Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

October 2018

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

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General comment

This paper enabled learners of all abilities to apply their knowledge to a variety of styles of examination questions. Many showed good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. Generally, learners did not always apply their knowledge well to the requirements of the question, often quoting the physics in general terms and not relating it successfully to the context.

The longer mark questions on this paper were more text based than mathematical and learners did not answer such items as expected. Command terms were not always noted, and subsequent explanations were seen to miss on key points so explanations, although they may have contained correct Physics, did not always answer the question and scored low. Most responses showed reasonably clear working out so that marks could be awarded if the final answer was incorrect.

Time was an issue for some as not all learners managed to complete all of question 18. Weaker learners tended to perform better than expected on the multiple-choice items however this was sometimes at the expense, time-wise, of question 18.

The mean mark on the paper as a whole was 25.7; this was 8.5 marks lower than the mean on same paper last October however the spread of marks around the mean was slightly greater for this paper. However, as is commonly seen on the IAL paper, this was particularly noticeable around, mostly below, the E grade boundary where there was a greater spread of marks compared to that at the A grade boundary. Timing was an issue for some learners as items towards the end of the paper were left blank on some scripts, usually as a result of spending too long on the multiple-choice items. The mean score for questions 1 to 10 across all learners was 6.0 which was very similar to last October for the multiple choice items.

Section A – Multiple Choice

	Subject	Percentage of learners who answered correctly	Most common incorrect response
1	Units	74	D
2	Vector and scalar quantities	34	A
3	Work done	35	D
4	Hooke's law	71	C
5	Free-body force diagram	51	C
6	Stoke's law	29	B
7	Viscosity and temperature	75	-
8	Equations of motion	79	C
9	Velocity-time graphs	76	C
10	Viscosity and velocity of a liquid	79	-

Most learners 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. More able learners did not perform as expected on this section, questions 2,3,5 and 8 confusing many hence more able learners, at the A boundary typically scoring an average of 8. Question 5 was answered particularly poorly and far lower than expected at the top end of ability and question 9 was answered better than expected by learners, particularly those of lower ability. Timing was an issue on the paper as a whole for some learners and some low scoring learners fared better on the multiple-choice items than their higher scoring counterparts. Thus, demonstrating that a disproportionate amount of time spent by some on this section.

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

Q02– The symbols ΔW, F and Δs were not defined as the equation for work done is given the back of the paper and it was expected that learners would be familiar with theses terms. Therefore the common incorrect assumption that Δs, the displacement is a scalar quantity can only be explained by proportion of time spent spent by some on this response.

Q03– A surprising number of learners selected the most common incorrect response D. Although most learners therefore realised that increasing the force by a factor of 4 would increase the extension by the same factor, few realised that x was the increase in extension when an additional load of 7.5 N was added.

Q05– It was clear to most learners that the normal contact force R must act perpendicular to the slope by A and C being the most common responses. The component of the weight *W* down the slope must be considered when looking at all the forces acting parallel to the slope. As the box is being pulled up the ramp at a constant speed, the component of *W* added to the frictional force *F* should be equal to the tension *T.* Hence response A was correct as T>F.

Q06– According to Stoke's law the frictional force acting on a sphere is proportional to the radius of the sphere. A larger spehere with 8 times the volume of the original sphere will have a radius $\sqrt[3]{8}$ or 2 times larger. Therefore the frictional force will be 2 times greater than that for the smaller sphere.

Section B

Q11(a)(i)– It is expected that an appreciation of *g* by learners beyond numerical value would be obtained when use of $W = mg$ is taught, the specification stating the re-arrangement of the equation of $g = W/m$. Some learners that are re-taking this paper that would have already covered fields should have had no problems with this question but it was answered poorly by most.

