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Examiners' Report
June 2009

GCE

GCE Physics 6PH01 / 6PH02

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June 2009

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Contents

Unit 6PH01

General comments

This paper gave candidates opportunities to demonstrate their understanding of the full range of topics in this unit, showing good progression from GCSE. All questions elicited responses across the range of marks, although full marks were rarer for some of the longer explanations than they were for the longer calculations.

Candidates applied themselves well to answering the whole paper, spending appropriate time on the multiple choice and the free-response parts of the paper. There were few blanks, but their occurrence was scattered and suggested lack of understanding rather than lack of time. The space allowed for responses was usually sufficient, although candidates are not advised to use it as a guide for the required length of response as writing sizes and styles clearly differ widely. Candidates should remember to indicate clearly on the paper the location of responses which extend beyond the space provided.

There were few unit errors, except for the Young modulus at the very end of the paper. Candidates could usually set out their answers logically, but they need not be afraid of setting out explanations as a set of simple bullet points. Some could still be encouraged to show stages clearly in their calculations. There were a number of places where a significant proportion of the candidature did not have a firm grasp of appropriate and specific terminology. Words which were often applied incorrectly on this paper included magnitude, uplift, upthrust, plastic, elastic, brittle, gravity, resultant, reaction and displacement. Candidates are recommended to learn standard definitions thoroughly to avoid such mistakes.

Responses were usually given to the required extra significant figure in 'show that' questions, and candidates were able to use their calculators correctly and quote answers sensibly in most cases, although some had a problem with degrees and radians in the questions involving angles.

With a comprehensive list of formulae and relationships supplied, candidates did not have to remember these, although it clearly helps with timing and planning answers if they do. Candidates are expected to be able to apply a number of laws which are not given on the paper, however, and it helps if they are able to quote the standard wording directly from memory, even if they do not need to do so directly in a particular examination. On this paper, candidates who remembered Newton's First Law in full were more likely to access the final mark in question 15, for example.

Candidates do not always seem to realise that the questions in section B are structured, with parts (a), (b), (c) etc. all linked and parts (i), (ii), (iii) etc. following directly from each other. This was particularly useful in question 11.

Candidates sometimes give prepared responses to situations similar to, but not the same as, the question as it is written on the paper. This can be a particular issue over time with multiple choice questions which may look familiar but ask for something quite different. Candidates should always read each question carefully. Sometimes underlining or highlighting key items of information can help.

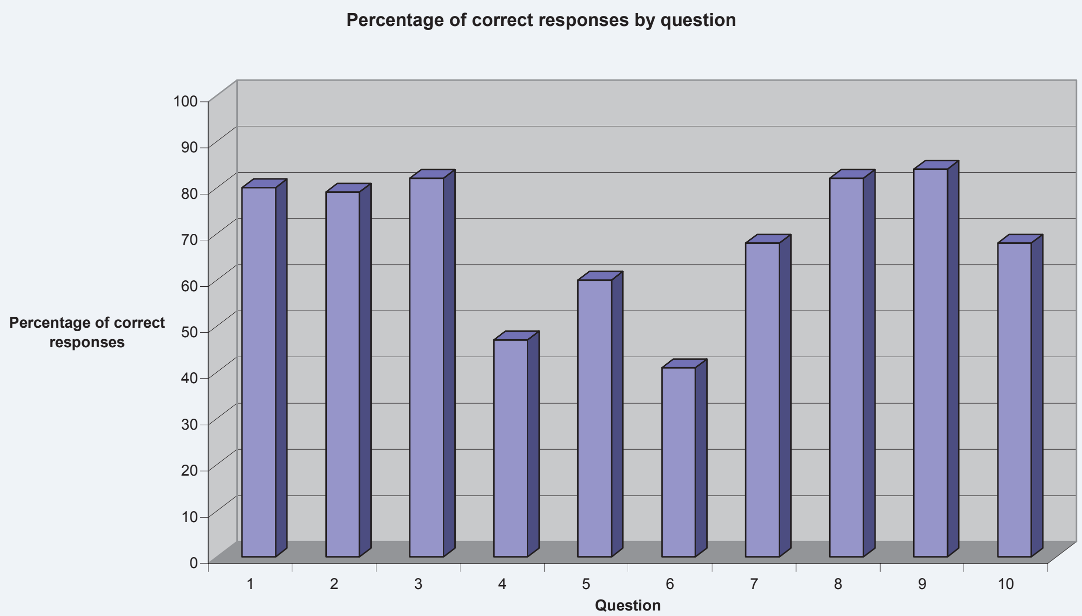
Section A

The vast majority of candidates attempted all of the multiple choice questions, with under half of a percent failing to do so completely.

In increasing order of difficulty, the multiple choice questions were 9, 8, 3, 1, 2, 10, 7, 5, 4 and 6.

Questions 1, 2, 3, 8 and 9 were answered correctly by a sizeable majority, and questions 5, 7 and 10 by a good majority of candidates. For questions 4 and 6, approximately half the cohort provided the correct response.

Question 4 required a unit conversion and an axis reversal to find the correct answer, and Question 6 was most easily answered by using the units which may be unfamiliar.



Section B

Question 11(a)

The majority of candidates gave a correct response. Of those who did not, most knew that a vector involved something extra, but either expressed it poorly or selected the wrong factor. Not all candidates used the term 'magnitude'; a number who did use it did not understand it. This was evident from the response "scalars have size, whereas vectors have size and magnitude".

*11 (a) Explain the difference between scalar and vector quantities.

(1)

Scalar ~~vector~~ quantity only has direction, and no magnitude, vector quantity has direction and magnitude

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Examiner Comments

In this example the candidate has defined vector correctly, but has incorrectly stated that a scalar has only direction, rather than magnitude.

*11 (a) Explain the difference between scalar and vector quantities.

(1)

A scaler quantity has magnitude but no direction, such as mass, a vector quantity has magnitude and direction such a weight.

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Examiner Comments

This good response answer gains the mark for explaining the difference and also includes examples of each.

Question 11(b)

A surprising number of candidates thought the conclusion was incorrect even though they had answered part (a) correctly. They were unable to distinguish between velocity and speed, or displacement and distance. A number of others only gained a single mark for realising that velocity is a vector or stating that its direction was changing, indicating its vector nature. The clearest answers, well set out and gaining the QWoC mark, simply quoted the formula for velocity, stated that the final displacement was zero and drew the appropriate conclusion, sometimes as three simple bullet points.

(b) When asked to run one complete lap around a track, a student says, "However fast I run, my average velocity for the lap will be zero".

Comment on his statement.

(3)

The student is referring to the fact that his total displacement will equal zero so however fast he went zero divided by any number still equals zero so his statement is true and accurate.

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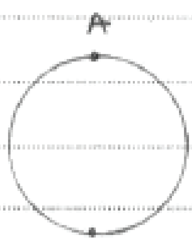
Examiner Comments

This responses gains two marks because it has identified the zero displacement and how it leads to zero velocity, but has not explicitly stated why 'zero divided by any number' is relevant – e.g. by stating the formula for velocity.



Suppose he starts at A. When he completes the journey around the track, his displacement equals to 0 (as he returns to the initial position and displacement is a vector)

$$\text{Velocity} = \frac{\text{displacement}}{\text{time}} = \frac{0}{\text{time}} = 0$$

His statement is correct.

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Examiner Comments

This answer has set out the three required points. Although they are in a different order to the mark scheme, they still show a logical progression from displacement = 0, to velocity = displacement/time to velocity = 0.

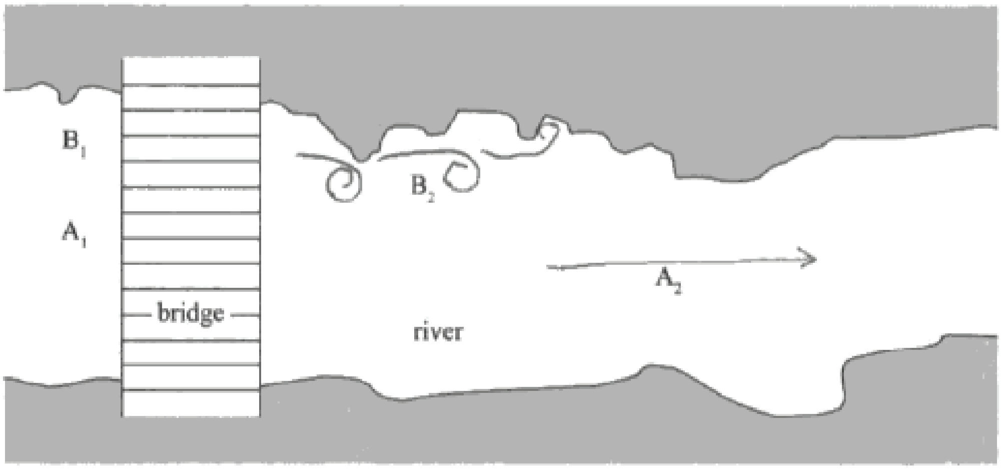
Question 12(a)

The mark for drawing turbulent flow at B_2 was rarely missed, although imprecise drawing so that either lines crossed or there were too few lines to show layers not crossing meant that occasionally the flow at A_2 was not demonstrated sufficiently to obtain a mark.

Question 12(b)

Candidates all seem to have at least a basic understanding of this topic, but were sometimes unable to adapt it to this situation and made references to flow around obstacles in the river. Most responses identified laminar and turbulent flow correctly and many got full marks for the descriptions, although one of the marks for the descriptions was sometimes lost through use of vague wording, such as the presence or absence of 'disturbance' or 'smooth flow'. The clearest descriptions usually referred to the velocity at any point over time. Eddies were a common way to gain the turbulent description mark.

12 In the game of Poohsticks, sticks are dropped into a river from one side of a bridge to see which reaches the other side first.



