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Examiners' Report
June 2025

Int Advanced Level Physics WPH11 01

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Introduction

The topics covered by the WPH11 unit focus on candidate's ability to understand and apply the physics related to basic mechanics and to materials. This knowledge was tested using a range of familiar and unfamiliar contexts.

Responses from students demonstrated a wide range of ability, both when dealing with the application of mathematical approaches to solve physics problems, and when writing descriptions and explanations.

Many aspects of the paper were well answered by a large proportion of candidates, but some questions revealed some relatively common misunderstandings and misconceptions. A fairly large number of candidates struggled to correctly apply the efficiency equation, where they had to consider the physics of the situation in order to determine the correct total energy input to a battery. And when interpreting a force-compression graph to determine a change in energy, it was relatively common for candidates to multiply the change in force by the change in compression, which was incorrect physics.

Many of the calculations were attempted well by many candidates, although when trigonometry was involved, as in the Q19(b), this tended to cause problems for more candidates.

Descriptions and explanations from many candidates lacked detail, and often did not answer the question that was being asked. The description of the changes in energy and momentum in Q18(c), for example, was often done poorly, for example, and the explanation of energy conservation in Q20(c) often described the forces acting rather than discussing energy.

The standard of written English did not, in most cases cause any difficulty to examiners. Candidates were able to record their knowledge clearly, even if not in the best English.

Most candidates demonstrated a broad understanding of the meaning of most physics' terms used in the paper, but there was sometimes a lack of detail in that understanding which meant that candidates could not write definitions with full accuracy, and sometimes struggled to apply terms appropriately in explanations.

Question 11

This question was answered well by the majority of candidates.

For those who did not score all 3 marks, it was relatively common for the unit to be omitted, or a wrong unit of kg to be given instead of N. There were also a number of candidates who only used F=ma to calculate the mass of the boat, and did not then go on to calculate the weight.

11 A resultant force of 4800 N acts on a boat.

The acceleration of the boat is $0.31\ \mathrm{m\,s^{-2}}$.

Calculate the weight of the boat.

$\Sigma F = ma$

$4800 = m(0.31)$

$m = 15484\ \mathrm{kg}$

$= 1.5 \times 10^4\ \mathrm{kg}$

Weight of boat = $1.5 \times 10^4\ \mathrm{kg}$

ResultsPlus Examiner Comments

This answer scored 1 mark.

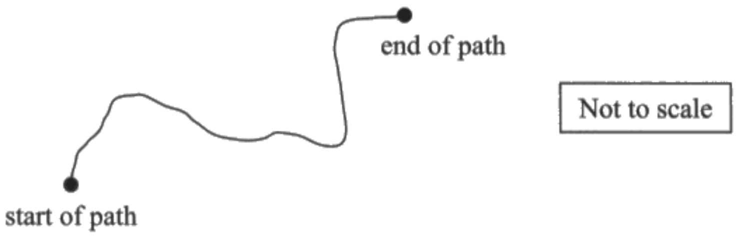
ResultsPlus Examiner Tip

This candidate clearly substituted into F = ma and determined the mass of the boat. The correct unit is given for mass, but only MP1 was scored because the candidate did not go on to use W = mg to calculate the weight.

Question 12(a)

Nearly 70% of students gained some credit for describing why the distance travelled and displacement were different. It was relatively common for students to describe the displacement as the shortest distance from the start to the end, which was not quite enough to gain credit. A fair proportion of students gained credit for identifying that distance is a scalar quantity and displacement is a vector.

12 A person rides a bicycle along the path shown.



(a) At the end of the path, the magnitude of the displacement from the start is less than the distance travelled by the person.

Describe why the displacement is less than the distance travelled by the person.

(2)

~~di~~ Displacement is less than the distance travelled because it has a direction. ~~when~~ Because displacement has direction, it is the shortest path possible to be taken between 2 distances.

ResultsPlus
Examiner Comments

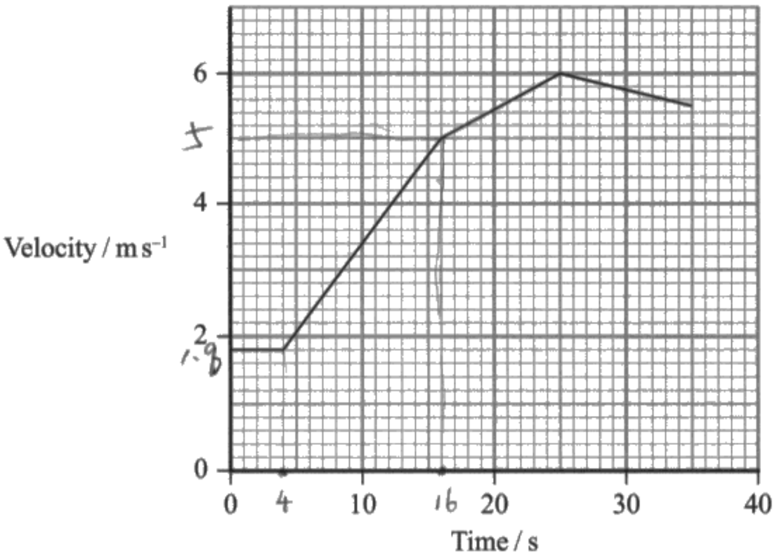
There was only one path taken by the bicycle in this question, so stating that 'displacement is the shortest path' was not enough to gain credit, and candidates needed to make it clear that the displacement is measured in a straight line.

