Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

January 2024

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH11)
Paper 01 Mechanics and Materials

Introduction

The unit WPH11 covers candidate's ability to understand and apply the physics involved in basic mechanics and properties of materials. The application of this knowledge in a range of familiar and unfamiliar contexts was examined.

Several questions asked for candidates to recall some basic facts, the conditions for equilibrium or what is meant by elastic behaviour. While some candidates were able to answer these questions well, there was a fairly large proportion who were unable to include the details needed to give complete answers. Learning these definitions can be helpful to candidates, not just in terms of giving a definition when asked, but also in terms of understanding the physics related to these concepts.

Most candidates demonstrated a good ability to answer questions requiring calculations. However, in questions where students were asked to deduce an answer, it was common for students who calculated an appropriate value to just state their answer rather than comparing their calculated value with a value given in the question.

The core practical task to determine the Young Modulus was assessed in question 17. This question proved to be challenging for many students. Many students used terms such as precision, accuracy, resolution and uncertainty without appearing to appreciate the differences in the meaning of these terms.

The standard of written English seen by the examiners in this paper did not, in most cases, cause any difficulty. The candidates were able to record their knowledge of the subject clearly, even if not in the best English. Apart from the * questions, where the structure of the candidates' responses was being assessed along with the physics, lack of skill in written English was not penalised, as long as the responses were clear and unambiguous.

Comments on Individual Items

Section A: Multiple Choice

	Subject	Correct response	Comment
1	SI unit for stress	**D**	$\text{Stress} = \dfrac{\text{Force}}{\text{cross} - \text{sectional area}}$
2	Scalars and vectors	**A**	Acceleration, momentum and weight are all vectors
3	Elastic strain energy	**A**	$\text{Elastic strain energy} = 0.5 \times \text{force} \times \text{extension}$ $\text{So extension} = \dfrac{2\times \text{ elastic strain energy}}{\text{force}}$
4	Power	**D**	At a constant speed on a horizontal surface, work is done against resistive forces at a constant rate. As the cyclist moves uphill at a constant gradient and the same speed work is also done against gravity at a constant rate, so the power initially has a constant lower value, then a constant higher value.
5	Effect of air resistance on motion	**C**	Air resistance causes the time taken to fall to increase, so the velocity just before hitting the ground is less than that calculated.
6	Resolving forces.	**C**	The vertical component of the tension is T cos 80°. Tension acts in both directions along the wire, so 2 T cos 80° is equal to weight. Therefore $T = \frac{W}{2\cos 80°}$
7	Stiffness constant for a spring	**C**	$F = k\Delta x$. Change in length is the length L of the spring minus the initial length L_0 , so the equation describing the graph is $F = k(L - L_0)$, which can be written as $F = kL - kL_0$. Comparing this with $y = mx + c$, it can be seen that the gradient is equal to k.
8	Density	**D**	$m = \frac{W}{g}$ and volume of a cube = $L^3 = \frac{m}{\rho}$. Therefore $L^3 = \frac{W}{g\times\rho}$ and $L = \sqrt[3]{\frac{W}{g\times\rho}}$
9	Stress strain graphs	**C**	Breaking stress is the stress at the end of each line. Yield stress is at the top of the initial straight section of each line.
10	Work done by a force	**D**	The area under the graph between 0 and t is the change in velocity of the object. The object starts from rest, so the mean velocity is therefore $\frac{X}{2}$ and the distance moved = speed × time = $\frac{Xt}{2}$

Question 11

Q11(a)

Most students realised that the rubber band returned to its original length, but is was very common for students to fail to state that this occurs when the force is removed. Some students referred to Hooke's law in their response, which was not relevant to this situation.

Q11(b)

This question proved to be quite challenging to students. Some students did not realise that a numerical answer was needed, and instead described the energy transfers that led to heating. The majority of the correct answers counted the number of squares between the two graph lines, or counted the number of squares below each line and calculated the difference. There were some good answers which divided this area into trapezia and triangles to determine the area, before then calculating the energy.