A stick is dropped into the centre of the river at A_1 and moves at a steady speed to A_2, winning the game.

Another stick is dropped into the river near its edge at B_1, and ends up swirling around at B_2.

(a) Add to the diagram to show the water flow at A_2 and at B_2.

(2)

(b) Name and describe the type of water flow at A_2 and at B_2.

(4)

A_2 ~~lalaflow~~ lamina flow - linear paralled flow

B_2 turbulent flow - not uniform

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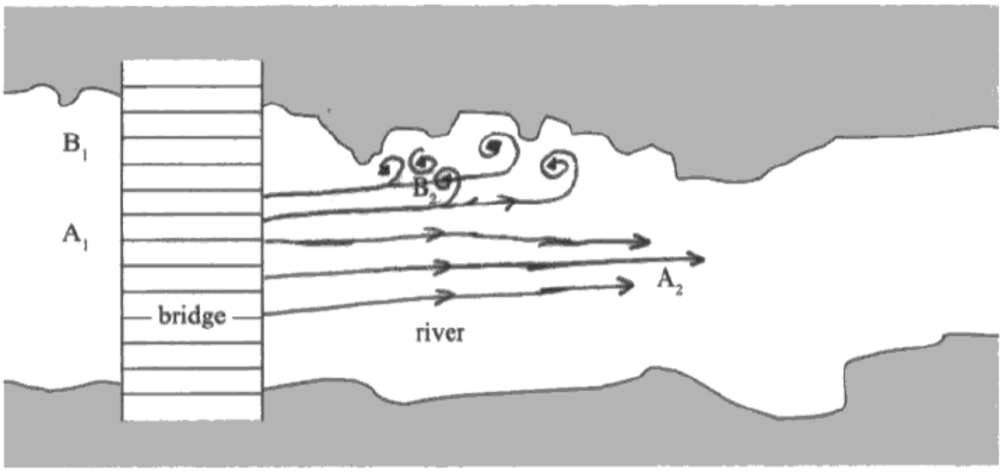
Examiner Comments

This response shows eddies to gain one mark for the diagram, but a single line is not sufficient to demonstrate laminar flow. The flow types are identified correctly, with a spelling error, but 'not uniform' is an insufficient description for turbulent flow. Since parallel must involve two lines, this candidate just gained this description mark.

12 In the game of Poohsticks, sticks are dropped into a river from one side of a bridge to see which reaches the other side first.



A stick is dropped into the centre of the river at A_1 and moves at a steady speed to A_2, winning the game.

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(a) Add to the diagram to show the water flow at A_2 and at B_2.
(2)

(b) Name and describe the type of water flow at A_2 and at B_2.
(4)

A_2 The water flow at A2 is laminar; layered flow where little or no mixing occurs

B_2 The water flow at B2 is turbulent, there is a lot of mixing and whorls/eddies are formed.

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Examiner Comments

In comparison to the previous example, this response shows sufficient lines for both marks in part (a) and has an improved definition of laminar flow referring, in this case, to lack of mixing between layers, so it gains full marks.

Question 13(a)

It is clear that candidates have studied this topic, and there were many good responses gaining full marks. However, there were a number of candidates who may have given satisfactory responses but lost marks through imprecise use of language, as previously seen for this topic, and lack of care over the graphs. Uncertainties about the terms 'deformation', 'elastic' and 'plastic' were evident in many answers.

Candidates sometimes wrote that brittle meant breaking without any deformation, even though they clearly drew a correct graph showing a marked linear region. Others used colloquial language, saying that brittle meant a material 'couldn't take much plastic deformation', without adding 'before breaking' which they may have intended but did not express. Others, such as 'can't take much force', suggest confusion with descriptions relating to strength.

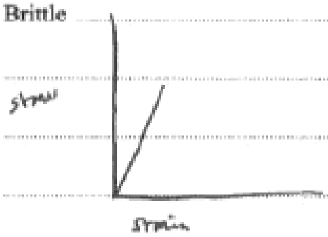
The ductile explanation in terms of plastic deformation was much rarer than the 'can be drawn into wires' option, which ensured this mark was usually awarded. Some candidates, however, described malleable behaviour.

Where graphs were incorrect it was most frequently by showing a clear plastic region in the brittle graph or none at all in the ductile graph. Many candidates clearly did not have a ruler.

13 (a) Explain the meanings of the terms brittle and ductile.
Sketch stress-strain graphs and use them to illustrate your answer.

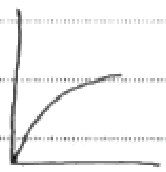
(4)

Brittle



If a material is brittle it means it cannot take much deformation. The graph shows it can take stress to an extent but not very much strain

Ductile



Ductile materials are those that can be drawn into wires

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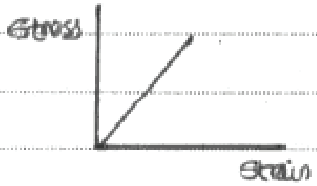
Examiner Comments

This response has satisfactory graphs, even though the linear region in the second is very small, perhaps due to the absence of a ruler. It gets the explanation mark for ductile by virtue of 'can be drawn into wires'. The explanation for brittle here refers to deformation, rather than plastic deformation, and uses the vague 'cannot take'. This response would obtain the mark with the addition of a few words to say 'cannot take much plastic deformation before breaking'.

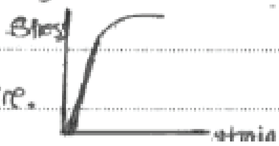
13 (a) Explain the meanings of the terms brittle and ductile.
Sketch stress-strain graphs and use them to illustrate your answer.

(4)

Brittle is a material that has a constant gradient on a stress against strain graph. A Brittle material is one that fails shortly after its elastic limit and under-goes no plastic deformation. An example would be ceramics.



Ductile is the ability of a material to be drawn into wires, it has a large region of plastic deformation on its stress against strain graph. Beyond a ductile material yield point there are large increases in strain for minimal increases in stress.
An example would be copper wire.



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Examiner Comments

This response is comprehensive, and includes more than one mark-worthy explanation for both brittle and ductile.

Question 13(b)

The majority of candidates gained two marks by identifying copper and its use as a wire, although many spent time unnecessarily describing electrical properties in some detail whereas the relevant part on this occasion was just the drawing out into a wire. Many candidates demonstrated their confusion about plastic and elastic behaviour by choosing rubber and others described situations involving malleable behaviour or casting of molten metals.

(b) Give an example of a ductile material and a situation where its ductile behaviour is desirable.

(2)

copper. Copper can be hammered into wires which through electricity is supplied. Aluminium. Aluminium can be moulded into sheets.

(Total for Question 13 = 6 marks)

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Examiner Comments

This response correctly identifies copper, but does not gain the second mark because hammering into shape is a description of malleable rather than ductile behaviour, even though many ductile materials are also malleable.

(b) Give an example of a ductile material and a situation where its ductile behaviour is desirable.

(2)

Copper. Its behaviour is desirable because it can be pulled into wires. Used in electricity.

(Total for Question 13 = 6 marks)

ResultsPlus

Examiner Comments

This example identifies copper and pulling into wires for the two marks.

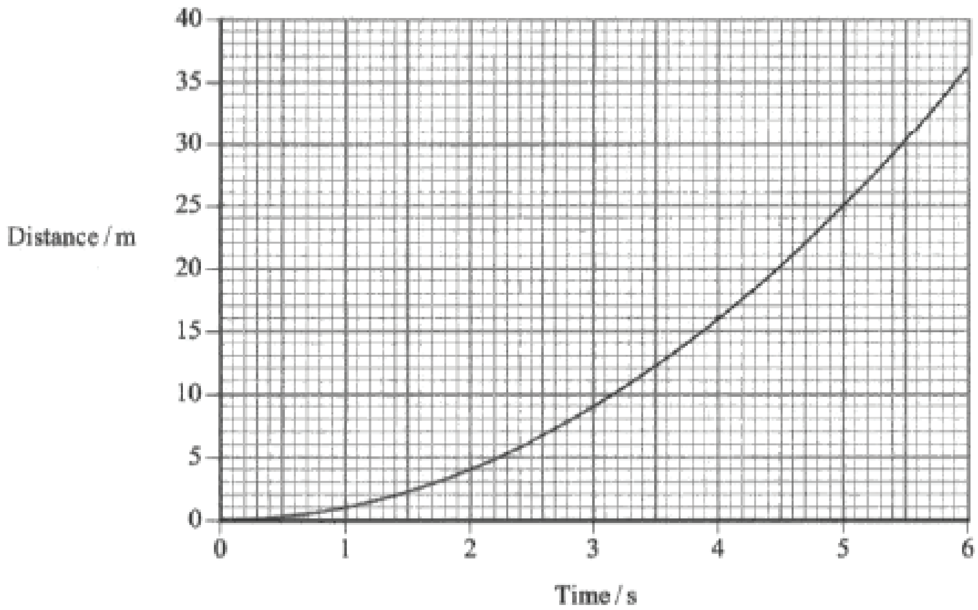
Question 14(a)

This question did not perform well for candidates across the entire ability range, despite its similarity to GCSE work. It was rare to see a tangent drawn, or gradient mentioned; most candidates calculated the average speed by dividing the distance at 4.0 s by the time. Occasionally candidates realised this and doubled it. Some others used equations of constantly accelerated motion which, although not intended, satisfied the instruction to 'Use the distance-time graph'. A number of those who drew tangents did not use them, or used them for part (b).

Question 14(b)

Most responses in this part successfully used the previous answer with an initial speed of zero in $v = u + at$ to obtain marks with 'error carried forward'. Some used other equations of motion. A fair proportion of candidates, however, repeated the error from part (a) by calculating another value of average speed for another point on the graph, often 36 m and 6.0 s, and using this to find acceleration. Some used this average speed as their acceleration value. A few tried to use the gradient of the curve or the area under the curve. There were occasional unit errors in this part.

