Principal Examiner's Report

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Pearson Edexcel International
Advanced Level in Physics (WPH01)
Paper 01 Physics on the Go

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Paper Introduction

This is the first time that the Edexcel International Advanced Subsidiary level in Physics has been sat by candidates in an October exam series. The specification examined and assessment structure of the paper is the same as that in previous series. Section A of the paper contains 10 multiple choice questions while section B contains questions of increasing length and usually of increasing demand. Unit 1, Physics on the go examines both the mechanics and materials component of the course providing a transition for candidates between GCSE and Advanced level. Although there is no overlap with the other units, the skills and concepts covered, especially in the mechanics topic are used as a basis for the teaching of circular motion, momentum and simple harmonic motion in units 4 and 5.

This paper enabled candidates of all abilities to apply their knowledge to a variety of styles of examination questions. The majority of the questions on this paper were context based and aspects of the practicals referred to would have been unfamiliar to most. It was good to see that, on the whole, the candidates were able to apply the physics they had learnt to these real and unfamiliar situations even though they had not studied them directly. Timing was not an issue at all with this paper with the vast majority of candidates, across all abilities attempting all of the questions.

The quality of open response style questions was good, with candidates giving clear descriptions of the physics involved within the context of the question in a clear and logical manner. The shorter calculations were successfully answered by many as were the longer calculations. However, errors were made as many candidates did not correctly consider powers of 10, usually when reading from a graph. The working out of calculations for many candidates was also missing or too brief to gain method marks where the final answer was incorrect. This was particularly evident in question 13 where most candidates could correctly calculate the distance fallen in the given time but many could not scale these values to determine the corresponding position on the reaction. Few responses gave any stages of the working for the scaling so no further credit could be given in most cases.

Questions 14b (high jump), 17aii (Plimsoll line) and 19cii (Young modulus) also assessed the quality of the candidates' written communication. For these questions, in addition to the correct physics requirement, the examiner looked for clear and logical arguments written in reasonable English. These particular responses were answered very well with candidates setting out their explanations in a logical manner. Candidates should be aware though that in such questions, if answers require a mathematical element to their description, they must make sure that all terms are defined. Equations should be re-arranged to make the subject being discussed the subject of the equation. The examiner, in these questions particularly, should not have to make any assumptions that would have been made or complete missing steps that the candidate has omitted.

While candidates are not penalised for their use of too many significant figures on this paper, they are usually expected to quote an answer to at least 2 significant figures. This was a problem in question 18bi where, due to the commonly selected values from the graph to calculate the gradient, the answer for many was exactly 8. As the data could be read from the graph to 2 significant figures the final answer should have been quoted with the same precision as 8.0 ms^{-2}.

Section A – Multiple Choice

	Topic	Percentage of candidates who answered correctly	Correct Response
1	Units and scalar quantities	81	B
2	Free-body force diagrams	78	D
3	Hooke's law	70	A
4	Projectile motion	40	A
5	Work done	74	C
6	Elastic strain energy	60	B
7	Properties of materials	26	D
8	Newton's third law	82	D
9	Stoke's law	64	C
10	Effect of temperature on viscosity and flow rate	80	C

While most of the multiple choice questions were answered very well and as anticipated, with increasing numbers of correct responses as the ability of candidates increased, a few were not answered as expected. The mean score for questions 1 to 10 across all candidates was 6.6 with A grade candidates typically scoring 8 and E grade candidates typically scoring 6.

Question 4
This question was based on projectile motion and the independence of vertical and horizontal motion of a projectile. However, this was based on actual rather than theoretical data and the diagram had to be interpreted. Hence, the most common incorrect answer was C, a response based on projectile motion where air resistance is considered to be negligible as in most calculations. For this object, due to air resistance, the horizontal spacing of the object decreased, indicating that the horizontal velocity was decreasing. The vertical spacing increased indicating an increasing vertical velocity.

Question 6
This question was answered successfully by the more able candidates however, as is seen when questions require a calculation for the area under the graph, less able candidates tend to approximate the curve to a straight line. No calculation was required but this question was intended to not only test an application of elastic potential energy, but to appreciate that this equation is only true for linear regions of the graph as it is based on Hooke's Law. Hence the commonly seen incorrect response of $W = 0.5\ F_1e_1$ (A) rather than the correct response of $W > 0.5\ F_1e_1$ (B).

Question 7
Insufficient information was given in the question for candidates to be able to make a decision as to whether the material is malleable, incorrect response C. For that to be true the question would have stated that the force applied was compressive, however no direction for the force was given. The only conclusion that could be made was that due to the large plastic region and subsequent large area under the graph, the material is tough.