Question 12(b)

The majority of candidates realised that a gradient of part of the graph would give an acceleration, but only about half of all candidates scored all 3 marks on this question. Some misread the scale on the y-axis, and used an incorrect initial velocity of 1.9 m s-1 instead of 1.8 m s-1. Another common error was to use the maximum and minimum velocities from the graph.

While most students recognised that the steepest part of the graph would have the greatest acceleration, some candidates calculated the acceleration during each section of the graph, and then selected the greatest value as their final answer. This approach could lead to being awarded full marks on the question

(b) The velocity-time graph for part of the bicycle ride is shown.



Determine the maximum acceleration of the person on the bicycle.

(3)

a = gradient = $\frac{\Delta V}{t}$

from 4s to 16s, gradient is maximum

$a_{max} = \frac{\Delta V}{t} = \frac{5-1.8}{16-4} = \cancel{0.258}$ ms^{-2}

0.267

Maximum acceleration = 0.267 ~~0.258~~ ms^{-2}

ResultsPlus
Examiner Comments

This candidate clearly laid out the working for this question, indicating which section of the line they were considering on the graph, and then making it very clear how they arrived at their final answer. But looking closely, it appears that their initial reading of velocity from the graph may have been incorrect: it looks like they possibly went back to check their working, and amended the value of speed from 1.9 m s -1 to 1.8 m s -1. Having corrected themself, they scored full marks.

ResultsPlus
Examiner Tip

It can be worth encouraging candidates to go back and check their work if they have time left at the end of the exam.

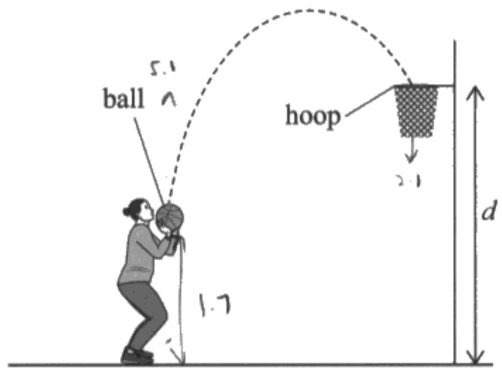
Question 13

This question was generally answered well, with nearly 80% of candidates gaining at least one mark, and just over half gaining all three marks. The most likely reason for a student only scoring two marks was because they did not compare their calculated value for d with the 3.0 m given in the question.

13 In a game of basketball, points are scored by throwing a ball so that it falls through a hoop.

The rules state that the distance *d* between the hoop and the floor should be 3.0 m.

A basketball player throws the ball so that it falls through the hoop, as shown.



The ball was thrown from a height of 1.7 m above the floor.

The initial vertical component of the velocity of the ball was 5.1 m s^{-1}.

As the ball entered the hoop, the vertical component of the velocity of the ball was 2.1 m s^{-1}.

Deduce whether *d* was 3.0 m.

$u = 5.1$ $\quad v^2 = u^2 + 2as$

$v = 2.1$ $\quad 2.1^2 = 5.1^2 + 2 \times (-9.81)(s)$

$s = x$ $\quad 19.62x = 5.1^2 - 2.1^2$

$a = -9.81$ $\quad x = \frac{21.6}{19.62}$

$x = 1.1\ m$

$d = 1.7 + 1.1 = 2.8 < 3.0m$

$\therefore$ d is not 3.0m

ResultsPlus
Examiner Comments

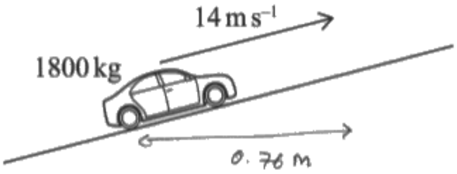
The approach taken by this candidate was the most commonly seen, and matches the approach on the mark scheme. It was possible for candidates to score full marks on this question by taking a slightly different approach, for example by determining the initial vertical speed of the ball needed if the hoop was 3.0 m above the ground, and comparing this with the initial vertical speed of the ball given in the question.

Question 14

The vast majority of candidates realised that they needed to calculate the change in gravitational potential energy, the change in kinetic energy, or both of these quantities. However, it was far less common for students to determine that the total energy input to the battery was the change in kinetic energy minus the change in gravitational potential energy, so only about a quarter of all students managed to gain full credit on this question.

14 The brakes in a car reduce the kinetic energy of the car. In an electric car, some of this energy is transferred to the battery in the car.

An electric car of mass 1800 kg moves at a speed of $14\,\mathrm{m\,s^{-1}}$ up a hill, as shown.



The driver applies the brakes to bring the car to a stop. During braking, the vertical displacement of the car is 0.76 m and the energy stored in the battery increases by 45 kJ.

Calculate the efficiency of using the brakes to charge the battery.

$\text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}} = \dfrac{176400}{189820.08} = 92.9\%$

$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 1800 \times 14^2 = 176400$

$GPE = mg\Delta h = 1800 \times 9.81 \times 0.76 = 13420.08$

Efficiency = 92.9%

ResultsPlus
Examiner Comments

Many candidates, as in this case, were able to demonstrate appropriate use of the kinetic energy equation and the gravitational potential energy equation. However, when it came to determining how to put their calculated values into the efficiency equation, many ran into problems. This question was about the efficiency of charging the battery, so answers needed to consider the useful output energy (the 45 kJ given in the question, which the majority did use), and the total energy input to the battery. Because the car was going uphill, the total energy input to the battery was less than the total initial kinetic energy of the car.

Question 15(a)

Most candidates correctly determined appropriate values from the graph, although some made power of ten errors when writing the compression value in metres instead of nanometres.