14 The graph shows how displacement varies with time for an object which starts from rest with constant acceleration.



(a) Use the distance-time graph to determine the speed of the object at a time of 4.0 s.

(3)

T=4 u=16 ~~S v=u+at~~ $S = \frac{u}{T} = \frac{16}{4} = 4\,ms^{-1}$

Speed = $4\,ms^{-1}$

(b) Calculate the acceleration.

(2)

$V = u + at \quad 4 = 0 + 4a.$

$a = 1\,ms^{-2}$

Acceleration = $1\,ms^{-2}$.

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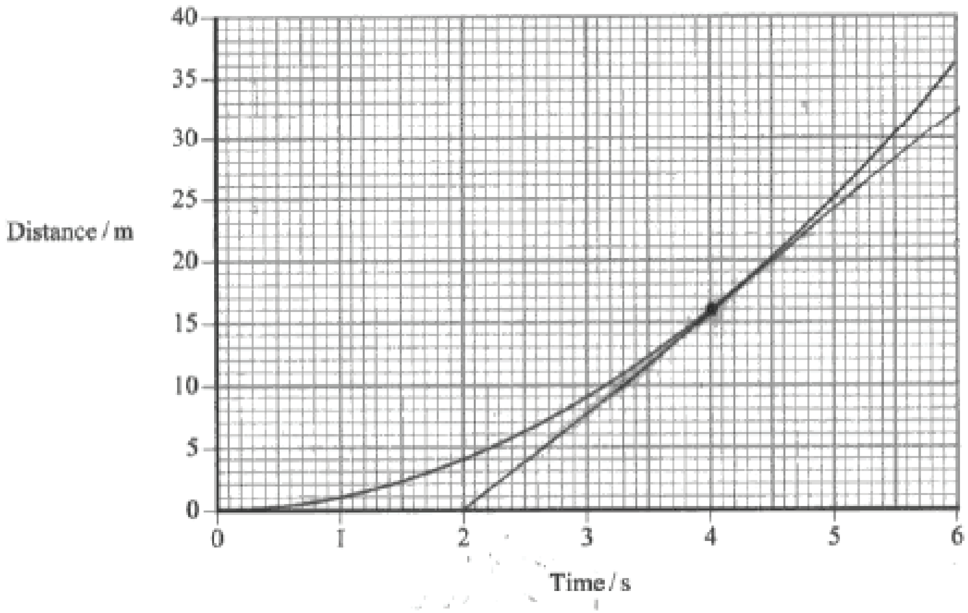
Examiner Comments

This response is typical in failing to use the gradient of a tangent to the curve for part (a). It gets a single mark for use of speed = distance/time. The method and calculation in part (b) gain both marks, allowing for the error in (a) to be carried forward.

14 The graph shows how displacement varies with time for an object which starts from rest with constant acceleration.



(a) Use the distance-time graph to determine the speed of the object at a time of 4.0 s.

(3)

Speed = $\frac{\text{distance}}{\text{time}}$ (As shown in the diagram the speed at 4.0s is the gradient of the tagent to the curve at 4s)

Speed = $\frac{32.5}{4}$ = 8.125 m/s

Speed = 8.125 m/s

(b) Calculate the acceleration.

(2)

∴ v = u + at ∴ at = v − u ∴ a = $\frac{v-u}{t}$ = $\frac{8.125}{4}$ ≈ 2.03 m/s²

Acceleration = ...

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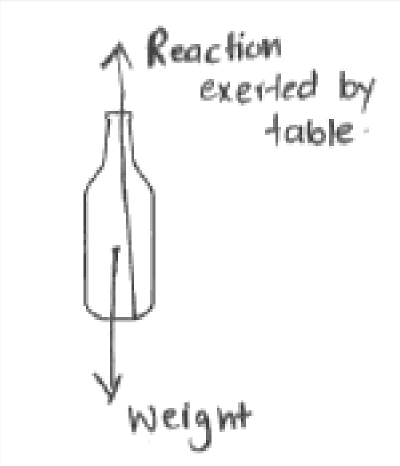
Examiner Comments

This response correctly draws a tangent and uses its gradient to find the instantaneous speed at 4.0 s and goes on to use this to find the acceleration in part (b) to get full marks.

Question 15(a)

Most candidates gained at least one mark and at least a third obtained both marks for the diagram, but there were a number of common errors. Candidates were asked for a free-body force diagram, rather than just being asked to 'add to the diagram' as in some other questions, responses were expected to include co-linear forces. Poor terminology was again often evident, examples being the use of 'upthrust', 'uplift' or just 'contact force' for the normal contact force and 'gravity' being used for weight. Some labelled a downward force as the push of the bottle on the table, possibly thinking of a question about a Newton's third law pair of forces instead of the question on the page. Candidates need to restrict their free-body diagram to forces acting on the bottle. Another error was to label the upward force as 'resultant'.



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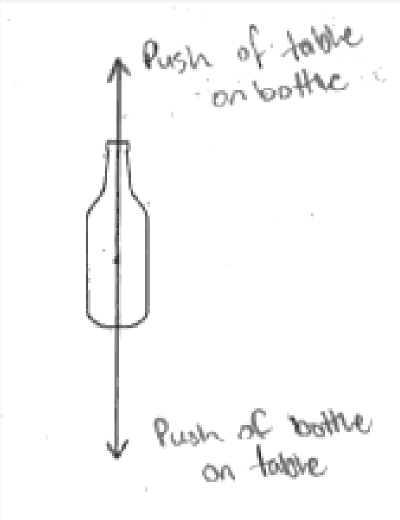
Examiner Comments

This response has the correct labels but the forces need to be along the same line of action to get the second mark.



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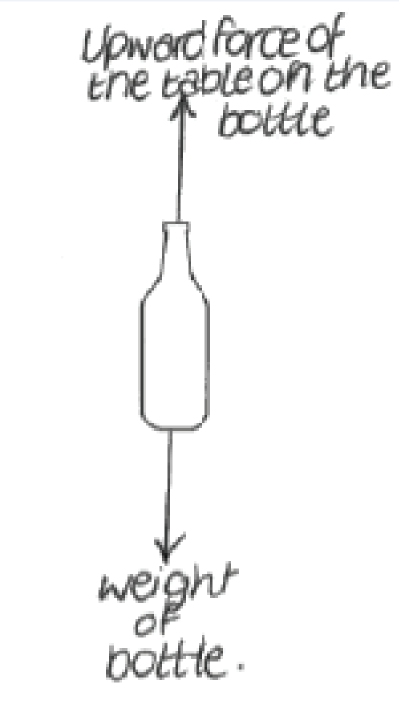
Examiner Comments

This response has one correct force acting on the bottle, and the forces are co-linear and well-drawn with a ruler. However the downwards force is exerted by the bottle so it only obtains one mark.



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Examiner Comments

This response has two correct forces acting along the same line of action(drawn with a ruler). Both marks awarded.

Question 15(b)

Candidates usually, although not always, spotted that the equal and opposite forces should refer to Newton's third law and linked the balanced forces correctly with Newton's first law (or sometimes the second law as an acceptable alternative). Some candidates stopped there, but many spotted the three marks and looked for something else. In either case, they only altered 'nothing can move' to an explanation that objects have no acceleration, or 'remain at rest or in uniform motion in a straight line', relatively rarely. This indicated that these candidates assumed that if forces are balanced the object must be stationary. Some altered the final part to say that the object is in equilibrium, but this was insufficient as it is equivalent to having balanced forces.

Candidates who could quote the laws directly were more easily able to substitute the correct versions.

(b) The student writes the following incorrect explanation.

The force of gravity pulls the bottle down.
The bottle pushes down on the table, so by Newton's first law,
the table pushes up with an equal and opposite force.
According to Newton's third law, if the forces are balanced,
nothing can move.

The student's explanation contains errors.

Rewrite the student's explanation correctly.

(3)

The force of weight pulls the bottle down. The bottle pushes down on the table, so by Newton's third law the table pushes up with an equal and opposite force. According to Newton's first law, if the forces are balanced nothing can move.

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Examiner Comments

In this response the references to Newton's third and first laws are correct for two marks, but the third change was to substitute 'weight' for 'gravity'. 'Nothing can move' has not been corrected.

(b) The student writes the following incorrect explanation.

The force of gravity pulls the bottle down.
The bottle pushes down on the table, so by Newton's first law,
the table pushes up with an equal and opposite force.
According to Newton's third law, if the forces are balanced,
nothing can move.

The student's explanation contains errors.

Rewrite the student's explanation correctly.

(3)

The force of gravity pulls the bottle down.
The bottle pushes down on the table, so by Newton's third law, the table pushes up with an equal and opposite force.
According to Newton's first law, if the resultant force on the bottle is zero it will either remain stationary or continue moving at a constant speed, and as the speed is initially zero the bottle will remain stationary.

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Examiner Comments

This response correctly numbers Newton's laws and also completes the definition of the first law and applies it correctly to this situation to be awarded three marks.

Question 16(a)(i)

Candidate responses varied between scoring no marks, obtaining one mark for using density to find the mass for the volume flowing in one second, or often obtaining three marks for the full answer, although they were sometimes fortunate in their answer because the flow rate was already 'per second'. A number simply multiplied the given numbers together and got an answer of 3 900 W, which they often said was close to 40 kW, failing to notice the power of ten difference caused by not using g anywhere in their calculations. The examiners felt that some candidates used the 'show that' value and trial and error to get the correct answer.

(a) In a feasibility study, the following information was collected about one possible hydroelectric site:

mean rate of water flow into turbine = 0.13 $m^3 s^{-1}$
change in height of water = 30 m.

