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Examiners' Report
June 2011

GCE Physics 6PH01 01

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Introduction

There was a good range of performance in this paper, with all candidates having opportunities to demonstrate their understanding and show progression from GCSE. Candidates generally show better performance with calculations than explanations, although the projectile question caused problems. The quality of written communication tended to depend on candidates' confidence in their explanations, whether or not they were correct, so that for questions such as 13 (b), 14 (c), 15 and 18 (e) answers were clear and logically organised, whereas for question 16 answers were harder to follow.

Section A

Performance was good on most multiple choice items in Section A, with many candidates of stronger ability giving 10 correct responses and no question achieving a correct response rate below 50%.

Some of the incorrect responses may suggest areas for improvement.

In question 1, about a fifth of the entry decided that force is a vector but weight is not, possibly suggesting some confusion between mass and weight.

The selection of D in question 4 shows that over a third are happy to state that an object thrown upwards on Mars will move upwards with an increasing speed. They clearly applied $v = u + at$ straightforwardly with positive acceleration, but did not stop to consider whether their answer was realistic.

For question 9, the minority who didn't choose the correct answer, chose acceleration, suggesting that they may not have read the question carefully and were thinking of the wrong graph.

Nearly a third chose the relationship for a falling object in question 10, again suggesting that they might have taken a bit more time reading the question. The number of sketches drawn was surprisingly low, but those who did a drawing chose the correct answer.

Question	Correct responses	Subject	Most common incorrect response
1.	65%	examples of vectors	C
2.	62%	units (energy)	A
3.	78%	stress-strain curve	A, D
4.	60%	$v = u + at$	D
5.	92 %	gravitational potential energy	D
6.	56%	v-t graph	D
7.	89%	hardness	A, D
8.	63%	forces acting on object on slope	B
9.	88%	s -t graph	A
10.	65%	forces on object rising through water	C

Question 11 (a)

Four fifths of candidates answered correctly, and those who did not nearly always mentioned direction. The problem was usually with including magnitude or describing it correctly, sometimes using the terms unit or measurement or the name of a quantity such as force or velocity in place of magnitude.

11 (a) What is meant by a vector quantity?

(1)

A measurment in which direction is needed.

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Examiner Comments

This candidate has remembered that direction is important but has failed to mention magnitude, perhaps thinking that it is indicated by 'measurement'.

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Examiner Tip

Learn standard definitions and descriptions.

11 (a) What is meant by a vector quantity?

(1)

A vector quantity has direction as well as a force.

ResultsPlus

Examiner Comments

A number of candidates answered by including the name of a vector quantity in place of 'magnitude'. This candidate may have been thinking of a particular force in Newtons as a magnitude, but it would then suggest that all vectors are forces.

Question 11 (b)

Only a third of candidates gained both marks, with another third getting a mark for mentioning that direction was changing. Many of those who did not get marks either said that velocity was constant because speed was constant or that velocity was decreasing because of friction. Some candidates addressed the magnitude of the component of velocity in the initial direction, describing it as decreasing and becoming negative when the car had turned far enough. A significant number said that the velocity would be zero because after completing a circle the displacement would be zero. These students were confusing instantaneous velocity with average velocity and many seemed to be influenced by a question from summer 2009.

(b) A car is driven around a bend at a constant speed.

Explain what happens to its velocity.

(2)

The car's wheel would be turned to drive around the bend so it would have more friction acting on it so the speed would decrease.

(Total for Question 11 = 3 marks)

ResultsPlus
Examiner Comments

A large number of candidates ignored the statement about constant speed in this question. This suggests that they are only focusing on some of the information. Important points here are 'around a bend' and 'constant speed' as well as the instruction.

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Examiner Tip

Identify all the key points carefully - possibly by underlining or with a highlighter.

(b) A car is driven around a bend at a constant speed.

Explain what happens to its velocity.

(2)

At constant speed it's acceleration is zero and it is because of this that it's velocity will therefore remain constant and not change

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Examiner Comments

This was a typical response, possibly due to acceleration often being used without reference to direction in questions related to speed. Following on from part (a), it should have been clear that this question was about vector quantities.

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Examiner Tip

Remember that acceleration is a vector quantity and refers to any change in velocity, whether of magnitude or direction.

(b) A car is driven around a bend at a constant speed.

Explain what happens to its velocity.