Q11(a)(ii)– The specification requires "use of the concept of the centre of gravity of an extended body", therefore it is expected that learners will have a good understanding of what the centre of gravity represents. Loosely worded responses such as " the point through which the weight appears to act" or "the point where all the forces are balanced" were not seen to demonstrate sufficient understanding of the concept of the point. References to gravity as oppose to gravitational force and mass in place of weight were also commomly seen.

Q11(b)– Learners generally did not know how to answer this question often just showing that the units for *g* of N kg^{-1} were equivalent to that for aceleration of m s^{-2}. Without an explanation few algelbraic responses could score any marks. Many learners gained credit for the latter half of the explanation in that they equated *mg* to *ma*, leading to the cancellation of the masses and MP2 being awarded, without explaining why they were able to make the assumption that the weight is the resultant force. Therefore MP1 required learners to justify use of $mg = ma$ by stating that in free fall the resultant force is *mg* or even the weight is the only force acting on a falling body.

Q12– A well answered question with marks generally awarded for reasons, rather than explanations, the common mark of 2 being scored through MP1 and MP3. The most common reason responses were concerning reaction time or resolution, with very few using the idea of what happens when the ball is released. Learners were commonly discussing human error rather than reaction time and failing to score MP1. The resolution route was more successful with learners discussing precision or comparing the resolution numerically. Explanations were less successful, with learners omitting percentage and just saying uncertainty, which is a concept that teachers should review with learners. The other two explanations were rarely awarded. Discussions of parallax were quite common to see but the question clearly stated a known distance, so this could not score.

Q13(a)– Question 13, in general, required a significant amount of reading and understanding of the graph in order to answer the question sufficiently. Many answers were left blank with many not addressing the question and referring to balanced forces, not recognising the distances should be in terms of D and h, which were clearly marked on the diagram. Those learners that realised this were generally more successful at recognizing distance P than distance Q

Q13(b)– The command word of 'explain' required the learners to use their knowledge to explain the shape of the graph. Therefore an explanation in terms of the forces acting on the cylinder was required so that the initial region of constant tension, subsequent increasing tension and finally a constant but greater tension could be explained. Weaker learners tended to describe the shape of the graph in terms of the variation of tension with height rather than explain it. A common misconception was to explain the situation assuming a resultant force, usually gaining no marks; learners need to be reminded of the significance of constant speed. Other learners didn't recognise that there would be an upthrust in the water, limiting their maximum mark to 2 but rarely scoring any marks if omitted. Where upthrust was recognised, it was common to award MP1, 5 and 6. It was rare to award MP3. MP4 was often missed as learners talked about the volume of the cylinder decreasing, rather than that of the displaced water, this being a mark to explain the decreasing upthrust as the cylinder left the water. Upthrust and drag were sometimes confused, with drag increasing as the cylinder raised.

Q14(a)– Question 14 mostly covered specification points 9, 10 and 11 i.e. resultant force, weight and Newton's third law. Part (a) has again been examined before in other contexts, the answers primarily looking for identification of the correct 3rd law pair and the effect on the resultant force of the rocket. The situation was often misunderstood as descriptions including the hot gas exerting a force on the external air or the ground resulting in the external air or ground pushing upwards on the rocket rather than the hot gases. Despite this it was quite common to award the second mark as many learners recognised that there must be a resultant force, even if they couldn't correctly apply Newton's 3rd law.

Q14(b)– The idea of apparent weight was not appreciated by most learners and therefore there were generally two scores most commonly awarded for 14(b). A smaller number of learners (31 %) scored full marks for those who knew that the apparent weight is the reaction force and could then formulate an equation for the resultant force and equate this to *ma*,
i.e. apparent weight − weight of crew member
= mass of crew member × acceleration of crew member (i.e. of spacecraft)

The majority of learners (50%) scored either MP1 for use of $W = mg$ to calculate an effective 'apparent' mass of the crew member using 81 kg, rarely providing any additional working or, more often, MP3 for use of $F = ma$ using 3700 N and 81 kg obtaining an acceleration of 45.7 m s^{-2}, the most frequently seen answer.