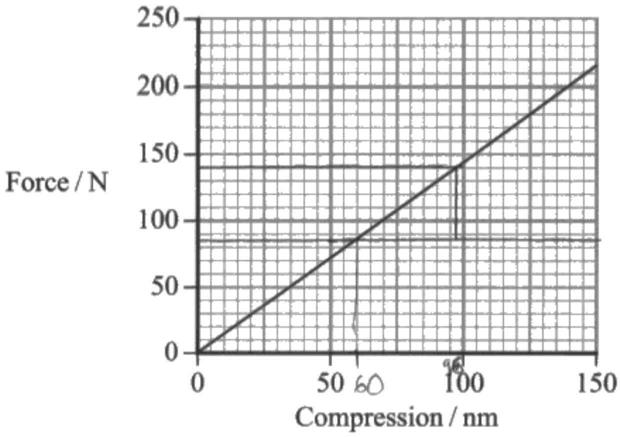
Those who determined the area under the graph tended to be more likely to arrive at the correct answer than those who used the equation. Those using an equation based approach often incorrectly substituted a change in force and a change in compression into the equation, where they should have substituted into the equation twice and determined the difference in values of energy calculated.

Some students took an alternative approach of using the graph to determine a value for k, and then using this to calculate the increase in elastic strain energy. This approach could gain full credit.

15 A builder uses bricks to build a wall.

As the wall gets taller, the force on a brick at the bottom of the wall increases.

A force-compression graph for this brick is shown.



(a) Determine the increase in elastic strain energy in the brick as the force increases from 85 N to 140 N.

(3)

E_{el} = Area under graph = $\frac{1}{2} \times b \times h$

$E_{el} = \frac{1}{2} \times \Delta x \times F$

$= \frac{1}{2} \times [(96 \times 10^{-9}) - (60 \times 10^{-9})]\,\text{m} \times (140 - 85)\,\text{N}$

$= 9.9 \times 10^{-7}$ J

Increase in elastic strain energy = 9.9×10^{-7} J

ResultsPlus
Examiner Comments

In this response, the candidate attempted to calculate the area under the graph, which was a valid approach to take. However, they have only considered the triangular section of that area between 85 N and 140 N. There was a tolerance allowed on the values of compression read from the graph, so this candidate scored the first mark for taking two valid readings of compression.

Question 15(b)

Around half of all students scored this mark for defining elastic deformation.

For those who did not score the mark, many appeared to be defining the wrong term, with answers indicating that students were describing the elastic limit, or plastic deformation or another term from this area of the specification.

(b) The brick undergoes elastic deformation.

State what is meant by elastic deformation.

(1)

deformation such that after the (compressive) force is removed, the body returns to its original shape

ResultsPlus
Examiner Comments

This candidate gave a correct definition, and was awarded the mark.

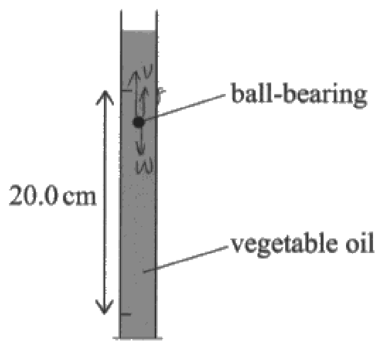
Question 16(a)

Only about half of candidates gave an acceptable answer. Of those who did not gain a mark, many stated that the diameter or radius of the ball-bearing should be measured, which they had already been told. Another popular incorrect answer was to measure the drag force. Some students described the conditions for Stokes' law to apply, which was insufficient.

16 A student used a falling-ball method to determine the viscosity of vegetable oil.

He measured the diameter of a ball-bearing.

He dropped the ball-bearing into a measuring cylinder containing vegetable oil, as shown.



$F = 6\pi\eta r v$

The ball-bearing reached terminal velocity. The student then measured the time taken for the ball-bearing to fall 20.0 cm.

(a) Give one other measurement needed to determine the viscosity of the oil.

(1)

mass of ball bearing → this gives weight

$w - u = F$

ResultsPlus
Examiner Comments

This candidate not only described that the mass would need to be measured, but then described that the mass should be used to determine the weight. Just giving the weight would have been enough on its own for this question.

Question 16(b)

Nearly 70% correctly calculated the viscosity of the oil.

(b) The diameter of the ball-bearing was 1.24 mm. The time taken to fall 20.0 cm was 1.3 s. The student calculated a value of 5.6×10^{-5} N for the viscous drag on the ball-bearing.

Calculate the viscosity of the oil.

(3)

$F = 6\pi\eta r v$ $\qquad$ $v = \frac{0.2m}{1.3} = 0.154$

$5.6 \times 10^{-5} = 6\pi\eta \times 1.24 \times 10^{-3} \times 0.154$

$\frac{5.6 \times 10^{-5}}{6\pi \times 1.24 \times 10^{-3} \times 0.154} = 0.0161$

Viscosity = 0.0161 Pa s

ResultsPlus
Examiner Comments

In this response the student has calculated the terminal velocity of the ball bearing, and used the Stokes' law equation. However, they have used the diameter of the ball instead of the radius, so have ended up with an answer double what it should be.

ResultsPlus
Examiner Tip

On WPH11 papers, it is relatively common for questions to include data about the radius or diameter of a sphere. Students should be encouraged to consider which value they have been given, and make sure that they take this into account in their calculations.