WPH01_01_Q11a

Candidates were mostly able to identify laminar flow in the wider pipe and turbulent flow in the narrower pipe. Subsequent explanations of laminar and turbulent flow were not always sufficient with omitted terms mostly concerning the speed and direction in such flow. Such statements were treated as neutral rather than incorrect so candidates referring to eddies usually managed to gain a mark for their description of turbulent flow. The confusion of some candidates as to the behaviour of a fluid within a layer (or at a point) or across the fluid as a whole was evident and those candidates that had not learnt this explanation by rote slipped up.

WPH01_01_Q11b

While most candidates could identify a factor that contributed to the type of flow in each pipe, many missed the subtlety of the question in that there had to be a difference between the two pipes for this factor to differ the flow. Some factors would have been constant so candidates were expected to realise that the factor referred to in their response would be different between the pipes.

WPH01_01_Q12

12(a) - This calculation was generally well done with most candidates scoring all 3 marks. Errors were either due to omitting 'g' in the calculation of the gravitational potential energy, an incorrect time division for the power (typically to minutes rather than seconds) and failure to calculate a power, quoting just the gravitational potential energy.
12(b) - Few candidates managed to pick up both marks, however the idea that energy is transferred to thermal energy was the most common correct response seen. Many candidates identified that energy would be dissipated or transferred however they did not state where the energy was going to, a usual requirement for the mark in such questions. As this was a 2 mark response the candidates had to give a reason for this transfer of energy for the second mark. Due to the movement of the water through the air being a fluid moving within a fluid, references to air resistance alone were insufficient.

WPH01_01_Q13

The first two marks for question 13 were for a straight forward calculation using $s = ½at^2$ using the two given times. This produced the two distances that the 50 cm reaction timer would have fallen through in these times, a calculation that most candidates above an E grade could do successfully. Occasional marks were not awarded due to answers being quoted to just 1 significant figure.
The candidates were then required to scale these distances and indicate the positions at which the timer would be caught on a scale diagram of the timer. This required scaling down their values from using an actual timer of 50 cm to the printed one of 21.5 cm. A large proportion of candidates were able to scale and mark up the new distances successfully. However it was unclear as to how many of the remaining candidates determined their plotted positions due to so few showing any working.

Quite often, for those who did attempt a ratio, a method mark could be awarded as they usually had just made a mathematical error when manipulating their ratios.

WPH01_01_Q14

Question 14 is based on the idea of the position of the centre of gravity of a body and that the work done when lifting a body is the work done to lift the centre of gravity to a particular height. No clues were given within the stem of the question that the answer should be in terms of work done, however it was very encouraging to see that most candidates realised this and applied their knowledge well to this unfamiliar context.
(a) It was expected that most candidates would be able to identify the position of the centre of gravity for the athlete using straddle jump. Surprisingly few were able to identify the position with sufficient precision to score the mark; many being thrown by the position for the athlete using the Fossbury flop and marking a point outside the body. The position of the athlete was almost horizontal so anywhere within a region in the middle of the torso would have sufficed.
(b) This question could be answered in two ways:
• A comparison between the work done to lift the body of the athletes to the same height i.e. the work done by each athlete to jump over the same height of the bar.
• A comparison between the work done to lift the centre of gravity of each athlete to the same height i.e. the work done would be the same but the body of the athlete using the Fossbury flop would be in a higher position so they would be able to jump over a bar at a greater height. This approached worked well, with most candidates using either of these explanations and only a few confusing the two factors that would determine the work done.

WPH01_01_Q15a

Question 15(a) required the candidates to draw a vector diagram in order to determine the magnitude of the unknown weight W. The apparatus may have been unfamiliar to most candidates and no knowledge of this experiment was required, however the key information that the candidates had to use was the magnitude and direction of the two given forces of 3 N and 5 N.
Candidates could either use a vector diagram to determine the resultant force of the 3 N and 5 N forces or they could construct a triangle of forces, the weight being the third force. The only difference being the direction of the third force in each case. As is frequently seen with such questions, not all candidates are able to construct a vector diagram to scale from two given forces. Many candidates attempted to resolve the two given forces vertically and then added the components together. This did give the correct answer but the question clearly stated that the candidates were required to construct and use their diagram to determine the resultant force. Some candidates constructed individual vector diagrams for the 3 N and 5 N forces and the vertical component of each diagram could then be measured and added together, not entirely answering the question. In order to score full marks, the candidates had to have carried out every requirement set out in the command sentence of the question.
For those candidates that attempted a vector diagram using a single or combined for both of the forces, the scaling seen was generally good.

