Examiners' Report
Principal Examiner Feedback

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

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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, such as the conditions for Stokes' law, or the meaning of the term centre of gravity. While many candidates were able to answer some of these questions well, there were some, such as Q17(a) and Q15(a) where candidates struggled to give clear, concise and accurate 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.

Candidates' ability to answer questions requiring calculations or numerical answers was generally good. However, in the many questions where the physics of a phenomenon had to be explained, they did very much less well, and often did not fully address the question. For example, in question 18b, where candidates were asked to explain the shape of a displacement-time graph as a ball-bearing fell through a liquid, candidates often did not refer to the graph at all in their answers. Candidates often focussed their explanation on why the ball-bearing would reach terminal velocity, but without mentioning the graph.

A number of questions focussed on candidate's ability to interpret graphs. This included understanding the relevance of the area under a graph and the gradient of a graph. Many candidates struggled to understand the physical relevance of these quantities. Question 16bii, for example, needed candidates to understand how a force-extension graph related to changes in energy, and many candidates struggled to demonstrate that they understood this.

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	Scalars and vectors	A	Energy is a scalar and momentum is a vector
2	SI unit for momentum	A	Momentum = mass (kg) × velocity (m s^{-1})
3	Elastic limit	B	A stress above the elastic limit would cause permanent deformation.
4	Acceleration due to gravity	C	When accelerating due to gravity, negative velocity increases. The gradient of a displacement time graph represents velocity, so the gradient becomes increasingly negative.
5	Gravitational potential energy	C	Work done against gravity is equal to the increase in gravitational potential energy.
6	Kinetic energy	A	$$\frac{1}{2}m(v_2)^2 = 2 \times \frac{1}{2}m(v_1)^2$$ So $(v_2)^2 = 2 \times (v_1)^2$ Therefore $v_2 = \sqrt{2}v_1$
7	Efficiency	A	Application of efficiency equation with total power input = 2.1 GW + 3.4 GW
8	Young modulus	A	Young modulus is the same for both wires. If new length is l and new diameter is d_{new}, then $\dfrac{Fx}{\Delta x \times \left(\frac{\pi d^2}{4}\right)} = \dfrac{Fl}{2\Delta x \times \left(\frac{\pi d_{new}^2}{4}\right)}$ Therefore $l = \dfrac{2xd_{new}^2}{d^2}$ Substituting $d_{new} = 0.5d$ gives a corresponding new length of $0.5x$.
9	Vector sum of forces in equilibrium	D	The vector sum of forces in equilibrium is zero.
10	Work done by a force	B	Work done = 5 m × 30 N × cos (40°) = 115 J

Question 11

This question tested candidates' understanding of $\Sigma F = ma$.

Q11(a)

The weight of the rocket should have been subtracted from the thrust to give the resultant force.

A common mistake was to treat the thrust from the rocket's engines as the resultant force, which led to an incorrect answer.

Q11(b)

The best responses realised that the answer to this question is based on Newton's 2nd Law, so considered either the forces acting on the rocket or the mass of the rocket, or both in some cases.

The most common correct answer seen was from candidates who realised that the mass of the rocket would decrease as fuel was burnt. The decrease in mass would also cause a decrease in the weight of the rocket, which in turn would increase the resultant upwards force on the rocket, which was also seen in some answers.

A fair proportion of candidates explained why the rocket accelerated, by stating that the thrust was greater than the weight, rather than explaining why the acceleration would increase.

Question 12

Q12(a)

The vast majority of candidates were clearly familiar with the concept of conservation of linear momentum, but many candidates did not include crucial details in their responses. It was common to read answers which omitted the idea of **total** momentum remaining constant, or the idea that this only applies when no external forces act. Candidates should learn definitions such as this and be able to recall them accurately and completely.

Q12(b)(i)

Most candidates who scored full marks on this question took a mathematical approach, giving expressions for the total momentum before and after the collision, and showing that these were consistent. Candidates who attempted this approach usually demonstrated an understanding of the situation, and gained credit. However, successful answers which took more descriptive approach to answering the question were also seen.

Candidates should be aware that repeating information given in the question will not gain credit. Although there is certainly no harm in this, and it is sometimes helpful, it can perhaps make candidates think that they have made more points than they actually have. For example, an answer such as "the mass of each glider is the same, so the velocity after the collision is half the velocity before, and so momentum is conserved" may initially seem like a reasonable response. However, the first two parts are given in the question and therefore have provided no further justification for the conclusion.