Question 16(c)

Many students were able to explain how the temperature of oil affects the time taken for a ball-bearing to fall through a fixed distance, with around three-quarters of students scoring 2 or 3 marks. Those who only scored two marks tended to recognise how the viscosity of oil changes with temperature, but did not mention how this would affect the speed of the ball-bearing.

(c) The student repeated the experiment. He used the same oil at a lower temperature.

Explain how using oil at a lower temperature affected the time taken for the ball-bearing to fall 20.0 cm.

(3)

As the temperature of the oil decreases, the viscosity of the liquid increases. this results in viscous drag force on the ball increasing so the terminal velocity would be lower. therefore the time taken for the ball bearing to fall 20.0 cm would be more.

ResultsPlus
Examiner Comments

The majority of candidates correctly identified that the viscosity of oil increases as temperature decreases, as in this case. This candidate went on to give a good explanation which addressed all of the points needed.

ResultsPlus
Examiner Tip

Looking at the number of marks available can help guide students towards the level of detail needed in their response to a question. A 3-mark explanation is likely to need candidates to give 3 different points in their answer. Many students answering this question only gave two points, often omitting any mention of how the viscosity would affect the speed of the ball.

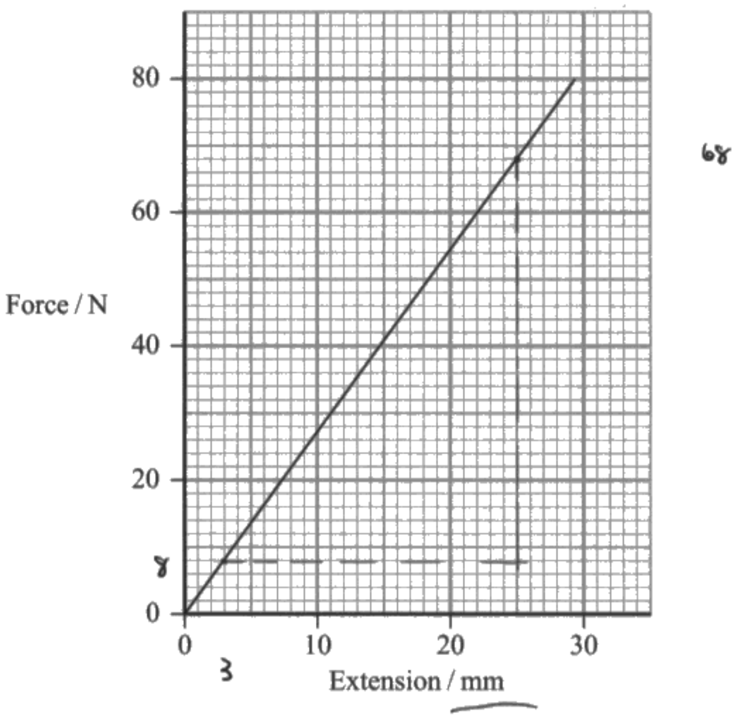
Question 17(a)

Just under half of candidates correctly determined which string was used, compared their value with one in the table, and gave a valid conclusion. Roughly another third of candidates scored 3 of the 4 marks, with many of these just omitting a comparison of their calculated value with a value from the table.

17 A violin is a musical instrument that has four strings, as shown.

(Source: © bob_sato_1973/Getty Images)

(a) A force-extension graph for a sample of one of the strings is shown below.



The table shows the stiffness for samples of three of the strings on the violin.

Each sample was the same original length as the sample used to obtain the graph.

String	Stiffness / $N\,m^{-1}$
X	1700
Y	2700
Z	6100

Deduce which string was used to obtain the force-extension graph.

(4)

$k = \frac{\Delta F}{\Delta x} \Rightarrow \frac{68-8}{(25-3)\times 10^{-3}} \approx 2727\ Nm^{-1}$

So it used string Y.

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Examiner Comments

This candidate took valid readings from the graph and used them to determine a value of k within the accepted tolerance. However, they did not give a numerical comparison of their calculated value with the value in the question, so did not score the final mark. A statement that 2727 is closest to 2700 would have been enough in this case.

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Examiner Tip

In 'deduce' type questions, a numerical comparison is often needed to score the final mark. This can often be achieved using symbols such as <,>,=, or , or by describing the comparison using words.

Question 17(b)

Candidates often made a good attempt to calculate the Young Modulus, with about three quarters being awarded 4 or 5 marks. Common mistakes included multiplying stress by strain, rather than dividing stress by strain, and giving an incorrect unit such as N m-1 or not including a unit in the final answer at all.

(b) The fourth string on the violin has an original length of 0.750 m.

When the tension applied to the string is 36 N, the new length of the string is 0.752 m.

The radius of the string is 0.85×10^{-3} m.

Determine the Young modulus of the material used to make the string.

(5)

$Y = \dfrac{\sigma}{\varepsilon}$

$\sigma = \dfrac{36}{\pi(0.85\times10^{-3})^2} = 1.59\times10^{7}\ \text{N m}^{-2}$

$= \dfrac{1.59\times10^{7}}{2.67\times10^{-3}}$

$\varepsilon = \dfrac{0.752-0.750}{0.750} = 2.67\times10^{-3}$

$= 5.96\times10^{9}\ \text{Pa}$

Young modulus = 5.96×10^{9} Pa

ResultsPlus
Examiner Comments

This correct answer clearly lays out all the working needed to arrive at the correct final value for the Young modulus.

