Moderators' Report/
Principal Moderator Feedback

January 2016

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

Edexcel and BTEC Qualifications

Pearson: helping people progress, everywhere

January 2016
Publications Code IA043305*

This paper enabled students of all abilities to apply their knowledge to a variety of styles of examination questions. Many students showed a good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. The quality of open response style questions was good, with some of the more able students scoring lower on the numerical questions due to power of ten errors and poor application of trigonometry.

There were a few questions where many lost marks through misreading the question, even though they knew the physics involved. This was particularly noticeable with question 18 where the mechanism of the Mangonel, in particularly the purpose of the launch angle, was misunderstood resulting in lower scores than expected. This was mostly due to students missing that the projectile was launched horizontally. Misreading the question was also notable in question 13b as the question asks why the brass is suitable for use in keys but the majority of students did not refer to the key in their answers. However, students did remember to give units with the calculated values and also, in general, rounded their answers correctly to an appropriate number of significant figures. Most responses showed reasonably clear working out so that marks could be awarded if the final answer was incorrect.

The mean mark on the paper as a whole was 38.6; this was just 0.3 marks greater than the mean on same paper last January. The spread of marks around the mean was slightly greater than last year. However, as is commonly seen on the IAL paper, this was particularly noticeable around the E grade boundary where there was a greater spread of marks compared to that at the A grade boundary. Timing was not an issue at all with this paper with the vast majority of students, across all abilities completed all questions on the paper. The mean score for questions 1 to 10 across all students was 6.1. A variation in the marks for section A was only produced at the top end of the ability range with the most able students scoring 8 or 9 with the majority of other students scoring around the mean.

Section A – Multiple Choice

	Subject	Percentage of students who answered correctly	Most common incorrect response
1	Vector and scalar quantities	86	mixture
2	Forces	31	B
3	Use of equations of motion	81	B
4	Properties of materials	46	C
5	Use of $W = mg$	90	B
6	Energy stored in a spring	67	C
7	Significant figures	10	C
8	Hooke’s Law	67	D
9	Hooke’s Law	93	mixture
10	Vector diagrams	42	A

While most of the multiple choice questions were answered as anticipated, with increasing numbers of correct responses as the ability of students increased, a few were not answered as expected.

Question 1

Virtually all students at the top of the ability range scored this mark. However, a small number of students that answered this question incorrectly, most likely did so due to rushing and not giving the first question on the paper the time it deserves. Papers are generally ramped in that the difficulty increases as the questions progress through each section however, as is often seen, question 1 often scores poorly for this reason.

Question 2

More information was given on this diagram than was required, confusing students with many assuming that the resultant force on the car ($T - F$) was the force of the truck on the car.

Question 4

This question required students to appreciate that while both brittle and malleable materials exhibit elastic behaviour, only malleable materials would go on to demonstrate plastic deformation without fracture.

Question 7

Unfortunately this question was not answered correctly by the majority of students. The students needed to appreciate that the answer to a calculation should only be quoted to the same number of significant figures (sf) as the measurement with the fewest number of sf. In this case the diameter was quoted to the fewest number of sf out of all of the measurements given. The mass and length were measured to 3 sf as while the diameter was measured to just 2 sf. Quoting the density to1 sf would give an answer of 9000 and to 3 sf would give an answer of 8950 (B) or 8.95×10^3 (C), to 2 sf the stated density would give an answer of 9.0×10^3.

Question 10

Students are less confident using the parallelogram rule for vector addition, although this was a more straightforward example combining perpendicular vectors. The construction lines were not included in responses B and D which may have confused some as a closed shape was not produced. However the direction of the resultant in distractor A, the most common incorrect response, was the wrong way round and missed by many.

Section B

Question 11

(a) Most students only scored the second mark for equating the force and the weight and the displacement with the height. Few thought to use the conservation of energy to explain why these two equations should be equivalent and made references to an energy transfer. Many tried to compare the units of the two equations or to substitute values from the diagram into both equations to show their equivalence. Although the latter used their equivalence it did not, as the question asked, provide an explanation.

