Examiners' Report
Principal Examiner Feedback

Summer 2019

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

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General comment

This is the final time that the Edexcel IAL WPH01 Physics will be sat. This paper was only sat by learners as a final chance to re-sit this module so would have been the second or third attempt for most.

Section A of the paper contains 10 multiple choice questions while section B contains questions of increasing length and usually of increasing demand.

The two areas of physics covered by Unit 1 are basic mechanics and properties of matter. The unit is designed to examine the learners on these subject areas in three distinct and important ways:

- testing their knowledge as described in the specification
- their understanding of the physics involved
- their ability to apply that knowledge in numerical and unfamiliar contexts.

To give a few instances from this particular paper, Question 11 tested the learners' recall of key terms (in italics) from the materials part of the specification followed by a short explanation requiring the application of knowledge to the context of heated glass. Understanding of physics involved was tested further in the higher mark questions with 'explain' as the command term such as 14bi and 17c.
Question 16a also examined knowledge over understanding but in an unstructured 6 mark question. However, this was deemed to be more challenging for many learners due to the lack of provided structure within the question and confusion between the key characteristics of a force-extension graph.
Question 16b is an example of where learners were expected to apply their knowledge to both a numerical and unfamiliar context. This question required both the resolving of a force and the completion of multiple calculations in order to derive a value for the extension of the wire.
Questions 12 and 17dii used the command word 'discuss' where learners were expected to describe, without the help of any structure within the contexts given in the question; a more familiar context in Q12 using Newton's third law and Q17dii the unfamiliar context of a pull-back car, the key to this being an understanding of the spring mechanism.

Overall, the learners found analysing data presented graphically to be more challenging on this paper as well as the longer open response style explanation and discuss questions.

The responses to numerical questions were generally good, and in most cases the physics of such questions was understood, and the right equation was correctly applied. For the higher mark calculations, learners did not always manage to synthesise all the required information and may have only attained a proportion of the marks, demonstrating knowledge but not the required understanding of the context. When responding to a question involving a calculation, it is important that the examiner is able to follow the learner's reasoning since most of the marks are awarded for the methods used in the calculation. Attention to the layout of the response is therefore necessary.

The standard of written English seen by the examiners in this paper was good and caused little difficulty in the marking of the paper. Apart from the Extended Open Response questions, where the learner's quality of written communication is being assessed along with the physics, lack of skill in written English is not penalised, as long as the response is clear and unambiguous.

Time was an issue for a small number as not all learners managed to complete all of question 17. Weaker learners tended to perform better than expected on the multiple-choice items, with a significant proportion, those attaining below an E grade, scoring the mean mark of 6 on these items, clearly at the expense, timewise, of section B.

The mean mark on the paper was 34. This was 1.7 marks lower than the mean on same paper last summer with a slightly smaller spread of marks around the mean for this paper. However, as is commonly seen on the IAL paper, this was particularly noticeable below the E grade boundary where there was a greater spread of marks below the boundary compared to that at the A grade boundary. The mean score for questions 1 to 10 across all learners was 6.0 which was very similar to last summer's paper for the multiple-choice items.

Section A – Multiple Choice

	Subject	Percentage of learners who answered correctly	Most common incorrect response
1	Units	64	
2	Hooke's law	62	B
3	Definitions of materials	82	
4	Energy stored in springs	51	
5	Vectors and scalars	60	B
6	Work done and power	93	A

7	Vector diagrams	76	D
8	Directions of forces	56	D
9	Free-body force diagrams	24	B
10	Displacement-time graph	46	B

As intended, the multiple-choice section scored quite highly. Each question is worth just one mark, so the learners should be discouraged from spending too much time on any one question in this section.

Most scored between 5 and 8 out of 10, the mode being 6.0 for the multiple-choice items. The mark scored was as expected for lower ability learners, typically scoring 6 at the E grade boundary and 8 at the A boundary. More able learners performed as expected on this section, questions 4 and 9 confusing many hence more able learners, at the A boundary typically scoring an average of 8.

An explanation of the distractors is now included in the mark scheme but a few, more significant points are mentioned below.