Candidates should be encouraged to use as much of the provided space as possible for the construction of their diagram. While a small range is usually accepted for the magnitude and where relevant the direction obtained from such diagrams, the larger the diagram, the closer the value tends to be to the correct answer. There was a little ambiguity in some responses as to the direction of the resultant which should have been downwards if it was labelled weight or upwards if it was labelled resultant. The majority of candidates managed to score at least one mark with this question, usually the minimum being for the correct scaling of the 3 N and 5 N forces.

WPH01_01_Q15b

Questions have been asked in the past requiring candidates to identify or explain the effect of parallax, usually in a familiar practical context. While the use of the mirror in this experiment was understood by many candidates, few could explain how it reduced parallax. References to the eye and string being parallel or the eye had to be perpendicular to the string or mirror or paper were common but were not clear enough. As with all descriptions of parallax, the eye, marker (in this case the string) and paper or scale must all be in line with each other. References to parallel and perpendicular are ambiguous as the string is a 3 dimensional object and has many perpendicular directions.

WPH01_01_Q16a

While the physics being examined in this question was fairly straight forward, the context was unfamiliar and parts of question 16 were not always answered well by all candidates. As was seen in question 16(b)(i) the candidates were confident in their use of components, most correctly calculating the component of the weight acting down the slope, but in a qualitative question the link could not be made. It was encouraging that so many candidates' responses demonstrated that they were starting to think along the right lines for quite a demanding question but most lacked the precision to score more than 1 mark. To answer 16a fully the candidate had to understand that when an object moves up a slope, in the absences of an upwards force i.e. an engine, it is the component of its weight acting down the slope that provides a downward force and increases the resultant force in the opposite direction to motion. Then by applying Newton's first law it can be concluded that the negative or backwards resultant force would cause a deceleration and the vehicle would slow down.
1 mark was awarded to candidates that answered in terms of energy transfers by identifying that the kinetic energy of the vehicle would be transferred to gravitational potential energy. However the required answer was in terms of components of weight. Many candidates appreciated that weight was a factor but often discussed vertical or horizontal components or did not specify a direction for the component.

WPH01_01_Q16b

The quantitative aspect of 16(b) made it more familiar to candidates than 16(a) with over half scoring full marks.
(b)(i) - This question examined the use of W = mg and the use of trigonometry to determine the components of vector quantities. The majority of candidates successfully used mgsin10 to determine the component of the weight of the lorry

parallel to the slope. A few candidates used cos rather than sin or omitted the 'g' in their calculation.
(b)(ii) - While most candidates used their calculated component of weight and the distance along the ramp to calculate the work done some gave themselves extra work and potential for errors by calculating additional quantities. Some candidates were unaware that they were not multiplying parallel forces and distances. In particular, the horizontal distance below the slope (180cos10) was often used in the equation for gravitational potential energy.
(b)(iii) - This part of question 16 scored very well with the vast majority of candidates equating the work calculated in part (b)(ii) to the kinetic energy of the lorry before entering the ramp. Some candidates chose to use their component of weight as the resultant force in F = ma to determine the deceleration and then a suitable equation of motion to determine the 'initial' velocity on entering the ramp. This worked in this question as candidates had not been told to consider any frictional forces as all of the braking was due to the weight and was credited as long as they had substituted a final velocity of 0.

WPH01_01_Q16ci

Part (c) of question 16 switched the physics being examined from mechanics to materials with candidates being given an alternative form of escape lane using steel strips. It was not answered as well as part (b) but candidates demonstrated that they could apply their knowledge of materials to the very unfamiliar context across parts (i) and (ii). The main answer required was a reference to the ramp length or position. Answers that were general, such as easier, safer or based on knowledge that the candidates would not be expected to have such as cheaper or would take less time to stop, were common.

WPH01_01_Q16cii

It is important in the design of a mechanical arrestor system that the strips extend beyond their elastic limit. This question required the candidates to identify that the strips can store energy and that this energy is not then given back to the car so that it wouldn't rebound and travel back down the slope. Many expressed the idea that stretching would help reduce the impact of the vehicle, increasing the safety of the passengers. Forces were mentioned frequently as was the snapping of the strips if they did not stretch beyond their elastic limit.