(i) Show that the power available to the turbine is about 40 kW.

density of water = 1000 kg m^{-3}

(3)

$\rho = PV$ potential energy = mgh

= $1000 kg m^{-3} \times 30 m \times 0.13 m^3 s^{-1}$

= 3 900 W ≈ 40kW (showed)

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Examiner Comments

This response shows an appreciation of the relevance of gravitational potential energy and quotes the formula, but does not substitute the correct values needed to gain this mark. It includes a product of density and volume, but shows no appreciation that this is mass and does not get this mark. Finally, the candidate is satisfied that 3 900 W is close to 40 kW and does not take advantage of the 'show that' value given as an indicator that they need to try again.

(a) In a feasibility study, the following information was collected about one possible hydroelectric site:

mean rate of water flow into turbine = 0.13 $m^3 s^{-1}$
change in height of water = 30 m.

(i) Show that the power available to the turbine is about 40 kW.

density of water = 1000 kg m^{-3}

(3)

$m = \rho V$ $\quad\quad$ $P = \frac{W}{t}$

$= 1000 \times 0.13$ $\quad\quad$ $= \frac{mg\Delta h}{t}$

$= 130$ kg $\quad\quad$ $= \frac{130 \times 9.81 \times 30}{1} = 38259$

$= 38259 \times 10^{-3} = 38.3$ kW

≈ 40 kW

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Examiner Comments

This response sets out the steps clearly, finding the mass flowing per second and calculating the energy change per second, explicitly including the time, to get full marks.

Question 16(a)(ii)

The single mark available for this part question was achieved by only one fifth of the cohort. Responses were often a basic reference to 'heat lost' without suggesting where the heat came from or 'because of friction' without suggesting at least the location of the bodies causing the friction.

Responses which gained the mark provided further detail, such as heat generated due to friction or friction generated between the moving parts of the turbine. Some responses successfully referred to fluid flow effects.

(ii) The study suggests a typical output for the turbine might be only 6 kW. Suggest a reason for this inefficiency.

(1)

heat lost as thermal energy. hence reducing the efficiency

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Examiner Comments

This response does not obtain the mark because there is no suggestion of why there is any heat involved in this water flowing through the turbine.

(ii) The study suggests a typical output for the turbine might be only 6 kW. Suggest a reason for this inefficiency.

(1)

Not all the GPE will be converted to electricity. Some may be lost as heat due to friction in the machines.

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This response is awarded the mark because it identifies friction in the turbines as a cause of generated heat which is subsequently lost.

Question 16(b)(i)

While a majority of candidates realised that energy output involved the product of power and time, there was a range of errors in substituting the values correctly. Some did not convert time to seconds correctly, using hours or minutes. Some chose the wrong energy source and some had problems with kW. Very often, even if the values substituted were correctly written down, the final answer was out by a factor of ten or often a thousand through incorrect use of kJ or MJ. Some candidates used Watts for their final answer.

(i) Calculate the maximum energy output from the solar energy system for a period of six hours.

(2)

10kW x 6 = 60 kW

Maximum energy output = 60 kW

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Examiner Comments

This response shows the use of energy = power x time to get the first mark, but does not convert time to seconds or provide an answer in Joules.

(i) Calculate the maximum energy output from the solar energy system for a period of six hours.

(2)

E = Pt = 10000 x 6 x 60 x 60

= 216000000 J

Maximum energy output = 216, 000, 000 J

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Examiner Comments

This response states that energy = power x time, uses Joules and the conversion of hours to seconds to arrive at a final correct answer for both marks.

Question 16(b)(ii)

Although this part-question continued from (b) (i) where energy output had been calculated, some candidate responses indicated that they believed that output referred to waste materials, such as carbon dioxide, from the generators. There was also a lot of discussion of how the use of diesel could fit in with a renewable energy scheme. The most straightforward answers calculated the energy maximum power output of the renewable sources (146 kW) and compared it with the combined power output of the two diesel generators (160 kW). Although many made an error and calculated 140 kW for the renewable output, the majority of candidates started out with the relevant calculations. It was less common to see them compare the values explicitly and draw a conclusion. Some decided that the diesel generators were unsuitable because their combined output was too large.

(ii) Discuss the suitability of the output of the stand-by diesel generators.

(2)

energy of rensable sorces = 146 kw
energy of Diesel Generators = 160 kw There would be wasted energy So they are not suitable.

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Examiner Comments

This response calculates the power outputs correctly, but does not draw the correct conclusion and is only awarded the first mark.

(ii) Discuss the suitability of the output of the stand-by diesel generators.

(2)

Maximum power of diesel generators = 160kW. Maximum power of renewable systems = 146 kW ∴ diesel generators would produce more than enough power to cover the other systems in the event of them failing, although burning diesel releases CO_2.

(Total for Question 16 = 8 marks)

ResultsPlus

Examiner Comments

This response correctly compares the power output by the two systems and gains both marks. The additional information about carbon dioxide does not affect the mark.

Question 17(a)(i)

This part-question involved a sphere moving through a liquid: some candidates labelled it as a sphere falling through the liquid with viscous drag acting upwards. Most candidates interpreted the context correctly, however, and labelled viscous drag downwards.

Question 17(a)(ii)

This part of the question asked for two stages to be explained, but the initial acceleration was often ignored. Candidates tended to mention the increase of viscous drag with speed and the eventual balancing of the forces, but then did not state how this related to a steady upwards speed. Some candidates linked the increasing viscous drag to a retarding force on the bubble which reduced its speed and some ignored weight when discussing balanced forces.

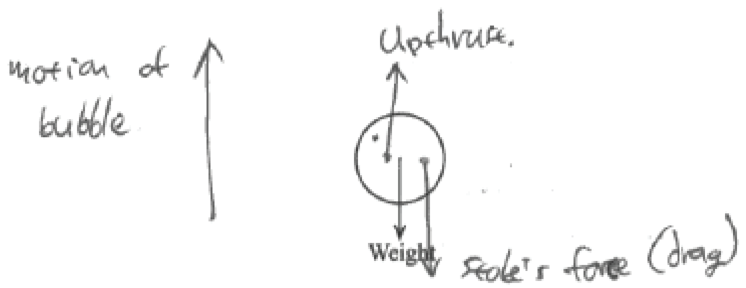
Question 17(a)(iii)

Most candidates converted their diagram to a suitable expression, although, as in January, some wrote formulae for upthrust or viscous drag rather than expressions linking the forces identified in the diagram.

17 A science centre houses a display with tall, transparent tubes of different liquids. Visitors can pump air into the bottom of the tubes to create bubbles that rise to the top at different steady speeds.

(a) (i) Add labelled arrows to the diagram to show the other two forces acting on a bubble as it rises through a liquid.

(2)



(ii) With reference to the forces on the bubble, explain why the bubble initially accelerates and then reaches a steady upwards speed.

(4)

At a certain point the sum of the bubble's weight and Stoke's force is balanced with the upthrust exerted on the bubble. At that point the resultant force is zero, and according to Newton's first law, it is moving at a ~~speed~~ constant speed – terminal velocity in this case.

(iii) Write an expression which relates these forces for a bubble moving at a steady upwards speed.

(1)

$W + F = U$ → upthrust
↳ weight
→ viscous drag (Stoke's force)

ResultsPlus

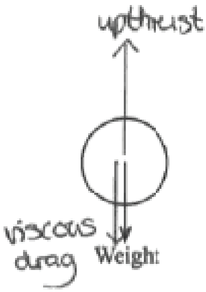
Examiner Comments

This response achieves full marks for labelling the diagram, and for the expression linking the forces in part (iii). It does not address the initial acceleration at all and, although writing of 'a certain point' implies a realisation that there is a change, the increase in viscous drag is not mentioned. The balanced forces and their effect on the motion are correct and given two marks in part (ii).

17 A science centre houses a display with tall, transparent tubes of different liquids. Visitors can pump air into the bottom of the tubes to create bubbles that rise to the top at different steady speeds.

(a) (i) Add labelled arrows to the diagram to show the other two forces acting on a bubble as it rises through a liquid.

(2)



(ii) With reference to the forces on the bubble, explain why the bubble initially accelerates and then reaches a steady upwards speed.

(4)

Viscous drag increases with speed, so initial drag is very small and the bubble accelerates. Upthrust is great because air has a much lower density than most liquids ∴ the bubble has a small weight. As speed increases, drag increases, until upthrust = weight + drag and $\Sigma F = 0$ ∴ $a = 0$ ∴ terminal velocity is reached.

$F = 6\pi r \eta v$

(iii) Write an expression which relates these forces for a bubble moving at a steady upwards speed.

(1)

Upthrust = weight + viscous drag

ResultsPlus

Examiner Comments

This response labels the diagram and gives the expression correctly. The answer to part (ii) refers to the initial small drag and its increase with speed for the first two marks. It then deals with the balanced forces and zero acceleration concisely to get the next two marks.

Question 17(b)(i)

Few candidates scored marks for this part-question. Many only stated that the weight was negligible. Some referred to the density of air being less than the density of the liquid. Others referred to the weight of the air being small but did not recognise that the difference had to be great in order to justify ignoring the weight.

Question 17(b)(ii)

Candidates usually stated that viscosity decreased with temperature for the liquid and that this had the effect of decreasing the terminal velocity, although some thought that the increased thermal energy of the particles increased the speed of the bubble. Some linked it to a decrease in density, despite the expression suggesting the opposite effect.

Question 17(b)(iii)

Candidates usually recognised a link between the size of the bubble and the speed using the expression given at the start of the section, but some tried to explain it without reference to the expression. This possibly indicated that these candidates were not used to the term 'expression'. Candidates rarely stated straightforwardly that speed is proportional to the square of the radius.