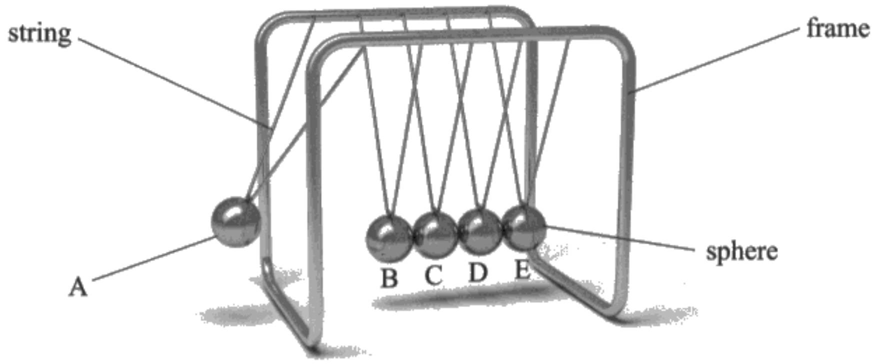
ResultsPlus
Examiner Tip

Laying out the working for calculations in an orderly way can help candidates to work through more complex calculations, and can help them to gain credit if they make an error along the way.

Question 18(a)

The majority of candidates were able to correctly calculate the mass of one sphere. Of those who did not score full marks, many candidates used an incorrect formula to determine the volume of a sphere, often either omitting the factor of 4/3 or squaring the radius rather than cubing it.

18 A 'Newton's cradle' has five identical steel spheres, A, B, C, D and E. Each sphere hangs on string from a frame, as shown.



(Source: © f9photos/Getty Images)

(a) Each sphere has a radius of 7.0×10^{-3} m.

Calculate the mass of one sphere.

density of steel = $7.8 \times 10^3\,\text{kg m}^{-3}$

(3)

$\rho = \frac{m}{V}$ Volume of sphere $= \frac{4}{3}\pi r^3$

$m = 29.32 \times 10^{-3}\,(7.8 \times 10^3\,\text{kg m}^{-3})$ $= \frac{4}{3}\pi(7.0 \times 10^{-3})$

$= 229$ kg $= 29.32 \times 10^{-3}\,\text{m}^3$

Mass of one sphere = 229 kg

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Examiner Comments

Forgetting to cube the radius when calculating the volume of a sphere meant that this candidate only scored MP2 for use of the density equation.

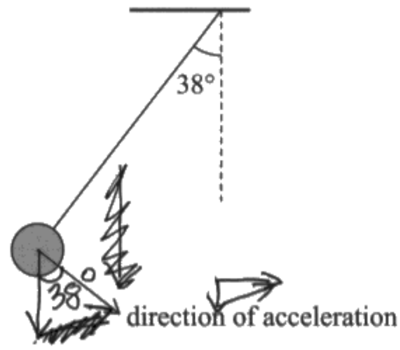
ResultsPlus
Examiner Tip

Having an idea of what a reasonable magnitude should be for an answer can help candidates to recognise when they may have made an error. In this exam paper, a student is about to pull one of these spheres to one side, so a mass of 229 kg should send up a warning signal to candidates that something is amiss.

Question 18(b)

This question proved to be challenging, with many candidates' using incorrect trigonometry to determine the relevant component of the resultant force. If a candidate used an incorrect value for the mass of the sphere that they had calculated in Q18a, they could still score full marks here, because the mass cancels out of the equations so the acceleration is independent of the mass. Some realised this and did not include the mass of the ball in their calculations at all, an approach which also used correct physics and could lead to full marks.

(b) A student pulls sphere A, so the string is at an angle of 38° to the vertical, as shown. The student then releases sphere A.



Determine the initial acceleration of sphere A when released.

(2)

$9.81 \times \cos 38^\circ$

$= 7.73\ m/s^2$

Initial acceleration = $7.73\ m/s^2$

ResultsPlus
Examiner Comments

Many candidates recognised that trigonometry would be needed in their answer to this question. However, in many cases, as demonstrated here, they weren't quite sure which trigonometry identity to use. The answer given here is less than the value of g so does not seem unreasonable. The candidate has drawn vector arrows on the diagram to help them, which can be really helpful, but the '38°' they have labelled next to the sphere should have been (90°-38°), which would have led to the correct answer.

ResultsPlus
Examiner Tip

Adding to diagrams, or drawing a sketch, can often help candidates to formulate their answers to calculations or to explanations.

Question 18(c)

Many candidates struggled to express their thoughts in a logical sequence, and used vague terms to describe the changes to energy and momentum. It was relatively common for answers to only partially address the question, and, for example, attempt to describe the changes to energy but make little or no attempt to describe changes to momentum.

A common misconception was to assert that it is a closed system and so the momentum does not change at all. Many answers gave an incomplete description of the law of conservation of momentum, stating that momentum (immediately) before the collision is the same as the momentum (immediately) after the collision but failing to refer to the total momentum.

Very few answers gained all 6 marks, and only about a quarter managed to score more than 2 marks. Most candidates identified that the gravitational potential energy of sphere A would initially decrease and the kinetic energy of sphere A would initially increase, and a fair proportion recognised that the total energy before the collision was the same as after the collision.

*(c) Diagram 1 shows the position of the spheres when sphere A is released.

After being released, sphere A collides with sphere B and comes to rest.

Spheres B, C and D remain at rest. Sphere E moves away from sphere D.

Diagram 2 shows the position of the spheres when sphere E reaches the highest point.