Q14(c)– Most responses included a correct reference to a reduced mass or weight of the spacecraft. Many linked this to a greater acceleration or more commonly that less fuel, force or energy would be required by the spacecraft. Some good responses even correctly discussed both a greater resultant force and a lower mass increasing the acceleration. Incorrect reponses tended to discuss the abilitty of the empty tanks to accelerate to earth rather than the effect of their detachment on the motion of the spacecraft.

Q14(d)– With 30 % of responses scoring 1 mark and a further 30 % scoring a second mark, most learners correctly explained that use of the parachutes increased the surface or cross sectional area with many identifying the increased drag force acting on the capsule. Area alone was not sufficient for MP1 and surface area was accepted although cross-sectional area (perpendicular to the direction of motion) was preferred. MP3 was less frequently awarded as many learners that attempted to make a statement about the resultant force incorrecty described a decreasing resultant force rather than one opposispete to the direction of motion. This is a common misconception, one that again has been evident in previous exam series and should be addressed when teaching about resultant forces.

Q15(a)(i)– The style of this question was unfamiliar to many learners, most only seeing a 'show that' to demonstrate a numerical answer, often without the requirement for any additional explanation. It was required that any assumptions or algebraic statements needed to be stated or justified.

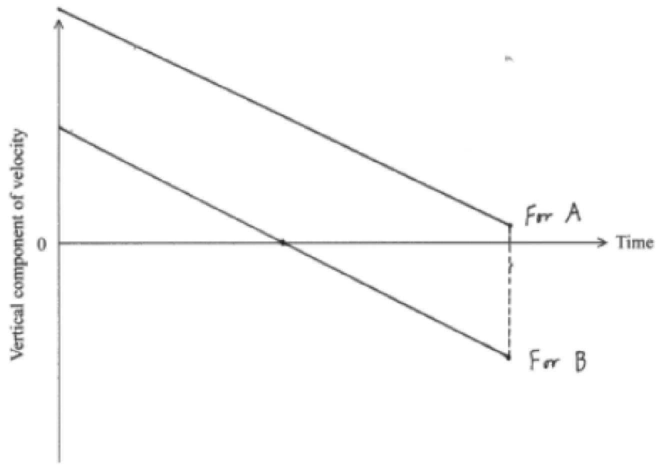
The starting point was to identify that the horizontal velocity or displacement is the same for both projectiles A and B. For MP2 examiners expected to see a statement of either the horizontal displacement or velocity for both A and B, clearly identifying which velocity/displacement belonged to which projectile.

Stating $u_A\cos\theta = u_B\cos45$, as was most commonly seen, without explaining what each half of the expression represented was not showing the examiners that the initial velocities were the same or what each half the of the expression represented. Really only adding to the original statement that 0.707 is cos45. Therefore MP3 could only be awarded if the learner had shown some working towards this end point of the explanation rather than just re-arranged the given equation.

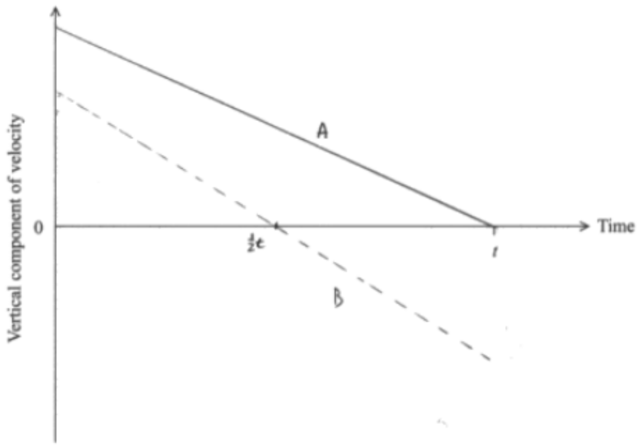
Q15(a)(ii)– This was more successfully answered than 15(a)(i) mostly because most responses clearly identified the start point of the explanation in that A was launched at an angle greater than B or at an angle greater than 45°. However, fewer responses ventured much further that such a statement and few were seen to attempt to construct the required inequality and use this with the given equation from part (i) to show $u_A > u_B$. Some considered the vertical component of velocity which was not relevant to the situation described.
Rarely did a response mention that the maximum range of a projectile was at 45° so to have a greater range at a greater launch angle the inotial velocity must be greater.