(b) If the weight of the air in the bubble is ignored, the steady upwards speed is given by

$$v = \frac{2\rho r^2 g}{9\eta}$$

Where ρ is the density of liquid, r is the radius of the sphere and η is the coefficient of viscosity of the liquid.

(i) Explain why it is reasonable to ignore the weight of the air.

(2)

Because air has a weight which is very small so it wouldn't really affect the bubble. so you don't need to take it into consideration.

(ii) Explain what happens to the speeds of the observed bubbles if the temperature of the liquid increases.

(2)

The speed of the observed bubble would increase is the [redacted] temperature was increased because the viscosity would decrease, [redacted] and also the molecules in the liquid will have more kinetic energy.

(iii) It is possible to create a small bubble followed by a larger bubble.

Use the expression to explain why the larger bubble catches up with the smaller one.

(1)

Because the radius of the sphere doesn't affect the speed of the bubble in any way. Unless the density of the liquid or coefficient of viscosity of the liquid is changed.

(Total for Question 17 = 12 marks)

ResultsPlus

Examiner Comments

This response refers to a 'very small' weight in part (i), but does not compare it with anything else, including the upward force of upthrust which would also be 'very small' for a small bubble. Part (ii) gains two marks for the reference to decreased viscosity and increased speed – the point about the molecules is irrelevant. The answer to part (iii) appears to refer to the expression but misinterprets it.

(b) If the weight of the air in the bubble is ignored, the steady upwards speed is given by

$$v = \frac{2\rho r^2 g}{9\eta}$$

Where ρ is the density of liquid, r is the radius of the sphere and η is the coefficient of viscosity of the liquid.

(i) Explain why it is reasonable to ignore the weight of the air.

(2)

The density of air is much less than the liquid. Therefore, the weight of air ~~is~~ << the upthrust.

(ii) Explain what happens to the speeds of the observed bubbles if the temperature of the liquid increases.

(2)

As T increases, the coefficient of vicosity will fall. as $v \propto \frac{1}{\eta}$. v will increase.

(iii) It is possible to create a small bubble followed by a larger bubble.

Use the expression to explain why the larger bubble catches up with the smaller one.

(1)

$v \propto r^2$ as r increases, v ~~rise~~ increases as well. A large bubble will have a bigger terminal speed.

(Total for Question 17 = 12 marks)

ResultsPlus

Examiner Comments

This full mark response makes a clear reference to the great disparity between the density of the air and the liquid and its effect on weight. The expression is used straightforwardly in the remaining parts to show the effect of temperature and radius on the speed of the bubble.

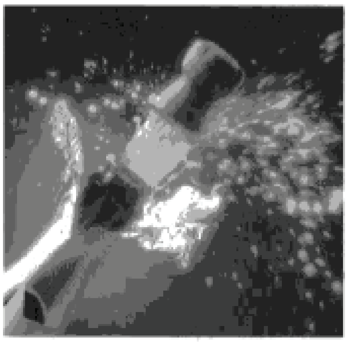
Question 18(a)

Candidates had little difficulty in calculating the work done on the cork.

Question 18(b)

The maximum speed calculation was generally tackled well using work done = kinetic energy gained. Some candidates created difficulties for themselves by using the force and mass to find acceleration and then attempting to calculate the speed. The second part was rarely completed satisfactorily when candidates used this method, often because they used the distance of 53 m. Of the candidates using kinetic energy, the factor of a half was sometimes missed in calculations, as was the square root.

18 Champagne bottles are often opened by 'firing' the cork out of the bottle. The world record for the horizontal distance travelled by a fired cork is 53 m.



The high pressure inside the bottle produces an average force of 150 N on the cork as it leaves the bottle. This force acts on the cork over a distance of 2.5×10^{-2} m.

(a) Show that the work done on the cork is about 4 J.

(2)

W.D. = F.S

W.D. = 150 x 2.5×10^{-2}

W.D. = 3.75 Nm

(b) Calculate the maximum speed at which the cork could leave the bottle.

mass of cork = 7.5×10^{-3} kg

(2)

K.E. = $\frac{1}{2}mv^2$

~~K.E.~~ $3.75 = \frac{1}{2} \times (7.5 \times 10^{-3})v^2$

v = 1000 ms^{-1}

Speed = 1000 ms^{-1}

ResultsPlus

Examiner Comments

This response has a correct value for work done to the required extra significant figure and uses work done = maximum kinetic energy. The final square root has not been applied to complete the calculation, so 3 out of 4 marks have been given for parts (a) and (b).

Work done = Force × distance

$= 150\,N \times 2.5 \times 10^{-2}\,m$

$= 3.75\,J \approx 4\,J.$

(b) Calculate the maximum speed at which the cork could leave the bottle.

mass of cork = 7.5×10^{-3} kg

(2)

$E_K = \frac{1}{2}mv^2$

$\frac{3.75\,J \times 2}{7.5 \times 10^{-3}\,kg} = v^2$

$v^2 = 1000$

$v = \sqrt{1000}$

$= 31.62\,ms^{-1}$

Speed = $31.62\,ms^{-1}$

ResultsPlus

Examiner Comments

This response shows a correct calculation in both parts, including the square root.

Question 18(c)(i)

Candidates usually found the vertical component correctly, although the 'show that' answer was not a clue for those who used cosine and calculated 24.5 m s^{-1}.

Question 18(c)(ii)

Candidates did not usually complete the range calculation completely, although a good proportion did. Many candidates calculated the horizontal component, and successfully found the time to find the maximum height, but then forgot to double this time before finding the total distance. They got answers of about 51.5 m, but they generally accepted it without question even though it is less than the world record.

Some candidates used the range equation successfully and were given full marks, but a fair number misquoted it and therefore gained no marks as they did not show any correct intermediate stages. This equation will not be disqualified in any way, but candidates should beware of risking a lot of marks if they chose to use it on another occasion.

Question 18(d)

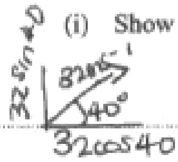
Candidates generally identified air resistance on the cork as a relevant factor, but it was rare for the explanation part to be complete. In this type of question we require both cause and effect, i.e. the identification of a relevant factor, such as air resistance, and an explanation of how it makes a difference, usually in terms of energy lost or a force causing a deceleration. For example, energy is dissipated as work is done by this force or this force decelerates the cork, reducing the range.

Many alternative answers were given, such as differences in the angle or initial pressure or the mass of the cork or the presence of wind etc. They still rarely gained the second mark for the effect.

Candidates who found only half the range in the previous part had a harder time trying to explain how a real life cork travelled further than the theoretical case and still sometimes quoted air resistance, even though this would reduce the range.

(c) The cork is fired from ground level at an angle of 40° to the horizontal with a speed of 32 m s^{-1}.

(i) Show that the vertical component of the velocity is about 20 m s^{-1}. **(1)**



32sin40 = 20.56 ≈ 20 ms^{-1}

(ii) Calculate the horizontal distance travelled by the cork through the air. **(5)**

v = u + at

u = 20.56 t = ? v = 0 a = −9.81

v = u − 9.81 × t

−20.56 = −9.81t

−20.56 / −9.81 = 2.1s

32cos40 = 24.5

t = 2.1

S = 24.5 × 2.1 = 51.45m

Distance = 51.45m

(d) Suggest an explanation for the difference between your calculated value and the world record distance. **(2)**

The world record distance may have been achieved with the bottle at a better angle.

(Total for Question 18 = 12 marks)

ResultsPlus
Examiner Comments

This response shows a correct value for the vertical component in part (i), and the horizontal component in part (ii). The time to reach the maximum height is calculated in part (ii), but this is not doubled to find the time to reach the ground again before multiplying by the horizontal component of velocity to find the range.
In part (d) the candidate indicates that a different angle may have been used to get one mark, but doesn't suggest that the better angle would be closer to 45 degrees.

(c) The cork is fired from ground level at an angle of 40° to the horizontal with a speed of 32 m s⁻¹.

(i) Show that the vertical component of the velocity is about 20 m s⁻¹. (1)

$\sin 40° = \frac{opp}{32}$ ∴ $opp = 32 \sin 40°$
$= \underline{20.6\ ms^{-1} \approx 20 ms^{-1}}$

(ii) Calculate the horizontal distance travelled by the cork through the air. (5)

X component:
$s = ?$
$u = 32 \cos 40°$
$= 24.5 ms^{-1}$
$v = 24.5 ms^{-1}$
$a = 0 ms^{-2}$
$t = ?$

~~$v^2 = u^2 + 2as$~~ ~~$v = u + at$~~

$s_y = ut + \frac{1}{2}at^2$
$0 = 20.6t + \frac{1}{2}(9.81)t^2$
$= 20.6t \mp 4.905t^2$
$0 = t(20.6 \mp 4.905t)$
$t = \frac{-20.6}{-4.905}$
$= \underline{4.1998 s}$

$4.905t = 20.6$

$s_x = \frac{1}{2}(u+v)t$
$= \frac{1}{2}(24.5 + 24.5)\ 4.199$
$= \underline{102.9}\ m$

Y component:
$s = 0m$
$u = 20.6 ms^{-1}$
$v = ?$
$a = 9.81 ms^{-2}$
$t =$

Distance = 102.9m

(d) Suggest an explanation for the difference between your calculated value and the world record distance. (2)

Because in a real situation, air resistance ~~can~~ and other resistive forces can slow down the speed of the cork, thus the cork may not travel such a long distance.*

*Also, some of the cork's kinetic energy has been transferred to the surrounding as thermal energy.