(b) A simple calculation with almost all students scoring both marks. A few students dropped a mark due to an omitted or incorrect unit (N or m).

Question 12

(a) This question provided some discrimination with only the more capable linking $F = ma$ to $F = mg$. The majority of responses stated Newton's second law followed by $F \propto a$ without considering the origin of the resultant force causing the acceleration.

(b)(i) This has been asked on previous papers and students were also then expected to identify that the initial velocity would be zero, either by a statement or by the omission of the 'u' term in the correct equation of motion. While most students were able to recall the correct equation, on average about 50 % of students failed to complete the response by using or referring to $u = 0$.

(b)(ii) This question discriminated well with the most common source of error identified to be parallax. Less able students tended to omit an explanation as to how the error would cause a greater value of g with no references to the measured time or displacement.

The question demanded the response to be about the system rather than human error such as throwing the ball or miscounting the frames. Many responses contained generic statements such the distance fallen or measured time would be incorrect. Air resistance was often mentioned but that would have resulted in a lower not higher value for g.

Question 13

(a)(i) The majority of students confused strength with strong giving explanations in terms of high breaking stress. Few appreciated that strength has a magnitude and many discussed the force on fracture as oppose to the stress. Students had to be clear that they were discussing the maximum stress at fracture and not just a maximum stress.

(a)(ii) Hardness was marked more leniently, particularly as, unlike strength, it is not as easy to define numerically. Generally responses stated the characteristics of a hard material i.e. resistant to scratching rather than hardness, its resistance to scratching.

(b) This question discriminated well with many students able to use the graph to identify some of the properties of brass that make it suitable for keys. Usually these marks were awarded for strong and stiff with comments regarding the toughness of brass being treated as neutral as it was not relevant for the applied stress in this context. Students describing the elastic limit were less successful, often identifying that the applied stress of 10 MPa was below the limit of proportionality which, although true, did not explain the elastic properties of brass.

Those who discussed malleability also did not gain the mark as the question did not ask about the manufacture of the key, merely its use.
Few students scored beyond 2 or 3 marks as applications of these properties to the key were rare. Marking points 2, 4 and 6 were conditional on being linked to the correct property of the brass so long responses that did not refer to the graph but discussed the key not breaking or bending in the lock would not have scored highly.

Question 14

This question provided a full range of marks with many scoring 2 (marking point 2 and 3) or 3 marks (marking points 1, 2 and 3). Only the best students used energy supplied or work done as a link between the amount of drag on the lorry and the fuel used i.e. the last mark. Most students appreciated that a comparison was needed between the two types of trailer with responses describing both trailers or stating the increase or decrease in the properties due to the design. Some responses stumbled with the description of the shape of the old trailer in comparison to the new trailer, not really knowing how to describe a less streamlined design.

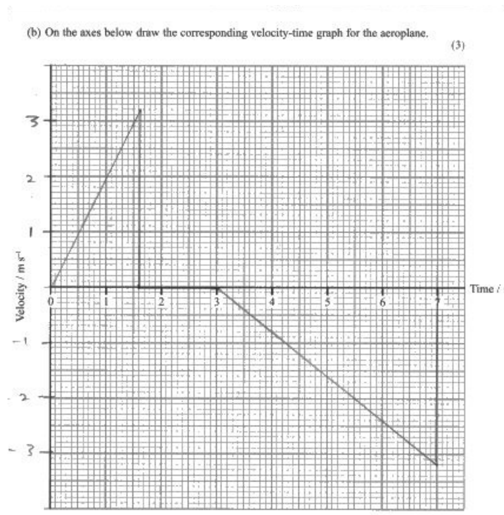
Question 15

(a) Most students answered this question successfully. The expected response was very straightforward and examiners were just looking for correct units for stress and strain. When students are asked to show the examiner something, they must realise that it needs to be shown to the satisfaction of the examiner so all steps of the argument must be shown, in particular here, why the strain has no units.
(b)(i) This question was well within the capabilities of a reasonable A level student with many good starts to the question seen. However, a surprising number omitted or were unable to convert cm^2 to m^2 for the area. Others went on to substitute incorrect dimensions of the cube into the equations or calculate the surface area or volume of the cube in place of the cross sectional area.
(b)(ii) This question was not answered as well as expected. Answers from less able students were vague, only describing the area changing and hence the Young modulus changing without a definite description of the changes, gaining no credit. Others correctly described the relationship between the cross-sectional area and the Young modulus but did not specify that the area would be increasing and the Young modulus increasing, hence only scoring one mark. The term 'area' on its own was accepted but students were seen to refer to the surface area, and should be confident in their use of the terms 'surface area' and 'cross-sectional area'.