Q02– This question may have been a casualty of some learners initially rushing through the paper, subtracting the increase in length from the length at 60 N to give 7 cm, B, with no phsyics basis for their reasoning. Those that were successful will have realised than for each increase in load by 10 N, the extension increases by 0.5 cm. Hence a 60 N load prodeuces n extension of 3 cm, giving the origial length as 6 cm (A).

Q04– Questin 4, as with 2 also produced answers with no correct physics basis as incorrect distractors A, B and D were equally selected. Again, those working through the stated of reasoning in a logical manner would have realised that two springs in series produces double the extension as each spring will extend by the same amount under the same load *F*. Thereofore there will be twice the energy stored.

Q05– This question was purely recall with both work and time being scalar quantities. The most common incorrect reponse being B, indicating that many learners believe work to be a vector quantity.

Q08– Only middle ability or higher learners scored will with Q8. This question concerned the direction of forces acting on a person when the train they are standing in accelerated to the left. As most of the incorrect reponses assumed that the force of the feet was also acting backwards. In fact the feet are being accelerated with the train due to the frictioanl force between their feet and the floor. Therefore the force on the feet is in the direction of motion, whereas the top half of the body is not being accelerated at the same rate so ‘falls’ as it is accelerated at a different rate to the feet.

Q09– This question was answered correctly by only those of the highest ablity. The non-perpendicular reaction force between the hinge and the wall, confusing many. The shelf has three forces acting on it, weight, the force of the wire on the shelf i.e. tension and the force of the wall on the wire. This force acts to the right and is not quite horizontal. The exact direction was not required but learners should be aware that, for the shelf to be in equilibrium, the resultant force must be zero so the lengths of each arowed lines is also significant. It is recommended that learners, in their prepartion for future exams, practice the identification of normal contact forces in a variety of contexts.

Q10 – Learners are very familiar with the standard velocity-time graph for objects reaching terminal velocity. They are less familiar however with the corresponding displacement- time graph. They should be able however, to translate imformation between the expected graphs and the known graph. Many however, selected B, proabaly due to mis reading the question and the axes as this graph has the shape of the velocity-time graph.

Section B

Q11(a) – This question examined basic recall of the proerties of materials.

(i) A reference to breaking or fracture was required unless the answer was in terms of shattering hence responses just indicating that the material does not deform plastically would have been insufficient for the mark.

(ii) This is a standard definition which as been asked in previous exam series. The response need to make it clear that it wasn’t the ability to withstand scratching i.e. a definition of hardness, but that the material cwas difficult to scratch.

(iii) Out of the three definitions, the definition of strong proved to be the most challenging for learners of all abilities. Again a reference to fracture or breaking was required and the answer had to be in terms of the stress and not the force needed to break the material. It is worth pointing out in the teaching why we use stress as oppose to force when describing the strength of materials. Spider’s silk being a good example of a strong material with a low breaking force.

(b) The learners were expected to apply their understanding of viscosity and temperature to heated glass. The second marking point was awarded more often than the first, with some learners not commenting on the viscosity at all. The most common correct responses for the second marking point were comments on flow and malleability. Quite a few learners gave a simple description of heated glass being able to be made into other shapes which wasn’t enough to gain the second mark.

Although it is sometimes appropriate to explain the converse of a question, explanations do not always elicit the relevant Physics. Therefore responses for 11b that were in terms of the behaviour at low temperatures and in terms of the brittle behaviour of glass did not sufficiently imply that this behavour would be reversed and why at high temperatures.

Q12 -This question gave learners a basic and familiar context and expected explanations as to why the information given was incorrect. Understanding of the Physics was not an issue; however, accuracy and detail were with many points made lacking crucial detail.

The first four marking points, particularly MP2, MP3 and MP4, were commonly awarded with learners having an awareness that the third law pairs are of the same type and act on different bodies, and also that the question was describing the first law. It was rare to award the last 4 marks at all, which indicates that learners need practice at identifying and naming third law pairs.

Teachers need to teach learners a definition of Newtons 3rd law which refers to forces rather than just vaguely action/reaction, as quite a few learners were unable to gain the second mark.

Rather the correct the information given in the question for MP7 and 8, many responses attempted to give specific examples of other N3 pairs such which were not credited as, although they were relevant to this context, they were not relevant to the question being asked.

