properties listed, in relative magnitude, but it is the property of hardness that prevents the scratching and students were only asked to explain this effect.
7	Free-body force diagram	36	C/D	The normal contact force always acts perpendicular to the surface the body is in contact with, so response C was incorrect. As students may be familiar from examples with vehicles, the foot pushes backwards against the floor so the frictional force acts in a forward direction.
8	Resultant velocity	90	–	High scoring correct response
9	Work done	61	C	The work done against gravity is the gain in gravitational potential energy and therefore the vertical distance moved by the object is required. Incorrect response C used the horizontal distance travelled.
10	Extension of springs	76	C	While Response C correctly identifies that the extension of L will be the same as spring M, the tension in spring N is double that in L and M as N is not 'sharing' the applied load. Therefore, the extension will be double that of L and M.

Section B

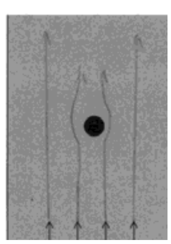
Question 11:

The context of the movement of the crystals through the honey to form larger crystals was grasped well by most students. Language was a barrier for some students and the preciseness of the responses did not always match the subject knowledge as it had to be clear for marking points 2 and 3 as to whether the honey or the crystals within the honey were being discussed. The link between the increase in viscosity (at lower temperatures) and the reduced speed of the crystals or rate of flow of crystals/fluid i.e. the increased drag force was often over looked, and the middle mark was awarded the least frequently

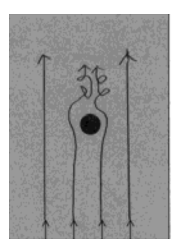
Question 12:

(a) This calculation was performed very well with 78 % of students scoring both marks. The most common errors were to omit the units or forget to transfer the $\times 10^{-4}$ from the calculator when writing out the final answer.

(b) As with previous questions where students have been asked to extend the flowlines of a fluid around an object a vast range of responses were seen. The example below on the right is a good response and scored both of the marks. 12(a) required the students to apply Stoke’s law to the motion of the ball bearing, a law that requires the assumption that flow of the fluid around an object to be laminar. Unfortunately, many students missed this point and consequently included a region of turbulent flow in their response (see the example of the right below). Any turbulent flow preventer MP2 for the inner two flow lines from being awarded. It was expected that students would continue the four flow lines therefore those that included additional lines or just drew lines for a small region next to the bearing did not always score both marks.



2 marks



1 mark
(MP1 only)

Question 13:

(a) This question was mostly well answered although some students selected and explained additional properties. While these additional properties such as toughness, stiffness or strength may be true for brass, they are not the properties that enable it to be pulled into shapes with a narrower diameter. Responses that explained ductile in general terms i.e. drawn into wires were not credited as MP2 required an application to the context and this was too specific to another application i.e. wires. Good responses went on after identifying the correct property as ductile to explain that this was because there would be a large permanent deformation under tension. A few students omitted the nature of the force i.e. tensile, but it was good to see so many students identify the difference between ductile and malleable properties in that one is under a tensile for and the other under a compressive force.

(b) This was not answered quite as well as part (a) and those students that did identify the property as malleable did not always explain it precisely enough for the mark. Bending into shape was seen in many responses which is just a repeat of the question and did not add any further Physics to the explanation. It was more common in (b) than (a) to see additional properties listed in the response.

Question 14:

(a) This question produced quite a spread of marks. The less able students attempted to use $F\Delta x$ for the work done which did not score any marks as the force is increasing and not constant. While the minimum to attain one mark was for approximating the curve to a straight line and using $E_{el} = \frac{1}{2} F\Delta x$, many students attempted to count squares with fewer approximating the region under the graph to a series if shapes such as a triangle and then counting squares for the remained. The range for MP3 was quite small so not all students, even if they had used the counting square method, had an answer in range. Many answers were a factor of 10^{-2} out as the candidate had missed that the units for the extension were in 10^{-2} m.

(b) Specification point 22 suggests that students should be familiar with force-extension graphs for copper wire, nylon and rubber and therefore should be able to draw an unloading curve for rubber. While many drew a curve, not all went back to (0,0) which demonstrated the elastic nature of rubber. The most common response seen was just a straight line form the maximum to the minimum applied force. This did score the second mark for the graph ending at the beginning of the given graph as it demonstrated the elastic properties of rubber. Some students forgot to answer (b) as the lack of an answer space often causes some students to miss a question part e.g. when the candidate has to add to a graph.

Question 15:

(a) Again, this response produced a good spread of marks with most students picking up a minimum of 1 mark, usually MP3 for a calculation of the instantaneous velocity of 40 m s^{-1}. Better students drew a tangent to the curve at 15 s scoring MP2. Use of equations of motion to determine the velocity were accepted as it had not been stated that the acceleration was uniform. MP1 was awarded the least frequently as many students omitted a statement as to why the given value of 15 m s^{-1} was incorrect or based their answer on incorrect plotting which was incorrect.