Diagram 1

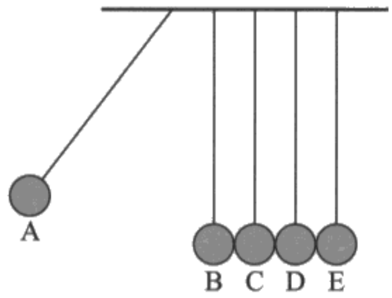
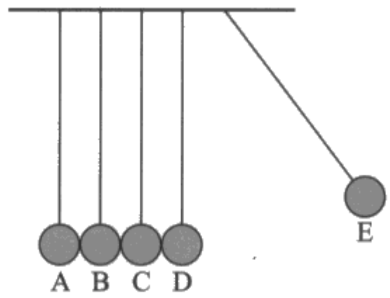


Diagram 2



Describe the changes in energy and momentum of spheres A and E, from the time sphere A is released until sphere E reaches its highest point.

Ignore the effects of air resistance.

(6)

When sphere A is released only weight is acting on it, at its release point it has its maximum GPE and no kinetic energy. As A drops its velocity is increasing therefore $p = mv$, so its momentum is increasing and the GPE is being converted to kinetic energy. Right before A collides with B its momentum and kinetic energy are at a maximum. The collision of A and B transfers the energy along to C, then D, then E. Since $F = ma$ and a force was applied to E it accelerates, as it rises kinetic energy is converted to GPE, its momentum is maximum right after the collision and decreases as E rises. Once E is at the top it has no kinetic energy and the same GPE that A had at the start due to the conservation of energy and the conservation of momentum.

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Examiner Comments

This response described the initial changes to gravitational potential energy, kinetic energy and momentum of sphere A, covering IC1 and IC2 in the mark scheme. The candidate went on to describe the transfer of energy from A to E during the collision, and gave a description of the conservation of energy so also covered IC4 and IC6. Overall, the response gives a good description of the energy changes, but lacks some details on the changes to momentum that occurred.

Question 19(a)

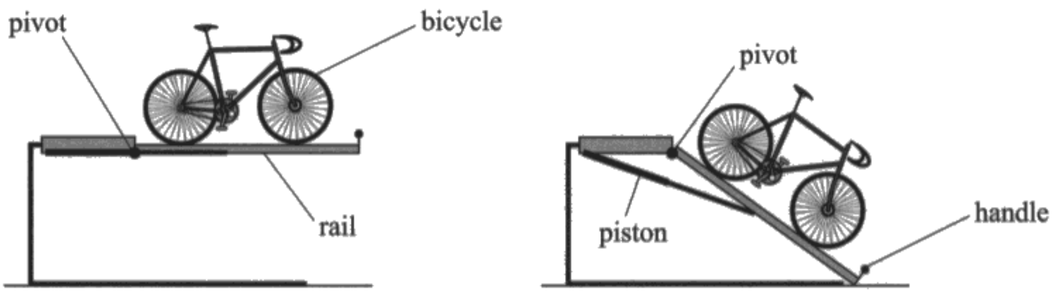
Only about a half of candidates were able to express the principle of moments accurately, with some candidates giving answers that described momentum, and many candidates giving an incomplete statement that the clockwise moment is equal to the anticlockwise moment. There needed to be some indication that the total moment needed to be considered, without which the mark was not gained.

19 A student stores her bicycle on a rack.

The bicycle rests on a rail that can rotate about a pivot.
To take the bicycle off the rack, the student uses a handle to lower one end of the rail to the ground.

A piston applies a force to the rail as the rail is lowered to the ground.

The diagrams show the bicycle on the rack before and after the rail has been lowered to the ground.



(a) When the rail is in equilibrium, the principle of moments applies.

State what is meant by the principle of moments.

(1)

The clock wise moment is equal to the anti clock wise moment.

ResultsPlus
Examiner Comments

In this answer, the candidate has missed the crucial point that the total momentum in each direction is what should be considered.

ResultsPlus
Examiner Tip

Learning the correct definitions of physics terms, with all of the detail, can help candidates score marks when asked for definitions, but also helps them to clearly understand what is happening in more complex situations and help enable them to gain higher marks in descriptions and explanations.

Question 19(b)

In Q19(b)(i), it was pleasing to see so many candidates correctly calculating the correct minimum force needed. The best answers often managed to accomplish this in just a couple of lines, clearly showing their working. Weaker answers only recognised that there needed to be a trigonometry identity used when determining the moment of one of the forces, typically the moment of force *F* about the pivot. Some candidates used incorrect trigonometry in their answers or did not use trigonometry at all.

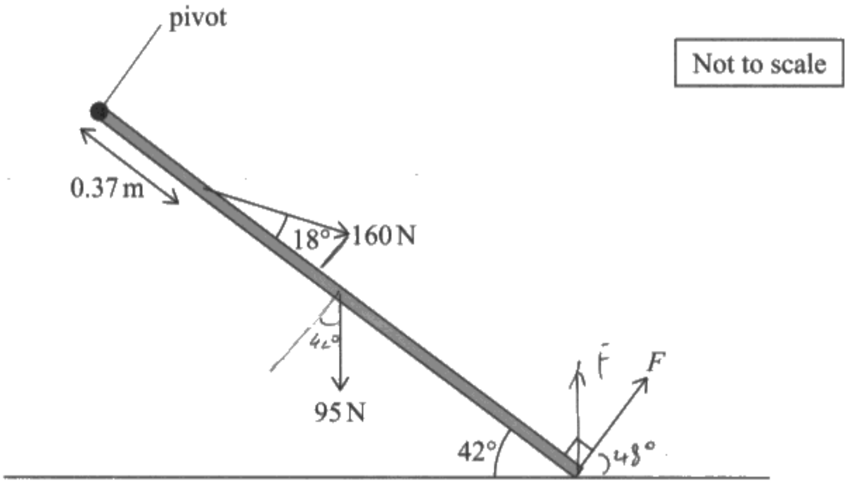
Candidates struggled far more with Q19(b)(ii), with few answers given that gave a logically ordered and coherent argument. Many responses did not give sufficient descriptions of the perpendicular distance from the line of action of a force to the pivot, often merely referring to the distance of a force from the pivot, for example. Some answers referred to the vertical component and horizontal component of the force, rather than the components parallel to or perpendicular to the rail.