(Total for Question 18 = 12 marks)

ResultsPlus
Examiner Comments

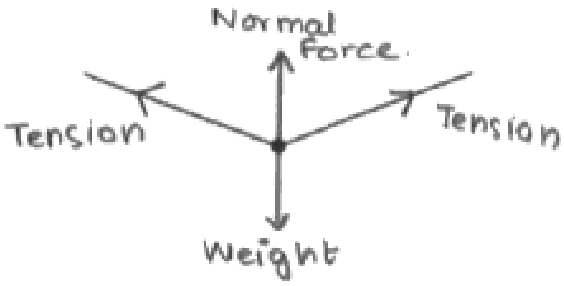
This is a full mark response. The variables are all neatly set out in part (ii), making substitution straightforward. The use of vertical displacement = 0 at the end of the flight eliminates the problem with failing to double the time to maximum height. In part (d) air resistance has been identified, as well as its effect on the speed of the cork.

Question 19(a)

The majority of candidates identified at least one force correctly, and a good proportion got tension, in the correct direction, and weight. Common errors included adding an upward vertical force labelled reaction, tension or resultant, omitting arrows or labels and labelling gravity instead of weight.

(a) Add to the diagram to show the forces acting at the midpoint of the line when a mass is hung from its midpoint.

(2)

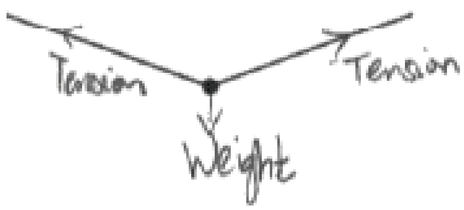


ResultsPlus
Examiner Comments

This response includes correct labels for tension and weight but has an added superfluous force labelled normal force, so only one mark was awarded.

(a) Add to the diagram to show the forces acting at the midpoint of the line when a mass is hung from its midpoint.

(2)



ResultsPlus
Examiner Comments

This response labels the weight and tension correctly for both marks.

Question 19(b)(i)

Most candidates completed this successfully. On rare occasions candidates did not quote the required extra significant figure.

Question 19(b)(ii)

Candidates often struggled with this part. They rarely included a basic diagram, although it would have helped enormously. Common errors were to forget to halve the original length of the line or to use cosine instead of tangent.

Question 19(b)(iii)

A fair proportion were able to answer this part correctly using the expression for the vertical component of tension, but many struggled with it and a significant number just left it blank. Again, a diagram was helpful to those who used one.

Question 19(b)(iv)

Finding the strain presented few difficulties to candidates, although a minority used the new length instead of finding the extension. Very few incorrectly applied a unit.

Question 19(c)

It was usual to give one mark for the use of the stress formula and one for stress divided by strain, but the third mark was rarely awarded. This was often because the units were omitted or wrong dimensionally or by prefix, e.g. Newtons or GPa instead of MPa. More frequently, the weight was used in the stress calculation instead of the tension from part (b) (iii). Some candidates who could not find tension previously used 60N and this was accepted as an error carried forward.

(b) A mass of 1.10 kg is hung from the midpoint of the line.

(i) Show that the downward vertical force on the line is about 11 N.

(1)

$g = 10 \quad 1.1 \times 10 = 11\,N$

(ii) This force pulls the midpoint down a distance of 48.5 cm.

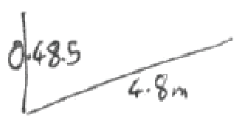
Show that the line is at an angle of about 84° to the vertical.

length of washing line when horizontal = 9.600 m

(2)

$\sin^{-1}\left(\frac{0.485}{4.8}\right) = 5.8^\circ$

$90^\circ - 6^\circ = 84^\circ$



SOH CAH TOA

ResultsPlus

Examiner Comments

This response shows the rare error of using g = 10 N kg^{-1} and fails to show the extra significant figure in part (i). In part (ii) a diagram has been used, but it has incorrectly identified the hypotenuse as 4.8 m long and subsequently used sine to find the horizontal angle which was then used to find the vertical angle.

(b) A mass of 1.10 kg is hung from the midpoint of the line.

(i) Show that the downward vertical force on the line is about 11 N.

(1)

$w = mg$

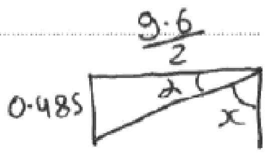
$1.1 \times 9.81 = 10.791\ N$

(ii) This force pulls the midpoint down a distance of 48.5 cm.

Show that the line is at an angle of about 84° to the vertical.

length of washing line when horizontal = 9.600 m

(2)



$\tan\alpha = \frac{0.485}{4.8}$ $\quad \tan^{-1}\text{ans} = 5.77\ (3sf)$

$x = 90 - \text{ans}$

$= 84.2°\ (3sf)$

ResultsPlus

Examiner Comments

This response shows a correct calculation of the weight in part (i). In part(ii) a diagram clearly shows the relevant lengths and the angle has been found to the required extra significant figure.

(iii) Show that the tension in the line is less than 60 N.

(2)

$\cos 84.2 = \frac{11}{T}$ $T = \frac{11}{\cos 84.2}$

$T = 108.85$ N

(iv) The washing line stretches so that the total length of the line is now 9.847 m.

Calculate the strain for the line.

(2)

strain $= \frac{\Delta x}{x} = \frac{9.847 - 9.6}{9.6} = \frac{0.247}{9.6} = 0.0257$

$0.0257 = 2.57 \times 10^{-2}$

Strain = 2.57×10^{-2}

(c) Calculate the value of the Young modulus for the line material.

cross-sectional area of the line = 6.6×10^{-6} m^2

(3)

$E = \frac{\sigma}{\varepsilon}$ $\sigma = \frac{F}{A} = \frac{11}{6.6 \times 10^{-6}} = 1.67 \times 10^{6}$

$E = \frac{1.67 \times 10^{6}}{2.57 \times 10^{-2}} = 6.49 \times 10^{7}$

Young modulus = 6.49×10^{7}

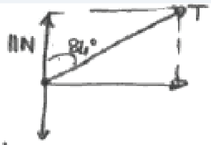
(Total for Question 10 = 12 marks)

ResultsPlus

Examiner Comments

This response shows the correct trigonometrical approach to part (iii), but the weight has not been halved as it should have been. The strain calculation is correct. In the final part, stress has been calculated using weight rather than tension, although it gets a mark for using a force divided by area. The stress has been divided by strain for a second mark, but the final answer is incorrect in magnitude and also has no unit, so no more marks can be awarded.

(iii) Show that the tension in the line is less than 60 N.



(2)

W ÷ 2 = 11 ÷ 2 = 5.5 N on each side of the string.

$\cos 84° = \frac{5.5}{T}$ ∴ $T = \frac{5.5}{\cos 84°}$ = 52.6 N < 60 N

(iv) The washing line stretches so that the total length of the line is now 9.847 m.

Calculate the strain for the line.

(2)

original length = 9.6 m

$x = 9.847 - 9.6 = 0.247$ m

$\varepsilon = x \div L$

$= 0.247 \div 9.6$

$= 0.026$

Strain = 0.026

(c) Calculate the value of the Young modulus for the line material.

cross-sectional area of the line = 6.6×10^{-6} m^2

(3)

$\sigma = F \div A$

$= 52.6 \div 6.6 \times 10^{-6}$

$= 7{,}969{,}696.97$ Pa

$E = \sigma \div \varepsilon$

$= 7{,}969{,}696.97 \div 0.026$

$= 306{,}526{,}806.5$ Pa

Young modulus = 306,526,806.5 Pa

ResultsPlus

Examiner Comments

In this response the tension has been calculated correctly with the aid of a simple diagram. The strain calculation is correct and the value for the Young modulus has been found and given with the correct unit.

Unit 6PH02

General comments

The first paper for this unit of the new specification was sat in January but attracted a very small entry. This was the first paper to be sat by a large cohort of candidates.

The most significant change in the paper for the new specification is the introduction of multiple choice questions. These provided good discrimination.

Several of the longer questions were context based. Students were given sufficient information to be able to apply their knowledge to the application being considered but they must realise that for some of the marks, reference must be made to the specific context. Questions that go over two pages are usually on facing pages and sometimes candidates need to refer back to the stem of the question, to remind them of the information that had been given. More detailed comments on this can be found in the question comments.

In a number of questions there was evidence to suggest that candidates were not familiar with using the data at the back of the examination paper. They need to be reminded that not all data is provided in the question and that they need to be familiar with the data that is provided.

There was a wide range in the quality of candidates' written English. In this paper there were three questions where quality of written communication was considered. Some students were able to give succinct responses with remarkable clarity given the pressures of an examination. At the lower end, candidates' ability to communicate their answers was poor given the level of study they have undertaken, with some unable to construct a legible sentence let alone extended prose. Some candidates' writing became very difficult to read. For this type of question, students should be encouraged to use bullet points for their answers.

Questions 1-10 Multiple Choice

Multiple choice questions allow for a fuller coverage of the specification to be assessed in each examination. It should be made clear that these questions are not meant to trick candidates but at the same time they are not give away marks. However candidates need to remember that each question is worth one mark and they should not spend too long on any one question. Average performance on the multiple choice questions correlated well with performance in section B.

In order of success, the questions with approximate percentages of correct answers and topics were

3. 86% properties of sound waves

9. 82% refractive index identifying correct angles

2. 80% frequencies of parts of the electromagnetic spectrum

8. 74% classification of waves

7. 71% factors affecting detail in ultrasound scan

1. 63% units of a volt

5. 61% condition for destructive interference

4. 56% resistors in parallel calculation

6. 33% energy levels for a mercury atom

10. 26% current and drift speed ratios for two wires.

Question 11

This question was answered well by the average and above average candidates with many scoring full marks. A common mistake was for candidates to find the total resistance for the whole circuit (88.2 Ω) but then to forget to subtract the resistance of the lamp. Other mistakes were to forget to convert mA to A or to try to use the $E = I(R+r)$ formula and then to make mistakes rearranging the equation.