Question 16

(a) Most students chose to use the area under the region of the graph for the acceleration of the plane to determine maximum velocity of the plane. Fewer used the deceleration of the plane or $v = u + at$ to calculate the maximum velocity. A few students misread the time to be 1.5 s instead of 1.6 s but this was only penalised once within question 16.
(b) At this point in the question the marks began to vary, while many students scored all 3 marks for (a) some just scored the first or first two marks in (b). Many students represented the period of motion with no acceleration as zero velocity, and many assumed that a negative acceleration also indicated a

negative velocity as shown below. The question also required some scaling on the positive velocity axes and the maximum velocity had to be accurately plotted using the scale used. The response shown would have only scored the first mark for the region of increasing velocity.



(c) The calculation of distance was straightforward for those scoring 3 marks in part (b), but those who made a mistake in part (b), particularly a negative speed found (c) more difficult. This question did allow for an error carried forward from the students' graphs. However the question asked for the distance travelled and not the displacement so the areas of all of the regions had to be added to score all three marks. Some of the better students that had incorrectly drawn a region of negative velocity did subtract these distances and could only then score the first two marks.

(d)(i) The calculation of KE was done well. The most common mistake was to forget to square the velocity, even having quoted ½ mv^2 which lost both marks.

(d)(ii) The calculation of power was also answered well with most students using the formula correctly. A small number of students did not use the correct time of 1.6 s but had missed the reference to the acceleration in the stem and used that total time of the motion of 7 s. A small number of students attempted to answer using work done/time, $F = ma$, to calculate the accelerating force. However, due to the number of additional steps involved, errors were introduced and not all students were successful in scoring both marks. Students using $P = Fv$ were rarely seen to use the average rather than the maximum velocity so could only score 1 mark for this alternative method.

Question 17

(a)(i) The Physics examined in this question was straightforward, however, due to two fluids being involved, as well as a reference to density in the stem, this question did not score well overall. The most common misconception was that, due to the decrease in density, the drop became lighter. This negated any mark the student may have earned for a correct statement as to an increase in upthrust. The majority of students scored 1 mark for the upthrust increasing, or an upwards resultant force, with few considering the step between the increasing volume and the increasing upthrust i.e. a greater volume of fluid displaced.

(a)(ii) Most students could correctly identify the three forces involved with a few students assuming that the wax drop was falling and adding the drag to the upthrust. Full credit was not given for an equation using symbols unless the symbols were defined as the question had asked for a word equation.
(b) This part of question 17 was answered more successfully. Perhaps because the responses required were more straightforward. A good range of scores were seen but surprisingly not all students commented on the decrease in temperature at the top, even if they had discussed its consequences. The student had to be clear as to whether they were describing the effect of a decrease in temperature on the wax drop or on the surrounding fluid. Some students did not grasp the concept, failing to realise that this was due to a decrease in temperature, answering in terms of increasing terminal velocity and increased drag.