(b) After taking the bicycle off the rack, the student lifts the rail back to its original position.

(i) The uniform rail has a length of 1.40 m and a weight of 95 N.

The student applies a force F to the handle, perpendicular to the rail. The piston applies a force of 160 N to the rail.

The diagram shows these forces acting on the rail.



Determine the minimum value of F needed to lift the end of the rail off the ground.

(5)

~~160 N · sin 18° × 95 N cos 42° + F = 0.~~

160 N · sin 18° × 0.37 m + F × 1.40 m − 95 N × cos 42° × 0.70 m = 0.

Solve that F = 22.23 N

= 22.2 N

Minimum value of F = 22.2 N

(ii) The student could have lifted the rail by applying a vertical upwards force to the handle.

The force needed to lift the rail is different when the force is vertical compared with when the force is perpendicular to the rail.

Explain how the minimum vertical force needed is different.

You do not need to include any further calculations.

(3)

the position of the force applying on the rail is different. the force in the moment principle is changet to the sub force such as $\vec{F}\sin\theta$ or $F\cos\theta$, makes the value of $\vec{F}$ different.

ResultsPlus
Examiner Comments

Full marks could be scored with just a couple of lines of working for Q19(b)(i), as in this case. However, Q19(b)(ii) proved to me far more challenging to candidates. In this example, as in many others seen, candidates struggled to know where to begin with their explanations, and often did not refer to components of force, or to the perpendicular distances from the lines of action of the forces to the pivot.

Question 20(a)

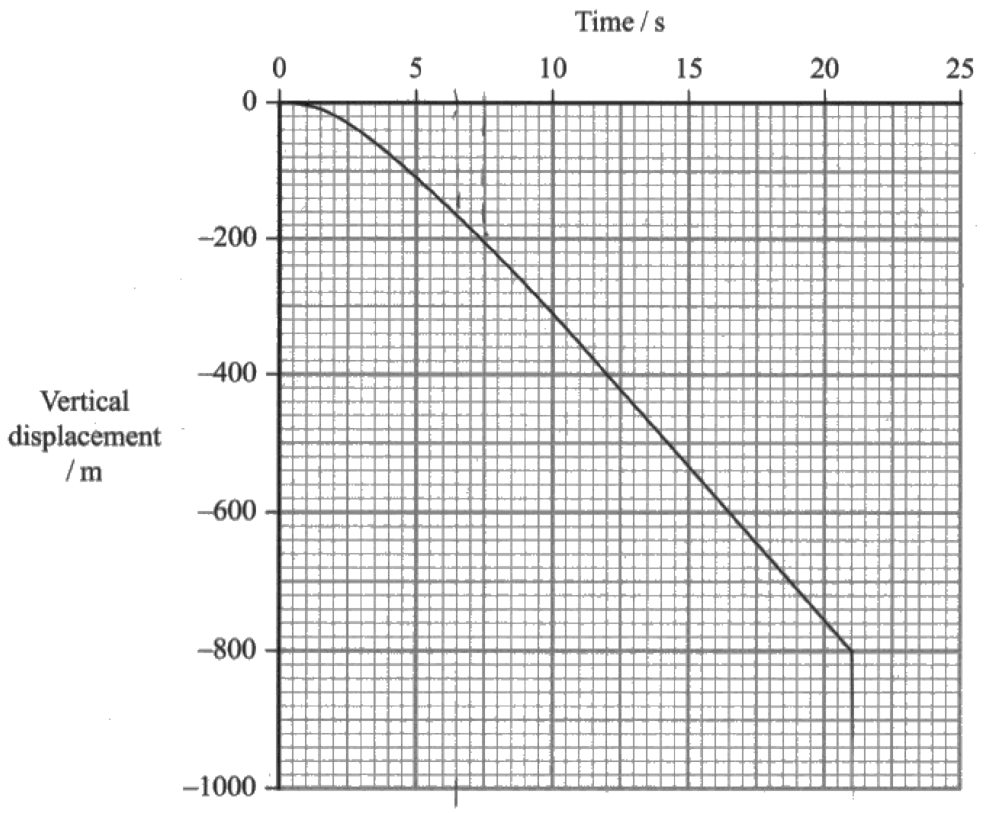
Nearly 80% of candidates gained some credit on this question, with slightly more than a third of all candidates gaining full marks.

Of those who gained some credit but did not score full marks, many did not give a unit for a calculated value of acceleration, and many did not attempt to determine a proportion of *g*.