(2)

The velocity steadily decreases as it turns the bend until it is going ~~in the~~ forward to its starting point at which time it will have a negative velocity. If it were to complete a circle then by one revolution its average velocity would be zero

(Total for Question 11 = 3 marks)

ResultsPlus
Examiner Comments

This is a typical response where the candidate appears to be referring to a question on an earlier paper.

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Examiner Tip

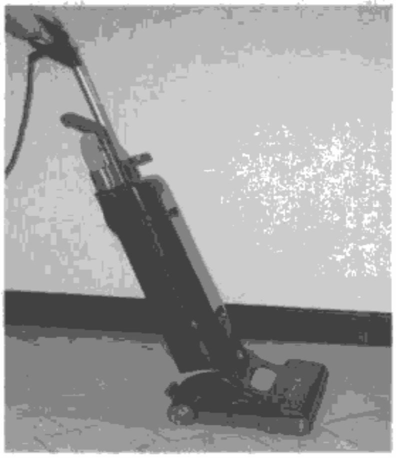
Using past papers for practice is a very good way to revise, but when it comes to your exam, make sure you answer the question on the paper in front of you and not the one you practised with.

Question 12

A straightforward question where the majority of the entry gained at least 5 of the 6 marks and nearly half achieving full marks. The most common mistakes were using the force of 38 N in part (b), rather than the horizontal component calculated in part (a), and using the time for one length of the room but the work for 20 lengths of the room in part (c).

A variety of units, correct and incorrect, were seen. As examples of correct alternative units, N m and N m s^{-1} were frequently used for work and power respectively, and J s^{-1} was often used instead of W.

12 The photograph shows someone using a vacuum cleaner.



(a) A force of 38 N is applied at an angle of 60° to the horizontal. The vacuum cleaner moves across the floor at a constant speed.

Calculate the magnitude of the horizontal resistive force acting on the vacuum cleaner.

(2)

Horizontal = 38 cos (60°)

= 19 N

Resistive force = 19 N

(b) The room is 5.5 m long. The vacuum cleaner is pushed 20 times across the room to clean the carpet.

Calculate the work done against the horizontal resistive force.

(2)

WD = f × D   D = 5.5

f = 20 × 38

= 760   WD = 760 × 5.5

Work done = 4180 J

(c) Each 5.5 m length takes a time of 9.0 s.

Calculate the rate at which this work is done.

(2)

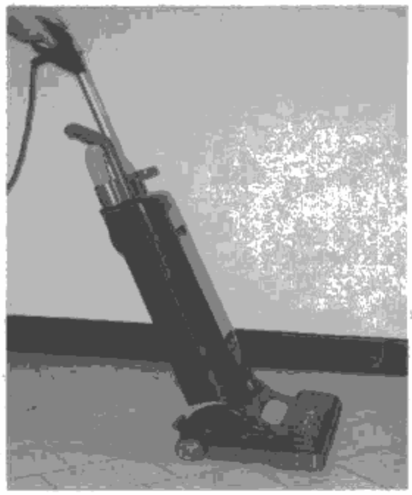
$E = \frac{P}{t} = \frac{4180}{9} = 464.4\ Js^{-1}$

Rate of work done = $464.4\ Js^{-1}$

ResultsPlus
Examiner Comments

This candidate calculates the relevant force, but then ignores it in part (b). In part (c) they use energy divided by time, but the time and the energy do not match.

12 The photograph shows someone using a vacuum cleaner.



(a) A force of 38 N is applied at an angle of 60° to the horizontal. The vacuum cleaner moves across the floor at a constant speed.

Calculate the magnitude of the horizontal resistive force acting on the vacuum cleaner.

(2)

See diagram R = resistive force FF = forward force

R = FF and FF = 38cos60 = 19 N

∴ R = 38cos60 = 19 N

Resistive force = 19 N

(b) The room is 5.5 m long. The vacuum cleaner is pushed 20 times across the room to clean the carpet.

Calculate the work done against the horizontal resistive force.

(2)

W = F × S 19 × (5.5 × 20) = 19 × 110 = 2090

Work done = 2090 W

(c) Each 5.5 m length takes a time of 9.0 s.

Calculate the rate at which this work is done.

(2)

$9 \times 20 = 180\,s$ Rate $= \frac{W}{t} = \frac{2090}{180} = 11.6\ Ws^{-1}$

Rate of work done = $11.6\ Ws^{-1}$

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Examiner Comments

In this response, the calculations are all correct. The candidate fails to get full marks in both part (b) and part (c), however, because the units are incorrect.