Question 18

Students needed to read the stem of the question carefully in order to understand the mechanism of Mangonel. While most students managed to gain credit for some marking points, the physics involved was often little more than the conservation of energy, however students had to be precise in their language when referring to physics quantities to avoid incorrect physics. As mentioned in the introduction and the summary, a good appreciation of the context is necessary to enable students to access all of the available marks.
(a)(i) Students found it difficult to articulate their understanding and technical terms such as elastic potential energy were not well used. Responses only referring to a greater amount of energy being stored were not sufficient to score the mark and very few students mentioned the force on the arm. The responses most commonly seen referred to the elastic properties of the rubber such as 'rubber is elastic' or 'does not permanently deform'.
(a)(ii) Most students mentioned the change in elastic (potential) energy to kinetic, but failed to mention the increase in gravitational at the same time. Other students, failing to understand the release mechanism of the Mangonel, thought the change to be $E_{el} \rightarrow E_k \rightarrow E_{grav}$ which is incorrect, as the band continued to contract as the arm was being raised.
(b)(i) This question discriminated well. Most students scored the third mark for a greater speed with many scoring either of the first two marks for a correct reference to energy. Not many scored the fourth mark, linking a greater velocity to a greater range using $s = vt$, perhaps thinking it too obvious to mention.
A common error was to confuse the release angle of the arm with the angle at which the projectile left the bucket. The projectile was not released until the arm was vertical i.e. with a horizontal velocity but no initial vertical velocity.
The alternative mark scheme for this response linking the increase in angle with an increase in force, therefore an increase in acceleration was rarely seen but described well when attempted.
Less able students tended to just refer to horizontal and sometimes vertical components increasing without mentioning velocity or force.
(b)(ii) The more capable students related smaller mass to a greater acceleration or velocity using $F = ma$. Although a statement that the applied force was constant was not required some students misunderstood the mechanism again and failed to realise that this would be constant, stating that the force would decrease as well. This was only a 1 mark question so such statements, although incorrect, were not penalised but worth a mention in this report if discussing this question with students in the future.

(b)(iii) The use of stiffer, shorter or doubled rubber bands was most common, and the increase of energy or force was quite an easy mark although missed by some. Some students mentioned increasing the length of the arm although that is a more doubtful way to increase the range. There must be an optimum arm length as too long an arm would result in such a large proportion of the stored energy transferred to gravitational potential of the projectile that the initial velocity of the projectile would be too low, even with an increased time in the air to increase the range. Tilting the model was a simple reason but was rarely mentioned, perhaps because many students had not noted that the projectile was released horizontally.

(c)(i) Large numbers of students missed that the projectile only dropped by 5 cm, using 8 cm or 13 cm in the equation, again emphasising the need to read the question well. Otherwise, the equation was used well.

(c)(ii) This question should have only required the students to use the equation $v = s/t$, twice. While the vast majority of A grade students scored full marks, less able students, at best tended to score just one mark for the initial velocity of the projectile of 10.6 m s^{-1}. Many students assumed the projectile was released at an angle, most responses were seen to involve trigonometry. Components of the initial velocity were determined and then used in equations of motion, taking the acceleration to be g, ignoring the initial horizontal motion of the projectile.

Question 19

(a)(i) Most students scored both marks with a few students truncating their answer and quoting 2.8 m s^{-2} rather than 2.9 m s^{-2}, costing them the final mark.

(a)(ii) While most students could score the first two marks for use of $F = ma$ few could go on to successfully explain that the box should have the same acceleration as the lorry, the concept of a forward frictional force on an object being too difficult an idea for most. Many answers seen were in terms of the resultant force on the box and if the acceleration was too great then the friction would push the box off the lorry.

(b)(i) Over half of the students answered this question correctly with most incorrect responses due to the parallel and vertical components being the wrong way round.

(b)(ii) Those students who had found the correct components in (b)(i) were usually able to correctly link the components of weight to F and R The vast majority of students that had got this far could then use the trig identity $\sin\theta/\cos\theta = \tan\theta$ successfully to obtain the correct angle of 18°. Some students did not appreciate that the friction force varied with the reaction force and so were unable to link their two equations.

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 the multiple choice questions so that key words in the command sentences and distractors are not missed.
- 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 unit conversions.
- Read the question carefully and do not make assumptions of your own. It is worth investing more time during the exam to make sure that you have completely understood the context of the question and what the question is asking. Do not just look for key words and re-write an answer on the same subject from a previous exam.
- Remember that a negative gradient on an acceleration time graph corresponds to a deceleration. The motion may still be in the same direction so the velocity will still be positive
- Learn precise definitions for the properties of materials given in the specification.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:
http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London WC2R 0RL