Question 12

Again, a question that was correctly answered by the average and above average candidates. Most candidates realised that they had to use the equation $I = Q/t$. This is an example of where candidates didn't realise that the electron charge was provided in the data and formula sheet at the end of the paper. Many candidates merely divided the number of electrons by 15 s.

Question 13

This question was about electron diffraction and was a context based question since electron diffraction is not specified in the specification. This is an example of where candidates need to think about the context.

(a) This required an explanation of diffraction and most candidates realised that this occurred when a wave passed a gap or obstacle. We did not accept 'bend' because of the confusion with refraction Candidates needed to talk about the wave spreading out. These marks could be scored by means of a diagram.

(b)(i) Most candidates were able to make the wave-particle duality link.

(b)(ii) The last part of the question asked about why substantial diffraction occurred and candidates were meant to apply their knowledge and realise that the wavelength associated with the electrons had to be similar to the spacing in the graphite.

(b) This diffraction pattern is produced by electrons passing through a thin sheet of graphite.

(ii) Suggest why substantial diffraction occurs.

(1) 1 Q13bii

Because the space between the atoms in the graphite is roughly the same as the electron wavelength.

ResultsPlus
Examiner Comments

This candidate correctly links spacing in graphite to electron wavelength and scores the mark.

(b) This diffraction pattern is produced by electrons passing through a thin sheet of graphite.

(ii) Suggest why substantial diffraction occurs.

(1) 0 Q13bii

Because the gap length is similar to the ~~rao~~ size of the electron.

ResultsPlus
Examiner Comments

This candidate is stating the condition for substantial diffraction but does not apply it specifically to the graphite and so does not score the mark.

Question 14

(a) It was very rare for a candidate not to identify the Doppler effect.

(b) There were some excellent answers from candidates who clearly knew and understood this effect. Where marks were lost it was usually due to lack of detail about whether the ambulance was approaching or going away or in referring to the frequency changing but not specifying an increase or a decrease.

(b) Describe and explain how the movement of the ambulance causes the frequency of the sound he hears to change.

(3) 2 Q14b

• The nearer as the ambulance approaches, the the frequency the person hears decreases increases
• As the ambulance travels away, the frequency from the ambulance to the person decrease

ResultsPlus
Examiner Comments

This candidate has described the changes but not given an explanation. There were three marks available but clearly only two points have been made. This should act as a clue to the student that more is needed.

(c) This was a difficult end to the question and some candidates could well have lost marks because of their inability to express themselves clearly. What was expected was that the candidates would realise that the changes in frequency would be even higher than in (b) but often they only referred to a change of frequency with no comment on relative values.

(c) Suggest how what he hears would be different if the ambulance were moving faster.

(2) 1 Q14c

The pitch would be higher when coming towards him, and lower when moving away, as the waves are stretched or compressed more.

5

ResultsPlus
Examiner Comments

This candidate does make reference at the end to the waves being stretched or compressed more but does not indicate that the frequency changes would be more than before. The use of the word even before higher and lower would have made all the difference. This candidate scored 1 mark

Question 15

This was a question where the more able candidates were able to score full marks but many other candidates showed weaknesses in their ability to apply their circuit knowledge to a more complex circuit.

(a) Most candidates were able to correctly find the potential difference across the 5 Ω resistor.

(b) A large percentage of candidates ignored the calculation they had successfully done in (a) and in finding the current I_2 used the 9 V as the potential difference across the parallel combination. Other candidates, having calculated 3 V for (a) then used 3 V as the potential difference for the parallel combination.

(c) This section was generally better answered than (b) with many candidates appreciating current values at a junction. In marking this section, we allowed error carried forward, i.e. they had to subtract their current value from (b) from the 0.60 A and use this current with the same p.d. that they had used in (b). However a significant number of candidates did assume that the current divided equally at the junction.

Question 16

This was the first question on the paper where quality of written communication was considered. It was a five mark question which meant that examiners were looking for five different physics points. Many candidates scored 3 or 4 marks because they did not make enough points. There were two common errors. One was to assume that the brightness of the lamp depends only on current. Below is a typical answer from such a candidate

Write a correct explanation.

- The ~~a~~ voltage across each lamp is the same
- Lamp ~~a~~ A has the highest resistance this means that as $I = V/R$ lamp B will be brighter than lamp A as more current will travel through it. ~~than it for lamp A.~~

~~Lamp B~~

- ~~[illegible]~~ The current will be split unequally between the two bulb. more will pass through bulb B as it has less resistance making it ~~[illegible]~~ produce more ~~[illegible]~~ light.

(Total for Question 16 = 5 marks)

ResultsPlus

Examiner Comments

This candidate scores 3 marks, identifying the same p.d. across the lamps, the currents being different and correctly identifying the bulb that will be brightest. The last part of the answer is a repetition and so scores no extra marks.

The other common mistake was where candidates did realise that brightness depended on power but did not refer to an actual power equation. The easiest equation to use was $P = V^2/R$ since if V is constant, power is inversely proportional to resistance. However many candidates only want to use $P=VI$. This was acceptable provided they establish the relative values of current for each resistor.

Some candidates spend a long time making one physics point, often repeating themselves.

Write a correct explanation. 2 Q16

The current is different in both lamps because in parallel circuit the current splits, so the total current is the sum of the currents of the lamps in parallel. Resistance = $\frac{\text{voltage}}{\text{current}}$; therefore if the resistance of lamp A is greater than B then the current for lamp A must be lower because resistance and current are proportional. As lamp A has a higher resistance it is harder to send a steady flow of electrons through it, which is also why the current is lower. If the resistance of lamp B is less and it is easier to send electrons through it, then lamp B will be brighter because it is receiving more current and they more energy. Also, the electrons do not lose energy despite it being harder for them to ~~lose~~ move through lamp A.

ResultsPlus

Examiner Comments

This candidate uses 8 of the 11 lines to establish that the current in lamp B is greater than the current in lamp A. All this for 1 mark

Question 17

(a) This was poorly answered by many candidates. Most answers were in terms of energy shells or how electrons move between energy levels rather than explaining what an energy level is.

(b) More candidates were successful here but there were still many wrong answers, often referring to protons or saying that it is something given out when an electron changes energy levels.

(c) $E_1 - E_2$ was the common error but some candidates who identified $E_2 - E_1$, then put it into the middle of a longer question.

(d) This was the most successful part of this question with a significant number of candidates scoring three marks. This is another example of students not using the data at the end of the paper. Because they did not think they knew the speed of the waves, some candidates used the wavelength as the frequency in $E = hf$. The other common error was confusion over units, with some candidates completing the correct calculation but using eV as the unit instead of joules.

Question 18

This question was generally well answered. Most candidates answered photon and energy correctly. Instead of metal, material was sometimes given. Photon was sometimes used again instead of electron and it was the work function mark that was most likely to be lost. Instead of writing work function, some candidates wrote a definition or stated threshold frequency.

Question 19

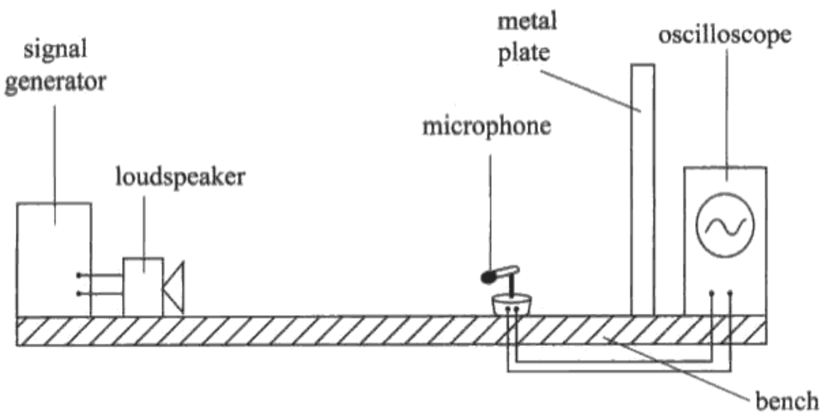
The question started and finished with candidates having to draw rays of light onto a diagram. These in general showed a very poor understanding of refraction through a prism. The stem of the question stated that the light hit the boundary at the critical angle and this was further supported by the angle being labelled c in the diagram. Despite this information, most candidates showed the light leaving the prism at an angle other than 90°. For the last part relating to the red ray, candidates did not stop to think about how the red would behave in relation to the blue and so commonly we saw the red ray being refracted more than the blue ray at the first face and then refracted the wrong way on emerging from the prism.

The calculations were generally much better with a significant number of candidates scoring full marks although again, some candidates lost marks because they did not realise that the speed of light was given in the data list.

Question 20

(a) A very small percentage of students completely missed the point of this question and spoke about intensity decreasing with distance, consequently scoring quite badly on the question as a whole. Most students did realise that the question was about superposition/interference/standing waves but commonly in this part, they did not seem to feel it necessary to talk about path difference of phase relationship, therefore limiting themselves to only 2 marks.

***20** The diagram shows an experiment with sound waves.



A loudspeaker is connected to a signal generator. A microphone is connected to an oscilloscope. Sound waves reach the microphone directly from the loudspeaker and after reflection from the metal plate.
As the microphone is moved towards the loudspeaker, the amplitude of the wave displayed on the oscilloscope varies through a series of maxima and minima.

(a) Explain why the amplitude of the sound varies in this way.

Becouse the sound wave from the loudspeaker and the reflected sound wave which are of same frequency, same wavelength and nearly equal amplitude, superpse. The constructive superposition is the maxima and the destructive superposition is the minima

ResultsPlus
Examiner Comments

This scores the first mark for identifying that superposition is occurring and the second mark for identifying the maxima at the point of constructive superposition.
The reference to frequency, wavelength and amplitude is unnecessary here.

Students tend to fill the space provided and assume they have answered the question without analysing their answer to see if they have provided sufficient different points.