WPH01_01_Q17ai

Question 17 is about upthrust, how it is determined and why it would change for an object floating in water. Candidates demonstrated a good understanding of the context with a good spread of marks across the ability range. Responses occasionally tended to lack precision and did not always refer to exactly the relevant physics for the particular question part.
(a)(i) Specifically referred to a heavier ship and why it would sit lower in the water than a lighter ship.
To gain marks, the candidates had to:
• Identify that the upthrust = weight of the ship
• Identify that due to the heavier ship, the upthrust would be greater

• Explain why a greater upthrust would result in the ship sitting lower in the water i.e. a greater volume of water would have to be displaced (so more of the ship would be below the surface of the water and it would sit lower). The candidates were told that the ship would be lower in the water so references to a greater volume of the ship below the water's surface were not adding enough to an answer to score a mark. As there are two weights and two volumes involved in this context candidates had to be very clear as to which weight or volume they were discussing.

WPH01_01_Q17aii

While still examining the physics of upthrust, this time the type of sea water was changed while the weight of the ship remained constant. Again, the candidate had to be clear as to which object they were discussing as the question asked candidates to explain the higher position of the mark on the ship for salt water. The physics involved in this context was slightly more demanding than that in part (i) and while many scored 1 mark, only the more able candidates managed to score beyond this.

WPH01_01_Q17b

While a very large proportion of candidates scored full marks for this question, the remaining proportion tended to not score any marks. This was almost entirely due to the level of detail of reasoning by candidates leading to the expression obtained to determine the answer. The relationship between the two lengths of straw below the surface of the water was not a direct ratio and is not given on the list of equations at the back of the booklet so the candidates therefore had to work through the physics of the floating straw to develop an expression for the two upthrusts.
Less able candidates tended to just assume that the ratio of the densities would give a direct ratio of the lengths with no justification that could have picked up some marks along the way for correct physics. Some candidates knew that the pressure at the depth of the bottom of the straw would be equal in both cases and used $P = h\rho g$, a formula that is not in this specification. This did score marks however, as it is the correct equivalent physics. As set out in the mark scheme the response required the following stages so that earlier work could be credited if a mathematical error was made.

- Upthrust = ρVg
- Where V = A x submerged length of straw
- The weight of the straw or the upthrust will be the same in both types of water
- substitution into $\rho V g = \rho_s V_s g$
- length of straw = 11.5 cm

As with all upthrust calculations, the 'g' is often forgotten as candidates try to memorise formulae, sometimes incorrectly, rather than work through from the idea of density, mass and weight.

WPH01_01_Q18ab

This question examined the use of velocity-time graphs and, although the experimental context may not have been quite the same as one used in a laboratory, the data was presented in what should be a familiar manner. With candidates on the whole successfully attempting all of the question.
(a) - Candidates were required to use the area under the graph to determine the total distance the panel fell through. The counting squares method usually produced an answer in range but if the area under the graph was approximated to a series of shapes and the area of each shape then calculated, some regions were omitted or the approximation was too broad. A series of smaller shapes would have produced an area in the given range. Weaker candidates were seen to attempt to use equations of motion to calculate the distance; this approximates the graph to a straight line and assumes that there are no frictional forces which is clearly not the case due to the shape of the graph.
(b)(i) - This part of the question required the candidates to use the gradient of the graph in the steepest region i.e. initially to calculate the acceleration. Again, weaker candidates opted for a suvat method and took a pair of points anywhere on the curve, typically at the end and then substituted them into a = (v-u)/t, scoring 0. The more able candidates drew a tangent in the correct region and anywhere up to 0.2 s was deemed to be the period of maximum acceleration. Tangents drawn were small and so did not always produce a value in range. Candidates that approximated the first 0.2 s section of the graph to a straight line had a calculated acceleration of 8 m s^{-2} exactly. As the data could be read from the graph to at least 2 significant figures, the calculated acceleration based on measurements from the graph was expected to be quoted to a minimum of 2 significant figures and answers of exactly 8 m s^{-2} were not awarded the final answer mark.
(b)(ii) This question was not answered as successfully as intended by many candidates. While most candidates could gain a mark for labelling their maximum acceleration onto the vertical axes and quite a few made this the maximum acceleration in their sketch, few were able to translate information regarding the shape of the graph from the given velocity-time graph to this acceleration-time graph. No notice was taken by most as to where the graph should end, i.e. 1.56 s as on the original graph or as to the shape of the decreasing acceleration line. Predicting the shape of the graph is a skill that probably only the most able candidates could manage successfully; the graph for acceleration against time should give a curve with decreasing acceleration and gradient as time increases.
Most candidates identified that the experiment had to be repeated although most responses then referred to calculating a mean. However to check the reliability the new data must be compared to the original data. When repeated the method must be identical and the entire experiment carried out again so suggestions such as repeating from a different height or re-watching would not be a way of checking the reliability.