(b) This question was found to be challenging by many students with many confusing the concepts of decreasing acceleration and deceleration. Most students assumed that the car was decelerating however, many contradicted themselves and went on to correctly describe a decreasing acceleration. Some assumed that the car was at terminal velocity and that the forces were already balanced rather than describing the stage prior to this. MP1, when awarded, was most frequently given for a decreasing acceleration and MP2 for the drag increasing.

Question 16:

(a) This question was not answered as expected. Some students assumed that the constant acceleration was due to the frictionless surface of the air track or assumed that the air provided the accelerating force. Students that identified that mass M was responsible for the acceleration of the glider did not always express their answer precisely enough in terms of the applied force, resultant force and resulting acceleration of the glider. While many could identify that it was the acceleration of the mass Those that did correctly identify that there was a constant resultant force acting on the glider did not always explain why sufficiently to gain MP3 i.e. with a reference to Newton's first or second law. Linking the constant resultant force to constant acceleration by stating $F = ma$ was not sufficient for this third mark.

(b)(i) Students are not always successful in their explanations and definitions of prescribed terms. This is often a centre based issue rather than one of the candidate's ability. A large number of answers referred to comparing the measured to the true value i.e. the error rather than the resolution of the measuring instrument.

(c)(ii) It was expected that students would describe an experiment using the equipment referred to in earlier parts of this question when describing the procedure. In many cases it was difficult to know whether the candidate was using this equipment or that from a different experiment due to the lack of detail provided when describing measurements to be taken. While most students could identify that a time should be recorded, the corresponding distance to be measure (with a metre rule) was not always defined clearly. The length of the track would not be the correct distance as the time is only being recorded between the light gates. Therefore, MP1 was harder to obtain as students had to be clear that they were measuring the correct distance. Most students identified that the relationship between the displacement *s* and the time *t* was not linear and described a suitable graph and consequential calculation in order to obtain a value for the acceleration. The less able students suggested plotting a graph of s against t or described using the values obtained in a suitable equation rather than using a graph as instructed. Very few students suggested how to obtain a range of readings (MP3) and many of those that attempted to suggested additional readings often changed the mass and not the light gate separation.

Question 17:

(a) Many students described the independence of the vertical and horizontal motion but were not answering the question in doing so. It was most common to award two marks for describing the constant horizontal velocity and the increasing vertical velocity. Few students referred to the photograph itself so scoring more than 2 marks was infrequent and more based on the candidate's ability to read the question rather than their knowledge of Physics. The question specifically referred to 'reference to the photograph' so it was expected that they would state what they could see (in the horizontal and vertical directions) and then describe the resulting motion. Statements only referring to increased or constant motion were not specific enough. For example, the horizontal motion is constant could be referring to a constant velocity or a constant acceleration and is too vague alone.

Many students missed out on the subtlety of the command term 'describe' and gave an explanation as to why the velocity would be increasing or constant in terms of the forces acting on the cyclist. Thus, giving the answer to a question had 'explain' been the command term.

(b)(i) This question produced a wide range of marks, with surprisingly few students scoring full marks, despite being a fairly typical projectile motion question. Many students scored a minimum of MP2 for use of the correct equations of motion, most commonly $s = ut + \frac{1}{2} at^2$ although not always with the initial velocity and acceleration in opposite directions. Many of these students remembered to use the correct vertical component of the initial velocity ($9.5 \text{ m s}^{-1} \times \cos 10 = 1.65 \text{ m s}^{-1}$) so most responses scored at least 1 mark.

Some students attempted to calculate a time for the cyclist to move up to the maximum height and then return to the same height and then calculate the height directly using a corrected value for the time of the motion. Unfortunately, few were able to carry out these steps successfully, many assuming that the initial velocity would then be 0 rather than the same value (9.5sin 10), just in the same direction this time as the acceleration. Only the best students that attempted to use this more circuitous method managed to score all 3 marks.

(b)(ii) This numerical question was well answered with 65 % scoring all 3 marks. Some students chose to divide up the motion depending on the vertical motion and then calculated the sum of the individual horizontal motions. Although a longer method, this was usually carried out correctly.

(c) This question was poorly answered, and showed that 'weightlessness' is a poorly understood concept generally. Many students discussed the resultant force rather than the reaction force, believing it to be zero at the instant of weightlessness rather than identifying the cause which would be a lack of a reaction force on the cyclist. Others thought it occurred where the velocity is zero or discussed terminal velocity. Those who did not manage to score full marks did sometimes gain credit for a reference to the weight being the only force acting on the cyclist.

Question 18:

(a) Nearly all students recognised the need to use both the equations for stress and the Young modulus, with the most common error coming from failing to convert the mass into kg. A few students were unsure of the units for strain, and possibly guessed a unit, which in some cases cost them the final answer mark. A small number of students assumed that the ribbon was a cylinder and were not able to calculate the area correctly, usually using the width as a radius or diameter.

(b) The most commonly awarded mark was MP2 for correctly stating plastic deformation. MP1 was not awarded very frequently, with students describing the plastic deformation in too much detail and not about the effect of a greater tension on a material. Many students assumed that the top of the ribbon underwent plastic deformation while the bottom the ribbon underwent elastic deformation. This is an acceptable explanation however there had to be a link to a greater difference in length between the two sides and the curling to award MP3.