Q15(b)– To answer this question successfully learners needed to identify that projectile A had not reached the maximum height yet, therefore would have a non-zero velocity at time *t*. More learners were successful in gaining the second mark as they realised the change in direction of the velocity of B, producing a line that crossed the time axis. Some learners were not able to access MP4 despite labelling the time *t*/2, the time at which the velocity of projectile B is zero as they had failed to recognise that the gradients would be the same and the lines parallel as both projectiles experienced the same acceleration due to gravity.

The response below scored MP1,2,3 but not MP4 as the time *t*/2 was not labelled on the time axis.



The response below scored just 1 mark, MP2, as the line for projectile B crossing the axis. The line for A is 0 at time *t* so no MP1, the lines are clearly not parallel so no MP3 and, as MP4 is dependent on MP3, although the time *t*/2 has been labelled, it cannot be awarded.



Q16(a)(i)– A significant number of students correctly started their explanation in terms of the resultant force by stating that the weight = drag force. However, a reference to terminal or constant velocity was also required for MP1 preventing many from scoring this mark. The subsequent explanations were split fairly equally between those attempting a more mathematical route, using Stoke's law to reach the conclusion that velocity is proportional to the radius squared and those that qualitatively described a greater air resitance required to reach a greater weight and the drag force increasing with speed (the alternative marking route). It was uncommon however to award the mark for velocity proportional to radius squared, although mathematically adept students sometimes derived the appropriate equation which should lead to this idea. Weaker responses discussed a greater time accelerating without explaining why this would be greater. MP4 was the most commonly awarded as, using either marking route, many learners could identify that the terminal velocity would be greater for larger droplets. The most common omission from good responses was to not refer to the velocity of the droplet as terminal, making their description ambiguous as to which stage of the motion of the droplet was being discussed.

A common misconception seen in many responses began by recognising that the weight of the larger droplets would be greater, but then often decided that this would give a larger acceleration, failing to make any reference to terminal velocity and usually scoring 0 marks.

Q16(b)(i)– Most responses indicated that the learners knew how to construct a scaled vector diagram in order to determine the magnitude and direction of a resultant velocity. The accuracy however of such diagrams, inparticularly the drawing of a line 8.5 squares long, led to a smaller number than expected scoring all 3 marks for the diagram. Omission of details such as labels and line arrows resulted in MP1 and MP2 not being awarded for what should have been a straightforward task. The graph paper provided was large enough that a 1:1 scale could be used however, many used the graph paper ineffectively choosing a scale of 2 m s^{-1} to 1 cm producing unecessarily small diagrams that prevented MP3 from being awarded.

Q16(b)(ii)– Many responses indicated that the magnitude of the resultant velocity was obtained by a Pythagoras calculation rather than through use of the diagram from (b)(i). This was permitted but the direction mark (MP2) was awarded less often, due to a lack of clarity as to which angle they were referring to, particularly common was the use of compass points rather than a direction to the horizotnal or vertical.

Q17(a)(i)– As the measurement taken to enable the cross-sectional area of a wire to be determined is the diameter, this was the given dimension. Many did not take note of this, assuming it to be the radius while a small number used the circumference in place of the area. As is commonly seen when three equations are being combined, particularly to determine the Young modulus, algebraic skills can let some learners down; those remembering the combined equation of $E = \frac{Fx}{A\Delta x}$ generally being more successful. Power of ten errors were generally introduced by those that did not know that the prefix giga represented 10^9.