Misconceptions regarding the applicability of N3 when an object is moving with constant velocity meant that MP6 was rarely awarded.

2 marks was the mode mark awarded for this question and there was little discrimination on the marks awarded across the ability ranges.

Q13a - This question required the learners to describe the graph for vehicle X, using information given on the graph as well as its shape. The first marking point was commonly awarded, and many learners were able to describe what the graph showed for the correct vehicle. Some learners described uniform deceleration but then added “at constant rate”. Whilst this was not penalised, teachers should ensure that learners have a clear understanding of the meaning of rate.

The value for deceleration was often found in part b of the question, as part of their subsequent calculations. However, the learners who didn’t provide clearly structured working, sometimes couldn’t be awarded the mark, as they didn’t explicitly show that it was the acceleration of X or didn’t state a unit.

Another issue with the third marking point was a lack of understanding as to whether a negative sign was needed when stating the value. This concept should also be reviewed when preparing learners.

13b - Surprisingly few learners worked out what had to be done here and consequently this did not score as well as part (a). The more successful learners determined the acceleration of Y and formed the two expressions for the displacement using $s = ½at^2$. Most could then equate the two expressions for s, and then were able to manipulate the quadratic equation to calculate the time. Very few learners were able to gain full marks from the alternative of using the area under the graph. Learners that quoted the correct answer of 4 s without any working out that could lead to tis value were not awarded any marks. Hence it should be encouraged that working out is shown for every item.

13c - This question was not well done with learners only putting forward very vague ideas which didn't relate specifically to the video recording and so were not enough to gain marks. The fifth mark in particular was rarely awarded. The ideas from this question could be used to improve performance by incorporating this as a practical activity as most learners appeared to not have any practical experience of using a video camera as a timer. Those who did understand the idea that the camera could be used as a timer, were imprecise about where the measurements of length were to be taken from, responses often implying that the measurements should be taken by placing the measuring device on the screen rather than in the recording. Those responses that mentioned fixed markers were the most successful as this often quantified their answers sufficiently to score MP2, 3 and 4, even if the explanation of the time measurement (MP1) was not awarded.

14a - This part of the question was done quite well, and most learners could use the density equation successfully with a value of density taken form the graph and many knew how to calculate the upthrust. However, some learners unable to read the graph scale correctly and/or associate the measuring point with marker 23. Such an error prevented the response from scoring both MP1 and MP4 as the final answer mark could not be awarded for a value that was determined from a misread graph point. Worryingly, a few learners despite multiplying by 9.81 to get a weight, still think that weight is measured in kg.

14bi – There was a frequent misconception on this question with learners discussing the effect of temperature on viscosity rather than the density. The fact that this question followed on immediately from a calculation involving density and upthrust and a graph of how density changes with temperature, shows that many learners view that paper as a series of short, unrelated questions, rather than multi-part ones with a common thread.

If the second marking point was gained, it was usually for 'upthrust would decrease', with learners rarely talking about the weight of the displaced fluid. Some learners discussing only drag rather than upthrust, preventing access to the second marking point. When the third marking point was gained, resultant force downwards was rarely mentioned with the majority successfully commenting on the relative sizes of upthrust and weight. A few learners simply compared the density changes within the liquid to the density within the sphere, preventing access to the second and third marking points.

Learners that did not move towards the viscosity decreasing but got started on the right ‘density decreases’ track, usually answered this question well. However, if they chose viscosity, they usually only scored MP3 if that. The most frequently awarded mark was 1, usually MP3 with the majority of those at E grade and above picking up a second or even third mark.

Just to note that common misconceptions seen were: using the word force rather than resultant force, describing the density of water as changing, describing changing weight of sphere and stating that the volume of displaces liquid is less.

14bii- required the learners to draw a free-body force diagram for the sphere as it moved downwards. It was encouraging to see that many took note of the direction and included an upwards drag and most responses included 3 correctly labelled forces, mostly in the right direction. Learners should be encouraged to use a ruler and to make sure that their arrowed lines are vertical. Ambiguous directions of forces were not awarded the mark. To score all 3 marks, the diagram had to be to scale, in that the weight had to be the same length or greater than the two upward arrows combined as the sphere would either have been accelerating downwards (as described in (b)(i)) or would have reached terminal velocity.