Question 20(b)

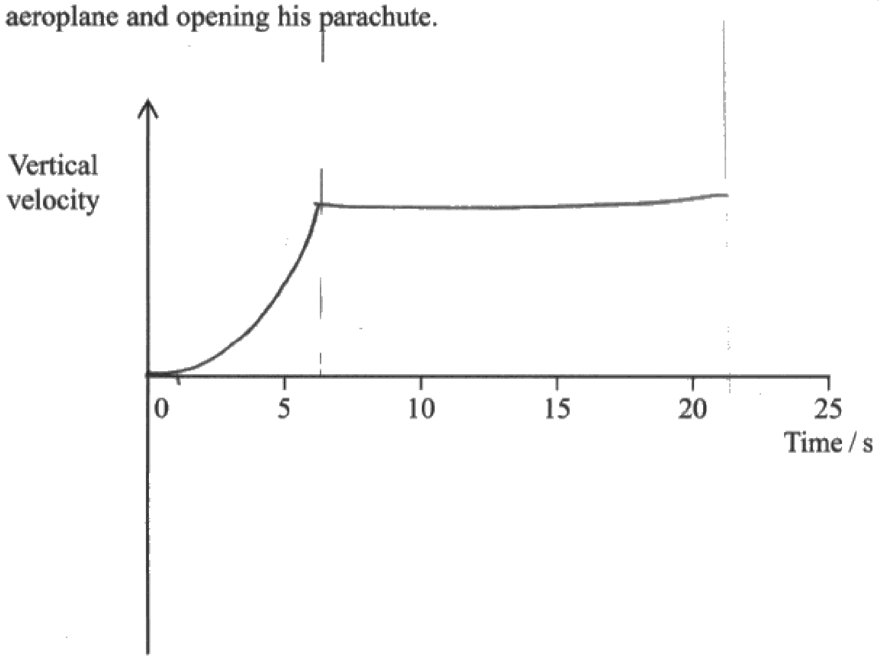
Only about 10% of candidates gained both marks on this question, with just under half scoring no marks at all. Many answers divided their line into two straight sections, often gaining the second mark for realising that the velocity became constant. There was judgement required to determine at exactly which point the skydiver reached terminal velocity, but so long as the line became parallel to the time axis at some point before 12 seconds, the second marking point was awarded.

(b) The displacement-time graph for the skydiver between jumping from the aeroplane and opening his parachute is shown.



Sketch the velocity-time graph, on the axes below, for the skydiver between jumping from the aeroplane and opening his parachute.

(2)



ResultsPlus
Examiner Comments

This scored 1 mark.

ResultsPlus
Examiner Tip

This candidate scored MP2 for recognising that the vertical velocity was constant after 12 seconds, even though their velocity was upwards and the variation in velocity shown from 0 to about 7 seconds showed the wrong shape of curve.

Question 20(c)

About 60% of candidates gained at least one mark on this question, but many responses ended up describing or explaining how the forces on the skydiver varied, rather than explaining how conservation of energy applied. Some candidates just stated the law of conservation of energy, without applying this to the skydiver. Some candidates stated that air resistance was negligible. Marking point 1 was the most often seen point made, with a fair proportion of candidates starting off their explanation with a statement that gravitational potential energy is transferred to kinetic energy but often getting no further with the explanation.

(c) After jumping from the aeroplane, the skydiver accelerated and then reached a terminal velocity before opening his parachute.

Explain how energy conservation applies to the skydiver before opening his parachute.

(4)

Energy conservation is that no energy is being lost. Before opening the parachute, the skydiver has kinetic energy. His weight is equal with air resistance so he travels at a constant velocity, so the resultant force is zero. The skydiver also loses gravitational potential energy since he loses height. So the GPE lost is equal to the KE gained so that they are the same, and the energy stays the same since none is dissipated to the surroundings

ResultsPlus
Examiner Comments

As was typical of many responses, this candidate gave much of the answer over to describing the forces and resultant force on the skydiver. The only creditworthy point made in this answer is the idea that initially gravitational potential energy decreased and kinetic energy increased.

Question 20(d)

When giving an explanation for changes in acceleration, there needs to be a reference to resultant force, which was missing from many responses. A fair proportion of candidates gave an answer which described the initial acceleration of the skydiver before the parachute was opened, which could score marking points 4 and 5, but could not score the first three marking points. Some answers described a change in upthrust rather than a change in air resistance, which often led to no marks being awarded. Only about a fifth of candidates scored 3 marks or more.

(d) The skydiver opened his parachute and his speed changed. After a time, he reached a terminal velocity.

Explain how the forces on the skydiver caused his acceleration to vary after his parachute opened.

(5)

The weight of the skydiver acts downwards, and air resistance acts against the skydiver, ~~alongside~~ upwards. ~~As time passes, the drag force increa~~ ~~At first, there is no air resistance, however,~~ At first, air resistance is negligable. Hence there is a downward resultant force, so the skydiver accelerates, as time passes, the air resistance increases, and the resultant force will ~~sto~~ decrease, alongside acceleration until the acceleration is 0, and no resultant force acts on the skydiver. This is when the skydiver is at terminal velocity.

(Total for Question 20 = 15 marks)

ResultsPlus
Examiner Comments

This candidate did not answer the question asked, describing how the forces on the skydiver caused acceleration before the parachute was opened instead of afterwards. They did score one mark for the resultant force eventually reaching zero and acceleration being zero when this occurred.

ResultsPlus
Examiner Tip

Candidates should read questions carefully to ensure they are answering the question that is actually asked, rather than answering a different question.

Paper Summary

Based on the answers given in this paper, candidates would benefit from:

- Learning definitions for physics terms and quantities to ensure they receive appropriate credit for the concepts they understand.
- Practising applying physics principles to a range of different contexts to build both confidence and problem-solving ability.
- Carefully reading and re-reading both questions and their answers to minimise the risk of misunderstandings or inconsistencies.
- Being reminded to always give an appropriate unit with calculated answers, as this is essential for full credit.
- Always comparing calculated values with relevant data provided in the question to support a valid and well-reasoned conclusion when answering 'deduce' type questions.

Grade boundaries

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