(b) A lot of students didn't realise that the distance between maxima was half a wavelength, some even drawing a sketch of a wave with wavelength shown as crest to crest. The frequency given in kHz was also a challenge for many candidates.

(c) This section was very badly answered with even the most able students rarely scoring any marks. By the time students got to this part of the question they seem to have forgotten that the question was about superposition of waves and so they were not talking about the resultant displacement of two waves. Some students who did realise that there was not complete cancellation tried to justify this in terms of phase rather than amplitude. Only a very few candidates realised that it was the similarity/difference in the distances travelled that was at the heart of the question.

(i) Explain why the minima never have a zero value.

The two waves never have the exact same amplitude because they have lost energy as they travel so the reflected has a lower amplitude than the emitted wave + do not totally cancel out

(ii) As the microphone is moved towards the metal plate, the amplitudes at the minima gradually decrease. Suggest why this happens.

(4)

The difference in amplitudes becomes less as the differen[ce] in distance travelled is less so difference in energy + amplitude is less they cancel out more sucessfully than at the loudspeaker, where one has travelled much further than the other

(Total for Question 20 = 12 marks)

ResultsPlus

Examiner Comments

A rare example of a candidate who does realise that amplitudes and distance travelled is the point to be considered.

Question 21

This was a testing question in which candidates needed to follow through a concept and use logical reasoning. Although most knew the basic equations, they found it difficult to apply it in a simple application. The candidates often did not use the ideas from one section of the question in subsequent parts.

(a) This was generally answered well, although a number of candidates did not clearly equate thinner to a decrease in cross sectional area and lost 1 mark. Quite a few decided that *I* = n*Aqv* was the appropriate equation to use, making it difficult to score any marks.

(a) A stretched wire becomes longer and thinner. Using an equation to justify your answer, explain what effect stretching a length of wire would have on its resistance.

(3)

$R = \frac{\rho l}{A}$ where ρ = resistivity l = length A = cross sectional area
Stretching a wire both increases length and decreases cross sectional area, both of which increases the wire's resistance

ResultsPlus
Examiner Comments

An example of a student who quotes the correct equation and makes correct reference to both length and area

(a) A stretched wire becomes longer and thinner. Using an equation to justify your answer, explain what effect stretching a length of wire would have on its resistance.

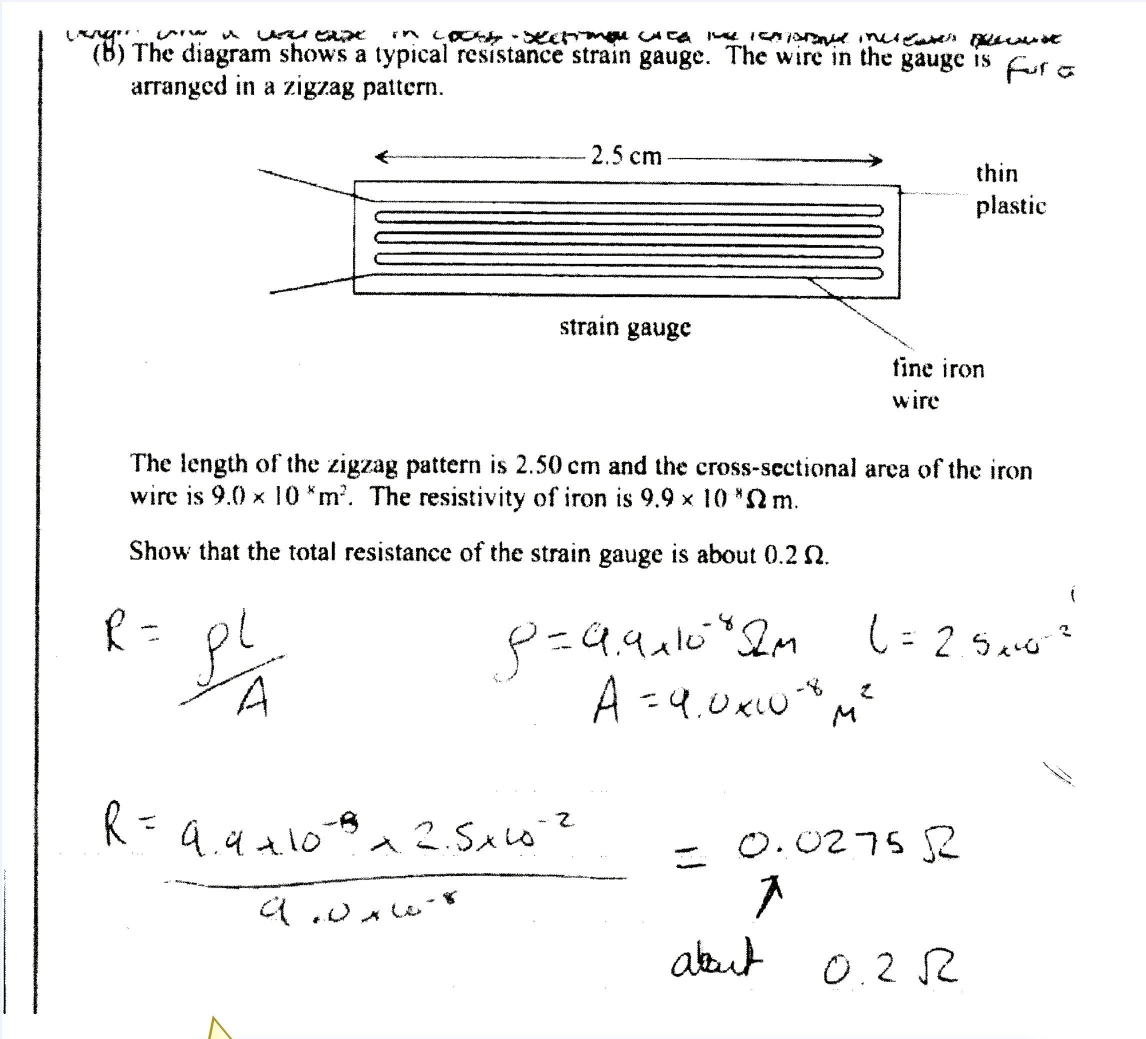
(3)

The length of the wire and its resistance are directly proportional, increasing the length of the wire would increase the resistance while decreasing the length will decrease the resistance

ResultsPlus
Examiner Comments

This student while clearly knowing the relationship between resistance and length, does not quote an equation or make any reference to area.

(b) Many students did not notice that there were 8 strips and a worrying number were happy to say that 0.0275 was approximately the same as 0.2. Some went back and altered their correct length of 0.025 m to 0.25 m to make it fit better (even though 0.275 is still not approximately 0.2).



(b) The diagram shows a typical resistance strain gauge. The wire in the gauge is arranged in a zigzag pattern.

The length of the zigzag pattern is 2.50 cm and the cross-sectional area of the iron wire is $9.0 \times 10^{-8}\,m^2$. The resistivity of iron is $9.9 \times 10^{-8}\,\Omega\,m$.

Show that the total resistance of the strain gauge is about 0.2 Ω.

$R = \frac{\rho l}{A}$ $\rho = 9.9 \times 10^{-8}\,\Omega m$ $l = 2.5 \times 10^{-2}$ $A = 9.0 \times 10^{-8}\,m^2$

$R = \frac{9.9 \times 10^{-8} \times 2.5 \times 10^{-2}}{9.0 \times 10^{-8}} = 0.0275\,\Omega$

about $0.2\,\Omega$

ResultsPlus

Examiner Comments

An example of equating 0.0275 to 0.2

(c)(i) This was omitted by many students and of those who did make an attempt, it was clear that many struggled to make an algebraic substitution from one equation into another.

(c)(ii) Most students did not realise that this was linked to (c)(i) and that they should be working with constant volume and using the fact that resistance was proportional to length[2]. The majority of answers assumed that area remained constant. Even the few who did attempt to use the correct relationship often made numerical mistakes in their calculations.

(c) (i) A wire of length l and cross-sectional area A is stretched. Assuming the volume V of the wire remains constant

$$V = lA = \text{constant}$$

Show that the resistance of the wire is directly proportional to l^2.

(2)

$$R = \frac{\rho l}{A} = \frac{\rho(V/l^2)}{(V/l)} \quad \therefore \; R \propto l^2$$

(ii) The length of the zigzag pattern, when under strain, increases to 2.51 cm.

Calculate the increase in resistance of the wire in the gauge.

(3)

$$R = \frac{\rho L}{A} = \frac{9.9 \times 10^{-8} \times 2.51 \times 10^{-2}}{8.96 \times 10^{-8}} = 0.0277\,\Omega$$

$$A = \frac{2.50 \times 10^{-2} \times 9 \times 10^{-8}}{2.51 \times 10^{-2}} = 8.96 \times 10^{-8}\,\text{m}^2$$

Change in $R = 0.0277 - 0.0275 = 2.20 \times 10^{-4}\,\Omega$

Increase in resistance = $2.20 \times 10^{-4}\,\Omega$

ResultsPlus

Examiner Comments

Candidate does realise the need to substitute for A = V/l but makes a strange substitution for l as well. (ii), a correct method, using $A_1l_1 = A_2l_2$ to find a new area, followed by a resistance calculation using the new length and area and final finding the increase in resistance. This candidate was penalised in (b) for omitting the ×8 and so was not penalised again in this calculation.

(d) It was extremely rare to award both marks for this section. Many candidates scored one mark for appreciating that the pattern gave a longer length of wire or that it fits into a smaller space. Very few went on to link this to an increased change in resistance of the wire. Answers were often vague and non-technical.

Statistics

6PH01

Grade	Max.Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	59	53	47	41	36

6PH02

Grade	Max.Mark	A	B	C	D	E
Uniform boundary mark	120	96	84	72	60	48
Raw boundary mark	80	54	48	42	36	31

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