Some candidates incorrectly treated each line as a single straight line, and then tried to use $E_{el} = \frac{1}{2}F\Delta x$. A lot of students did not convert the unit of extension from centimetres to metres.

Question 12

Both parts of this question were well answered.

Many students correctly resolved and used the horizontal component of u in part (a). However, it was reasonably common for students to incorrectly round their calculated answer to 0.138 s instead of 0.139 s. Students who made this error only scored 2 marks in part a.

In part (b), a minority of students made the error of thinking that the horizontal acceleration was *g* rather than zero. Some students either used the vertical component of velocity instead of the horizontal component, or just used 15.6 m s^{-1} without an attempt to resolve at all. These students scored no marks in part (b).

Question 13

Q13

Different approaches could be taken to score the first marking point, and it was common to see examples of both approaches – either the upthrust from the bubble of air decreasing, or the combined weight of the diver, air and water inside the diver increasing. It was less common for students to mention that the weight would then be greater than the upthrust, or that the resultant force would be downwards, but many students did mention at least one of these points.

Question 14

Q14(a)(i)

This was a challenging question. Many students referred to constant velocity rather than constant acceleration, and few students realised that the relevant point about the shape of the slide was that the gradient varies. Only a small proportion of students identified that the equations of motion can only be applied when there is constant acceleration.

Q14(a)(ii)

This calculation question was answered well by a large proportion of students. Most appreciated that the ideas of energy conservation needed to be applied. Some of these students made errors when re-arranging their answers. A few students used the equations of motion which led to a score of 0 on this question.

Q14(b)

Those students who used ideas of conservation of energy tended to score better on this challenging question. It was reasonably uncommon for students to recognise that the final velocity of both children would be the same. Some students discussed drag and friction in their answers, despite the question stating that resistive forces should be ignored.

Question 15

Q15(a)

Many students did not realise that this investigation was using small ball-bearings, and stated that a small, spherical object was needed was not. This did not score a mark as the information was given in the question. The most common mark scored was by students who mentioned laminar flow.

Q15(b)(i)

This question was reasonably well answered, with most student realising that arrows for weight and upthrust were needed. Some students did not label the weight arrow correctly: weight, W or mg were all acceptable, but some students labelled weight as G, which is incorrect. A small proportion of students did not start their arrows from the dot.

Some students appeared not to appreciate that the length of the arrow represents the size of the force, and therefore did not score the second marking point.

Q15(b)(ii)

The best students gave clearly laid out working to arrive at a value, then compared this with a value from the question, and gave a conclusion. However, there were many answers where the layout of the students working was very disorganised. While this did not prevent students from scoring full marks, those students who did lay out their working clearly tended to fare better as it was easier for them to keep track of their thoughts.

A small minority of students did not use an appropriate method to determine the volume of the ball-bearing, either treating the radius as a diameter or using a value of r^2 instead of r^3. Similarly, a small proportion of students substituted volume into the Stokes' law equation instead of a velocity. Power of ten errors were reasonably common.

Question 16

Q16(a)

To calculate the average acceleration, students should ideally have taken points from 0 velocity and 2.85 m s^{-1}. However, those who calculated the gradient of the straight line section were given full credit.

Common errors included responses where the student had just used one point from the graph to determine an acceleration. These responses could only score a maximum of one mark.

It was also relatively common for students to read time in seconds from the graph, rather than time in milliseconds.

***16(b)**

Some students began their explanation from when the ball was thrown. This did not prevent marks from being scored. The question as a whole was well answered, and it was common to award students the first three indicative content points. Some students did not refer to Newton's second or third laws at all. Those who did refer to these laws did not always apply them to the scenario given.

Of those students who scored five marks, it was relatively common that these were the first five indicative content points, and the sixth point that was not scored.

16(c)

Most students answered this question well, and seemed familiar with applying conservation of momentum to this situation.

Some students went awry by assuming that the ball and skittle stuck together, and adding the masses together.