15 – Over 19 % of learners were able to achieve all available marks on this question. Surprisingly, this was poorly done for many, and not answered as successfully as expected given that this question contained 11 marks without one word of explanation.

15a – In order to show that the horizontal velocity of the ball was about 30 m s^{-1}, the time taken to travel from the net to the ground had to be determined using the vertical motion. There were many responses that gained all four marks, although some learners tried to use distances from the left-hand side of the net, which meant that they could not score full credit due to the lack of symmetry in the trajectory of the ball. MP1 could still be awarded if an incorrect vertical distance had been used in the correct equation and may, regardless of their method were able gain the second marking point in question, as their calculations showed that they recognised that initial velocity was zero.

There are a few learners who do not recognise the independence of horizontal and vertical motion, and some tried to use Pythagoras to combine vertical and horizontal distances. Generally, quite a few learners do not seem to be listing their SUVAT values – a standard technique which can help them how to plan questions such as this.

15b- Many responses could gain full credit for 15b with most being able to apply v^2=u^2+2*as* with *v*=0. It was permitted to use *u* = 0 and calculate the velocity at a displacement of 0.510 m however, not all learners were consistent with the directions used and could not be awarded MP3 if a negative sign had been omitted and the final answer obtained incorrectly, even if the correct answer had been given. The most common error was to use an incorrect vertical height, only allowing access to the second mark.

Some tried to find a time of flight then $v = u +$ at, often with the wrong value of distance, so credit for working out i.e. MP2 could not always be awarded. Where the mark scheme states the use of an equation, a valid alternative method will be credited but where a series of formulae need to be used, i.e. a less direct method, the substitution into each of these formulae is required for the same mark, hence introducing more opportunities for mistakes to happen.

15c - Learners were able to successfully gain full credit for 15c despite having made errors in 15a and 15b. It was possible to use the show that values for velocity from parts (a) and (b), usually using Pythagoras, to determine the initial velocity of the ball.

Most demonstrated a good understanding of vector addition and trigonometry, even if they were using either the show that value, or their own incorrect values. Most learners used Pythagoras to gain the first marking point. Those that calculated the angle first and then used trigonometry, were more prone to errors. Teachers should encourage learners to draw a diagram to prevent confusion in using cos, sin and tan.

16a– This question was a recall question. There was no application to an unfamiliar context as the force-extension graph for copper wire should have been familiar to all learners. The mode mark for this question was 3, usually for MP1, MP2 and MP3 with most learners attaining an E grade or able scoring these marks.

Most learners were able to indicate the points on the graph, but some were careless and lost marks. Errors seen included putting the elastic limit before the limit of proportionality or labelling too low on the straight-line region of the graph.

The second mark was often gained with learners having a clear understanding that initially the wire obeyed Hooke's law. Generally, a lack of precision of the language used as well as some confusion between points meant that marks could not be awarded where a considerate attempt had been made at describing the points. It was pleasing however, that so many recognised, in the explanation of elastic and plastic deformation, for the need to refer to the force being removed. Teachers should ensure that terms are defined thoroughly as descriptions were often incomplete and hence unable to gain credit.

It was rare to award the last marking point as learners didn't appreciate that they needed to discuss the increase in force causing an increase in extension.

Quite a few learners need to read the question thoroughly as they didn't mark points on the graph, despite the clear instruction to do this, preventing them from being able to score MP1,2 ad 7. Learners should also be taught to look at the graph axes labels as many couldn't gain credit because they answered in terms of stress and strain, instead of force and extension.

16b - As mentioned in the introduction to this report, q16b required the learners to apply their knowledge to a numerical and unfamiliar context. The demand was also increased as the question required multiple steps within this calculation, without the aid of any scaffolding to help the learners.

It was common for learners to successfully gain MP3, MP4 and MP5 as they were able to use the equations relating to Young's modulus. However, some learners were unable to correctly resolve to calculate the force, and many others didn't appear to realise that this was necessary, and instead simply used the value of 10.8 N. It was also uncommon to see learners dividing by a factor of two, even if they did realise they needed to do the force calculation.