Q12(b)(ii)

Many candidates found this question to be very challenging. A lot of answers were ambiguous in their wording, and lacked sufficient detail to score.

For example, some answers referred to the forces cancelling out, rather than stating that the forces were equal in size and opposite in direction.

Other answers stated that the resultant force was zero. There are two gliders in this system, and each glider would experience a resultant magnetic force. To gain credit for an explanation involving the resultant force, it therefore had to be clear that the answer was referring to the resultant force **on the system**.

Question 13

Q13(a)

This question was answered very well, with the majority of candidates using the equations of motion to correctly determine the time taken for the ball to reach the ground. Some candidates did not round the time correctly, giving an answer of 0.71 s for the time taken, and a small proportion of candidates gave a value for t^2, but did not square root their answer.

Most candidates went on to calculate the velocity of the ball as it was projected from the machine, although some candidates incorrectly assumed that the horizontal acceleration would be 9.81 m s^{-2}.

Q13(b)

Candidates found this question difficult to answer. Many candidates described the angle of the displacement of the ball when it hit the ground, instead of the angle of the velocity of the ball when it hit the ground.

When explaining projectile motion, candidates should consider both horizontal and vertical components. Some responses that showed otherwise good understanding did not comment on the horizontal component of the velocity of the ball.

Question 14

Q14(a)

Drawing scaled vector diagrams is a skill that can be easily practiced, but this questions proved to be challenging to many candidates.

It was reasonably common for candidates to draw a free-body force diagram rather than a vector diagram with vector arrows drawn "tip to tail". Vector arrows should always be labelled, but this was not always seen.

Some candidates ignored the instruction to use a scaled vector diagram, and instead used trigonometry to calculated the magnitude of the tension. This approach could score the final marking point, but the vector diagram was needed to score the first three marks.

Q14(b)

This question was answered well by a fair proportion of candidates. It was pleasing to see that many candidates compared their calculated answer with data from the question, which was needed to score the final marking point.

There were many different approaches that could be taken, for example by working backwards from 35W to determine the time, number of repetitions, force applied or vertical distance moved. Any of these approaches could score full marks.

Some candidates did not read the question carefully enough, and used the force of 121 N from question 14(a), instead of the weight of 150 N given in this question.

Question 15

Q15(a)

The definition of the term centre of gravity should be straightforward, but the majority of candidates were not able to give the correct meaning. The most common problem seen was from candidates who did not appreciate that the centre of gravity is the point where weight **appears** to act. Many candidates instead stated that the centre of gravity is the point where weight acts, which was not sufficient to score the mark.

Q15(b)

The context of this question on moments proved challenging for candidates to interpret, but a fair number of candidates scored the first three marking points of Q15(b)(i) for correctly determining the moment of the weight of the ladder about the hinge and the moment of the weight of the board about the hinge.

Some candidates did not attempt calculations in Q15(b)(i), perhaps not realising that in some situations a full explanation does require relevant calculations. It was rare for candidates to appreciate that the block would also cause a moment about the hinge, so only a small fraction of candidates scored all 5 marks on this question.

Candidates who performed well on the first thee marking points of Q15(b)(i) tended to score well on Q15(b)(ii) too. There were also some candidates who struggled on Q15(b)(i) but scored both marks on Q15(b)(ii)

Question 16

Q16(a)

This question was reasonably well answered.

Candidates again needed to be aware that re-stating information in the question is not sufficient to score marks. For example, stating that one force is weight and the other is a magnetic force is given in the question, and is not the same as identifying that these are different types of force.

Some candidates simply stated that a Newton's third law pair consists of a pair of equal and opposite forces, which was not enough to score any marks. To gain credit, candidates needed to state why these particular forces do not form a Newton's third law pair.

16(b)(i)

A fair proportion of candidates scored full marks on this question, with the majority of candidates gaining some credit.

The most common mistake seen was in answers which did not use the strain equation to calculate the change in extension. Candidates who missed this step and then used $F = kx$ instead of $F = k\Delta x$ could still go on to score marking points 2 and 3.

It was also reasonably common to see some unit errors. Despite the fact that no unit conversions were needed, power of ten errors were also seen on a regular basis.

16(b)(ii)

This question was very challenging for candidates, and a large number of blank responses were seen. Of those who did attempt an answer, many did not add any annotations to the graph, as instructed in the question.