(c)(i) This was well answered with most students being able to make the correct link between the applied tension and the diameter of the curl formed. A few students did mix this up with the next question, 18(c)(ii), commenting on the shape of the edge.

(c)(ii) It was expected that students would identify that the area of an edge decreases when a shaper edge is used compared to a round edge and then link this to a curl with a lower diameter. However, responses seen were more of a comparison between the diameter of curl formed with a round and with a sharp edge. Such responses were credited. Again, answers to part (i) were seen here with descriptions linking tension and diameter.

(c)(iii) While students generally answer materials questions well, the context of this question and the mechanism of the curling added complexity. The most common idea to gain credit was for the idea that if the cylinder is rotating at a lower speed then the force would be applied for a greater time. Many students incorrectly assumed that this would result in a greater force or tension. However, few then made the connection to a greater time causing a greater extension and a greater difference in extensions to a smaller diameter of curls.

Question 19:

(a) Most students identified that the applied force onto the flyer was due to Newton's third law and the subsequent acceleration was because of Newton's first or second law. However, a common misconception that it is the ejected water colliding with the seawater or air that causes the 'reaction' force prevented many from scoring MP1 and MP2. Students were generally good at referencing the relevant laws, showing some experience of similar questions. Very well-prepared students may have recognised the similarity in the physics between this question and a question from a few years ago on the 6PH01 paper involving the movement of solid carbon dioxide due to the emission of carbon dioxide gas.

(b)(i) This question was answered correctly by most students. Those that were unable to reach the correct answer of 701.5 N usually dropped marks due to an incorrect vertical component of one of the forces or a rounding error, giving the final answer as 701 N.

(b)(ii) This question was found to be more difficult in that the students were told to ignore the tension in the pipe but had to still consider the weight and the vertical component of the force from the ejected water. Many did not include both forces in the resultant force or used 960 N rather than the vertical component of the force from the ejected water of 960cos12. In addition to this, the mass of the flyer was not supplied, and the students were required to calculate the mass using the weight determined in part (a)(i). The most common mark to award was MP1 or use of $W = mg$ and calculation of the weight although some students substituted the weight for the mass in $F = ma$.

(c)(i) Time may have been an issue but few students gave this question the time and consideration it required. Some responses were left blank while many attempted to work their way from the given quantities to the velocity through cancellation of the units. Such responses may have been mathematically correct but did not demonstrate any understanding of the Physics involved and were not credited. The students did not have to consistently refer to a rate or a time of 1 second and the most successful responses calculated a volume of water leaving the jet pack (each second) and then identified that the volume = cross-sectional area x length of water leaving the hose (each second). The response below scored all 3 marks. It can be assumed that the calculated volume of 0.0476 m^3 is the volume leaving the jet pack each second. This candidate has considered a time period of 1 second and went on to use their length of 10.3 m with $s = vt$ to determine the velocity. No units were given but the final answer mark could still be awarded as this is a 'show that' question.

$D = \frac{m}{V}$

$1030 = \frac{49}{V}$

$s = ut$

$V = \frac{49}{1030} = 0.0476\ m^3$ $10.3 = u(1)$

$u = 10.3$

V = cross sectional area $\times h$ $h = 10.3\ m$

$0.0476 = (4.60 \times 10^{-3}) \times h$

(c)(ii) This should have been a straightforward calculation with most students identifying that a gravitational potential energy or kinetic energy should be calculated. There was some confusion as to which mass to use. As the power of the pump was to be determined, the pump was supplying energy to the water and not directly to the flyer. Therefore, a mass of 49 kg was required. Again, the omission of the 1 s was not penalised although many students did try to calculate a time to use with the power. Most failing to realise that as the mass was a rate, any energy calculated was over a period of 1 second and automatically became the power. As the water was being accelerated to 10.3 m $s^{-1}$and then lifted to a height of 12 m, there were two components to the energy supplied to the water and hence the power of the pump. Therefore, it was very rare to see a candidate that had attempted to calculate both the kinetic and gravitational energies transferred to the water.

Summary

This paper provided students with a wide range of contexts from which their knowledge and understanding of the physics contained within this unit could be tested.

A greater understanding of the context and question being asked would have helped many students. A sound knowledge of the subject was evident for many but the responses seen did not reflect this as the specific question was not always answered as intended.

Based on their performance on this paper, some students could benefit from more teaching time and extra practice on the following concepts and skills:

- Slow down during multiple choice items, particularly the first few items
- Do not leave questions blank
- Remember to check responses if there is time at the end of the paper in case careless mistakes have been made, especially powers of 10 errors due to missed unit pre-fixes on graph axes.
- Appreciate the difference between the commands 'describe' and 'explain' when preparing to answer a question
- When a question asks for one piece of information i.e. one property or 'a' property, only give one property as correct answers will not be selected from a 'list'.
- Learn the difference between average and instantaneous velocity as well as distance and displacement

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

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