A few learners tried a reverse argument from the maximum extension of 1 mm to get back to a weight of 61.3 N. This method also failed to introduce the factor of 2 and the relevant trig hence usually scoring a maximum of MP3, MP4 and MP5.

The few that did manage to substitute in all of the values and evaluate correctly often missed out on MP6 due to incorrect rounding (so the final answer was out of range), missing or incorrect units or forgetting to compare to 1 mm.

17a- Far too many learners were not able to recognise that the area beneath the graph of force against pull back distance i.e. extension would be the work done. Teachers should be training their learners to recognise command words, and that 'estimate' will usually mean to use a technique other than just a single calculation.

Successful responses mostly used the counting squares method to determine the area under the graph, as well as other approximating the area to a series of shapes, reaching a value in range and scoring both marks. Just to note that not all reaching value for the work done in range quoted any units, preventing them from scoring MP2. A number used Nm rather than Joules which was accepted but unusual.

Many learners gained no marks as they simply used work done = maximum force x distance, rather than appreciating that they needed to take account of the varying force.

17b- This was a standard question which was predominately answered to a high standard. Some were unable to gain the first and third marking points as they were unable to successfully resolve to find the vertical change in height or didn't realise that this was necessary. However, the second marking point was often awarded as many learners could use the potential energy equation.

17c- The context of this question proved to be challenging for many learners. An appreciation that the tension in the spring provided the driving force for the car was required. Care had to be taken with the language used when describing the energy transfers during the compressing of the spring and subsequent motion of the car so that ideas were not confused, and the transfers clearly expressed. While most were able to explain the principle of conservation of energy, few were able to apply this to the context, usually due to not considering the input energy from the spring.

Generally, learners only accessed the fourth and fifth marking points. MP5 awarded usually for generic responses describing the transfer of some energy to heat. Learners should remember to discuss energy transfer rather than energy loss as this prevented some from gaining the fifth mark. The first, second and third marking points were rarely scored as learners did not include a reference to the energy stored in the spring.

17di- The vast majority of learners picked up both marks here with the odd response omitting a unit or forgetting to square the velocity in their evaluation of their substitution, even if had correctly been included. A small number omitted the square sign completely even though the kinetic energy equation was correctly stated, and all should be encouraged not to rush such straightforward questions so that attainable marks are not missed through careless mistakes.

17dii- as with Question 17c, an appreciation of the mechanism involved to propel the car forward was required. Therefore, although MP3 and MP5 were more generic and could be answered in terms of resultant force and frictional force, the other marking points required an understanding that as the spring began to contract on release, the tension and hence resultant force would reduce to zero, reducing the acceleration. Instead they focussed on the increase of drag force with speed which produced an opposing force as the only reason for the decreasing acceleration, generally not satisfying any of the marking points.

Some responses missed the command term of 'discuss' and simply described the graph, again scoring zero. Learners should read the question carefully as it instructed them to relate the graph to the forces acting on the toy car. Quite a few learners interpreted the flat section of the graph incorrectly, thinking that it meant an acceleration of zero, rather than a constant deceleration, or that the car had stopped.

The most common mark scored was MP3, usually for a link between the decreasing accelerating and the decreasing resultant force. So many answered in terms of a deceleration when they meant deceasing acceleration. Instead, the majority thought that the velocity was decreasing from the beginning, which was strange as the car started from rest. The usual misconception that a negative acceleration implies that the car was moving backwards was seen, not that it was now decelerating. Although the command sentence asked for an answer in terms of forces, energy got mixed up with force many times.

Summary

This paper provided learners 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 learners. 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 learners could benefit from more teaching time and extra practice on the following concepts and skills:

- The understanding of the command words such as describe, explain, discuss and estimate.
- Learn correct explanations and definitions of key terms that are in in the specification
- Read the question. If the question asks for the explanation in terms of a particular quantity e.g. forces, then don't stray into discussing the energies involved.
- Look at the marks assigned to each question. A question with 6 marks will have at least one extra stage involed compared to a 4 mark question. Use this to check that you have not missed out any interim steps such as resolving a force to be used in the equation.

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