The first marking point, for recognising that the area under the graph represents the elastic strain energy, was the most common mark scored.

Some candidates attempted to describe the situation using equations for elastic energy and change in gravitational potential, but used generic symbols such as F and x without relating them to a specific force, weight or extension. Since this question has several weights and extensions that these could refer to, the third and fourth marking points could not be scored in these cases.

Question 17

Q17(a)

Only a small proportion of candidates managed to state what is meant by upthrust. This is another example of a definition which candidates should be able to recall without a problem. Unlike the other questions on the paper asking for candidates to state the meaning of a term, however, candidates seemed to struggle to give even a vague description of upthrust. Perhaps many candidates have only ever used an equation for the weight of fluid displaced being equal to the upthrust, without actually having defined the term upthrust.

Q17(b)

The majority of candidates gained some credit on this question, although only the best candidates scored all seven marks.

In Q17(b)(i), a large proportion of responses successfully calculated the upthrust of the balloon. Some candidates used the values of the density of air and volume of the balloon to calculate the mass of displaced air, but then used this mass in the equation $\Sigma F = ma$, instead of using this mass to calculate upthrust.

In Q17(b)(ii), most candidates read a suitable value for density from the graph, and a high number of candidates went on to successfully calculate a relevant value. Some responses showed answers using the density equation along with a mass calculated from 17(b)(i). For marking point 2, benefit of doubt was given that candidates who took this approach had deduced that when upthrust = weight, $\rho V g = mg$, and this simplifies to $\rho V = m$ (i.e. the density equation).

Q17(c)

Many candidates struggled to express relevant physics points when answering this question.

A lot of responses described what happened until the forces became balanced and the balloon reached terminal velocity. These responses could still score some marks, but did not go on to explain that motion of the balloon up to its maximum height. It is not clear if candidates described this because they thought the question was asking about terminal velocity, or if they thought that the maximum height would be reached when the upthrust was equal to the weight, and therefore the resultant force would be zero.

The concept of decreasing acceleration is one which seems to be tricky. Many responses, including those from candidates who showed an otherwise very good understanding of the physics, demonstrated confusion that when acceleration decreases, the velocity is still increasing, but is just increasing at a lower rate.

Question 18

Q18(a)

This question was answered reasonably well, with the majority of candidates gaining at least one mark. Some candidates had clearly learned a definition by rote, without necessarily understanding the meaning of the terms. For example, the word laminar was often used, but not always applied to the flow of the liquid. A statement that "the object must be laminar" was not sufficient to score marking point 2. Some answers identified that the object must be spherical, but did not qualify this by stating that it must be small, or that it must be moving at a low speed, so did no score marking point 1.

Q18(b)(i)

Most candidates scored no marks on this question. The most common reason for this was that the answers did not often refer to the graph, and therefore could not explain the shape of the graph. Answers which explained how the forces acting on the ball caused it to accelerate to terminal velocity, but did not make any reference to the graph could score a maximum of 1 mark.

Some responses did describe the graph, but did not make any reference to speed or velocity and therefore did not score any marks.

A common misconception was that the increasingly negative gradient showed a decreasing speed, rather than showing an increasing downwards speed.

Q18(b)(ii)

This question was well answered, with the most common score being 3 marks. Candidates should have determined the gradient of the straight section of the graph, but many candidates did not do this, and instead selected a point on the graph and divided the displacement by the time.

A surprisingly high proportion of candidates interpreted v in the equation $F = 6\pi\eta\rho v$ as a volume rather than a velocity.

Q18(b)(iii)

It was reasonably common for candidates to score marking point 1 for recognising that viscosity decreases as temperature increases. However, a very low percentage of candidates managed to score all four marks on this question.

Many responses commented on the time taken to reach terminal velocity, but then in some cases didn't go on to state that the terminal velocity reached was greater.

A lot of responses had the idea that the velocity would be greater, but didn't specify that it was the terminal velocity, or just repeated the statement in the question that it took less time to fall a given distance.

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 skills at explaining situations in terms of the underlying physics. Candidates should practice explaining scenarios that are set in either familiar or unfamiliar contexts.

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

- Allocate time to doing core practical tasks, including describing the tasks and writing up the results to enhance memory retention for exams.
- 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 rounding final answers appropriately. Encouraging smart use of calculator memory functions can also be beneficial.