Question 13

This was a low scoring question, with half gaining only 1 mark, and most of the rest getting 2 out of 4. The candidates appeared to be answering a different question to the one on the paper and described a method using two light gates instead of the single gate shown. They frequently also gave details of how to calculate speed, but the question only asked for details of the required measurements. When candidates described the experiment shown they usually got a mark for describing how time could be measured, but neglected to mention the use of a ruler to find the length – often referring to 'known length' but not saying how it was known. Candidates often treat ICT methods as a 'black box' which gives the correct result for anything they need to know without requiring specific intervention on their own part.

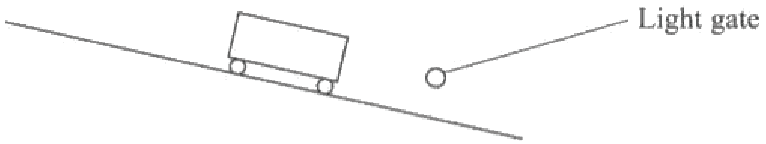
The most common mark awarded was for writing about reaction time, but in the rest of their discussion they usually went no further than to contrast this with a computer's lack of reaction time, which was not sufficient for a second mark. They rarely mentioned that reaction time could vary, either for the same person on different occasions or between people.

13 A student is required to measure the speed of a trolley rolling down a slope. This could be done using a ruler and stopwatch but the student prefers a method using ICT.

(a) The student uses a light gate as shown in the diagram.

Describe how the student obtains the measurements needed to calculate speed.

(2)



The student would use two light gates and put them a set distance apart, then when the two light gates are activated the time between them is known so the equation $v = \frac{s}{t}$ can be used to calullate time.

(b) The student thinks that the stopwatch method is less reliable than the ICT method.

Discuss what makes using a stopwatch less reliable.

(2)

It is less reliable as it ~~means~~ relies on the holders reflexes which may not accurately take the measurements. Also most stopwatches only go to milliseconds whereas computers can be far more accurate.

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Examiner Comments

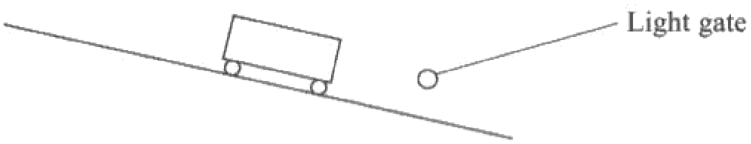
The instruction refers the candidates to the diagram, but here an additional light gate has been conjured up. There is reference to a set distance, but not how the distance is measured, which is what is asked for.
In part (b) reaction time is referred to, but not the way this can vary.

(13) A student is required to measure the speed of a trolley rolling down a slope. This could be done using a ruler and stopwatch but the student prefers a method using ICT.

(a) The student uses a light gate as shown in the diagram.

Describe how the student obtains the measurements needed to calculate speed.

(2)



Data logger attached to light gate. Car of known length passes through light gate. Sensor can find speed by ~~[illegible]~~ $s = \frac{d}{t}$. d = ~~speed~~ length of card, t = time light is blocked.

(b) The student thinks that the stopwatch method is less reliable than the ICT method.

Discuss what makes using a stopwatch less reliable.

(2)

Measurements using a stopwatch are less reliable because the stopwatch is manually controlled by a human. The time measured will be affected by the person's reaction time which would vary with each trial and is different for every person.

(Total for Question 13 = 4 marks)