WPH01_01_Q18c

The final part of question 18 examined AO3, the assessment objective that covers how science works i.e. practical skills. While candidates can use terms such as reliability, precision and uncertainty within the context of a practical, this question required the candidates to describe how the reliability of an experiment can be checked.

WPH01_01_Q19a

The Young modulus of a material is a measure of the stiffness of a material. It is also the ratio of the stress to the strain. If a candidate answered this question in terms of the given formula each term would have had to be defined.
Therefore stress/strain alone was insufficient as the stress would have to be defined as the force/area and the strain as extension/original length.
The term Young modulus is one of the italicised terms in specification point 24 where the candidates are expected to be able to explain the meaning and use of such terms. Specification points 18, 22 and 26 also contains a series of terms, also in italics, which indicates that candidates are expected to explain what is meant by each term. Particularly in the materials section of the specification of WPH01, candidates are expected to know short definitions of these terms.

WPH01_01_Q19b

Questions 19(b) and 16(c) were the most demanding questions on the paper in which the candidates were expected to apply their knowledge to the context of the question. As seen in all later parts of the question, candidates can calculate the Young modulus, manipulate its formula and explain a material in terms of it. However, although sufficient information was given in the stem, candidates that may have seen or used such lenses may have had a slight advantage. When describing the fit we were looking for a link between the high stiffness and the fit around the eye i.e. it would not stretch around the eye or that the lens would not change shape for a particular eye so would be uncomfortable. Answers just describing the stiffness of the lens would not get the mark as they had not linked this to the use of the lens.
Only a small number of candidates managed to get the mark for the fit of the lens but fewer candidates appreciated that the function was referring to the lens maintaining the same shape so that the sight could be corrected all of the time.

WPH01_01_Q19ci-ii

As with the majority of other calculations in this paper, candidates answered parts (c)(i) and (c)(ii) well. Marks were commonly not awarded due to taking readings from the graph for the Young modulus from beyond the linear region of the graph as well as omitted or incorrect powers of 10. Not all candidates knew that a prefix to a unit of 'M' was mega i.e. x 10^6.
(c)(i) - As mentioned above some candidates calculated the stress over the strain using values from the graph from beyond 7 % (the maximum strain in the linear region) producing an answer that was out of range. The most common error made by candidates however was forgetting to divide by 100 for the strain, as the values given on the graph were as a percentage. The value required for strain in the Young modulus equation is a ratio so that it is equivalent to the extension ÷ the original length. As the show that value was already in mega Pascals, many did not bother to use the mega prefix for the stress as any reading without × 10^6 would automatically give a Young modulus in MPa. This was not penalised but many candidates scored 2 marks more by luck than judgement by omitting this step.

(c)(ii) - The candidates could not ignore the factor of 10^6 here and this was the most common source of error, as was again not dividing by 100 for the strain. Some candidates tried to use πr^2 for the cross sectional area, the r being the thickness of the sample. Candidates could determine the area using either the stress at 8 % strain from the graph, and then using stress = force/area or some preferred to use their value of the Young modulus and use
E = force/(area × strain), although this tended to create more power of 10 and re-arranging errors.

WPH01_01_Q19ciii

This final question on the paper was answered by many of the candidates and produced some good responses. As mentioned earlier in the report, timing was not an issue for the majority of candidates and it is encouraging to see that many didn't tire or give up towards the end of the paper.
Many candidates may understand that when a force is applied across a sample, a thinner sample will provide a greater extension than a thicker sample. However this was mentioned in the stem of the question and candidates had to justify this statement using the equation for the Young modulus and their understanding from the stem of the conditions for the test.
Not all of the variables were mentioned in every response, so commonly the second mark was not awarded as candidates didn't mention both a constant force and that the Young modulus of the material would remain constant between tests. In addition to this, those who tried to answer using the equation directly, without defining the terms or re-arranging it to make the extension the subject of the equation tended to miss the third mark.

Paper Summary

This paper provided candidates 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 candidates. A sound knowledge of the subject was evident for many but the responses seen did not reflect this as specific questions were not always answered as intended. Based on their performance on this paper, some candidates could benefit from more teaching time and extra practice on the following concepts and skills:

- Slow down during the multiple choice items so that key words in the command sentences and distractors are not missed.
- In calculations, show all of your working out, trying to include as many stages as possible.
- 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.
- Practise constructing vector diagrams.
- When calculating the gradient of a graph or the area beneath a graph make sure that you are using the correct region.
- Always define letters used for quantities in explanations and definitions.

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