Q17(a)(ii)– The answer required a division of the extension of the string by the circumference of the string to determine how many turns would be requred to produce the calculated extension. These marks weren't often awarded. Many divided their answer to part (a)(i) by the diameter rather than the circumference and it was quite common to do the division upside down. Others added on the length to the extension before dividing.

Q17(b)(i)– Most responses referred to a point rather than a maximum force or stress beyond which the material will not return to its original length (when the applied force is removed) without stating what 'the point' represented. Usually in such questions a graph has been provided so a point would refer to a particular stress or force on the graph. Therefore very few responses scored the mark.

Q17(b)(ii)– It was common to award the second mark as many students recognised that it was important for the string to return to its original length. However, most learners omitted to say that a large force was applied to the string, and a small number were able to give an answer that related these ideas to the same frequency of sound. Others did not score as they discussed the importance of the string not breaking easily, which did not relate to the question asked.

Q18(a)– Many responses scored MP1 and MP2 for the energy transfers, however mark 3 was rarely awarded as learners were unable to compare the benefit of using the pole to jumping, often assuming it was because jumping alone did not involve any elastic potential energy rather than just a smaller amount of this energy. A large number of responses failed to recognise the store of elastic potential energy in the pole, instead scoring no marks for simply describing KE changing to GPE. MP1 and MP2 were sometimes not awarded due to a lack of precision in describing energy stores. They should be taught to describe energy stores fully, particularly with gravitational potential energy and elastic potential energy. Others recognised the energy stores but did not describe the transfer of these stores, again scoring no marks.

Q18(b)(i)– It was quite common to see this question answered in terms of SUVAT equations which gained no credit. It was expected learners would calculate the difference between KE at the start and KE at maximum height and equate this to the GPE gained to find Δh, the maximum possible change in height. Some found the difference in velocities and used this to find KE, others used one of the two values of velocity given which led to an incorrect value for Δh and so MP1 and MP3 were the most commonly awarded.

Q18(b)(ii)– With just a small number of all responses scoring full marks, only the best managed to score full marks in this multiple stage calculation. More successful learners tended to gain the elastic potential energy mark, using $F = k\Delta x$ and $E_{el} = \frac{1}{2}F\Delta x$ or the combined equation of $E_{el} = \frac{1}{2}k\Delta x^2$ for marks 1 and 2. The third mark for use of the kinetic energy equation was also often awarded, although some used the minimum velocity of 1.1 m s^{-1}, or the difference in velocity rather than the maximum horizontal velocity of 9.4 m s^{-1}. If students gained MP4 they usually also successfully gained MP5 as those with a value for E_{el} greater than that for E_k often inverted the equation so as to have an answer less than 1. Regular errors seen were to use the spring constant as force in the equation for MP2, or to use the weight instead as the force.

Q18(c)– Learners did not structure answers well and often gave multiple properties rather than the two required. It was noticeable that though many learners were able to give explanations, these were often linked to the wrong property. Teachers should check that learners have a full understanding of material properties, so that they can then apply the terms with accuracy.

Two correct properties commonly given were ‘strong’ and ‘high elastic limit’. Some thought that a stiff material would be required but failed to see that the pole would not bend much if at all with such a material. The idea of a pole needing to be flexible was common to see but was rarely linked to the material having a low stiffness or Young modulus or elastic modulus.

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 difference between the command words 'describe' and 'explain' e.g. Q13b where all the forces acting had to be considered rather than just the tension
- Re-inforcing the differences between accuracy, precision, resolution and uncertainty
- Learn correct explanations and definitions of key terms
- Explaining each step and any assumptions made in 'show that' and explanation questions in particularly making reference to both the motion e.g.free-fall or constant/terminal velocity and the resultant force.
- Vector diagrams: use sensible scales, measure all lines accurately and make sure that the direction is referenced to a direction that is relevant to the question.

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