A significant minority of students made errors when re-arranging the equation after showing correct substitution into the equation.

Question 17

Q17(a)

There was a significant number of students who did not attempt this question, suggesting that perhaps they were not familiar with using a micrometer to measure the diameter of a wire. Some students suggested that the best method to determine if the wire was uniform would be to determine whether the centre of mass was in the middle of the wire, an approach which scored no marks.

Q17(b)(i)

While a fair proportion of students answered this question correctly, many did not seem aware of the risks. Common incorrect answers included wearing a helmet, gloves or shoes. Some students suggested using small masses on the wire, which would lead to an inaccurate outcome of the investigation.

Q17(b)(ii)

Answers to this question often demonstrated a lack of knowledge about the meaning of the terms resolution, precision, accuracy and uncertainty. There were a significant number of students who did not attempt the question at all. The proportion of students who referred to resolution and went on to link this to uncertainty was very low.

Q17(c)

While this question was reasonably well attempted by the majority of students, a large proportion of students did not notice that the graph does not start at the origin.

Of those who did correctly identify that the change in force was 14 N, and went on to calculate a correct value for the Young modulus of the material being tested, many did not compare the value they obtained with the 106 GPa given in the table, and therefore did not score the final mark.

Question 18

Q18(a)

Many students showed that they were thinking along the right lines, but did not mention that they were referring to the resultant. Answers such as 'clockwise moment = anticlockwise moment' were often seen, but this was not sufficient to score the second marking point. It was more common for students to identify that the total clockwise moment should be equal to the total anticlockwise moment than to identify that the resultant force should be zero. Many students did not mention forces at all.

Q18(b)

It was disappointing how few students could give a correct definition of the centre of gravity. While many students could describe a vague idea of what is meant by the term, it was very common to see answers stating that the weight acts at that point or is concentrated at that point, rather than appearing to act at that point.

Q18(c)(i)

Students found all of question 18(c) to be challenging, with a fair number of students who did not attempt these question parts.

Many students recognised that this question required the calculation of moments of force. Students who either added to the diagram given, or drew their own diagram, found this to be beneficial. Some students made errors such as using the full width of the door to the centre of gravity rather than using half the width of the door.

Q18(c)(ii)

As with question 18(c)(i), those students who drew a diagram to help them tended to answer this question well. Students could use a mixture of Pythagoras' theorem and trigonometry, or could answer the question using trigonometry only. It was far less common to see attempts that used Pythagoras.

Many students calculated the complimentary angle, giving 62° instead of 28°.

Q18(c)(iii)

This was the most challenging question on the paper, with many students struggling to express their answers, and many vague statements which were insufficient to score marks. Some responses used symbols to help their explanations, but did not define what the symbols used were referring to. Very few students referred to the components of *F* in their answers.

Concluding remarks

There was a wide range of knowledge and skills demonstrated by candidates taking this paper. It was pleasing to see some excellent responses, particularly to some of the more challenging questions on topics such as moments and materials.

It was clear that while most candidates have a broad idea of what is meant by most physics terms, many candidates need to put more effort into getting the details correct and learning definitions more thoroughly.

Many candidates would also benefit from developing their knowledge of the practical skills that apply to to the core practical tasks on the specification. The terminology around practical work is another area which students would benefit from learning.

The recommendations for improving student performance remain similar to those in previous series, namely:

- Allocate time to doing core practical tasks, including learning the definitions of terms such as resolution, precision, accuracy and uncertainty.
- Practice applying principles in a variety of different contexts to boost confidence and problem-solving skills.
- Prompt candidates to thoroughly read and re-read questions and their answers to reduce the risk of misunderstandings and inconsistencies.
- Emphasise the importance of understanding and clearly defining basic terms and quantities to ensure candidates receive credit for concepts they comprehend.
- Teach candidates to effectively use calculators, and how to round final answers appropriately. Encouraging smart use of calculator memory functions can also be beneficial.