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Examiner Comments

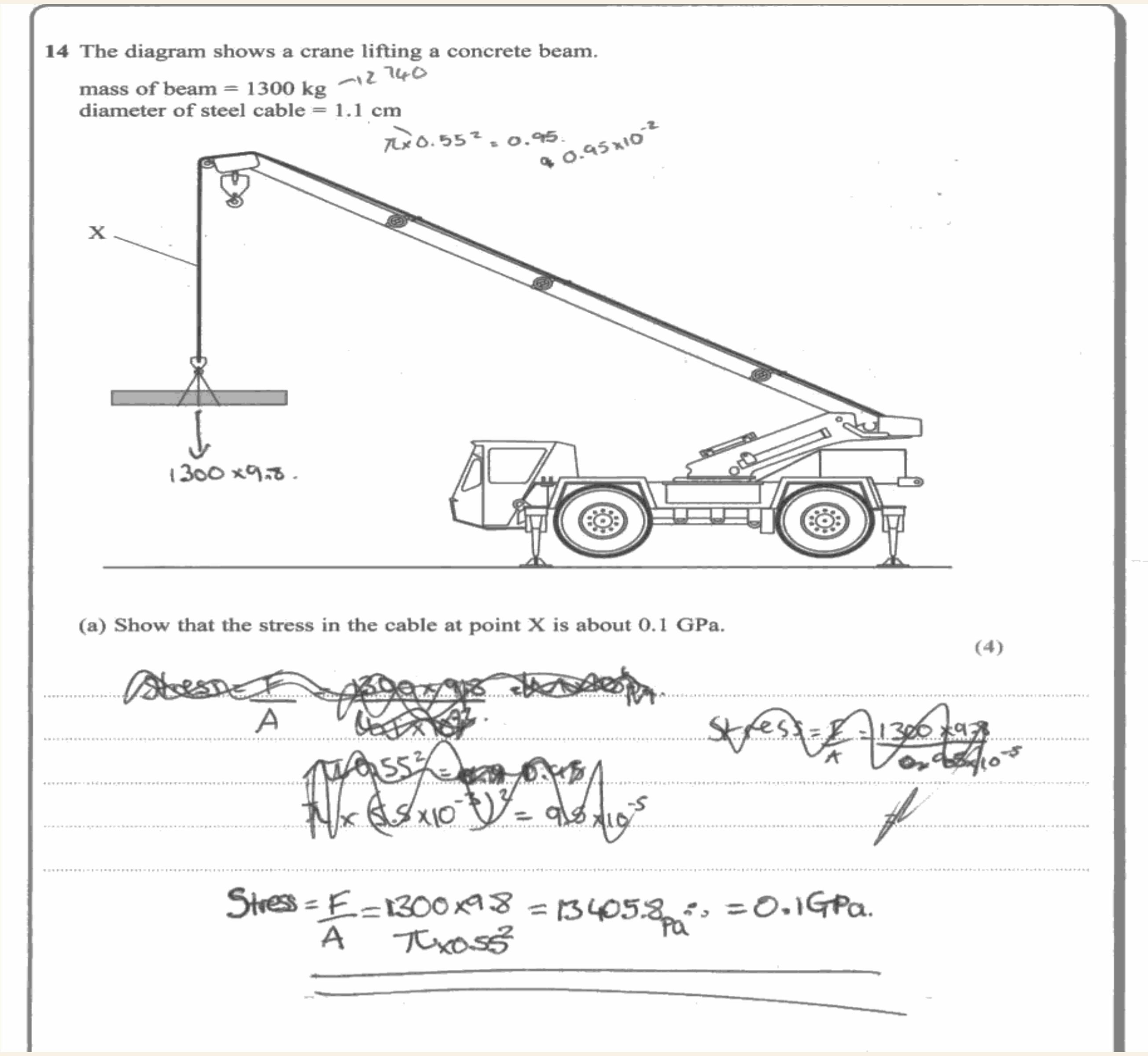
This answer refers to the correct time and length using the single light gate shown, but still does not say how the length would be measured.
The variation in reaction time is discussed.

Question 14 (a) (b)

The calculations in parts (a) and (b) were relatively straightforward, with a majority being awarded at least 6 of the 7 available marks and nearly half getting a full score. Candidates sometimes experienced difficulty with powers of 10, with GPa and also with cm when calculating area. Candidates who used standard form throughout the calculations rarely had a problem.

In part (a) a small minority used mass instead of weight and tried to disguise the disparity in their answer. A very small number used g = 10 N kg^{-1}. There were infrequent errors with the calculation of area, the most common being the failure to divide the diameter by 2.

In part (b) candidates rarely failed to assemble a full equation for the Young modulus from the given equations for stress and strain, but some had difficulties with the require algebraic manipulation to obtain the extension.



14 The diagram shows a crane lifting a concrete beam.

mass of beam = 1300 kg

diameter of steel cable = 1.1 cm

(a) Show that the stress in the cable at point X is about 0.1 GPa.

(4)

(b) The original length of the cable with no load is 15 m.

Calculate its extension when lifting the beam.

Young modulus for steel = 195 GPa

(3)

$E = \frac{\text{Stress}}{\text{Strain}} = 195 = \frac{0.1}{\text{Strain}}$ $\quad \text{Strain} = \frac{0.1}{195} = 5.1\times10^{-4}$

$\text{Strain} = \frac{\Delta x}{x} \Rightarrow 5.1\times10^{-4} = \frac{\Delta x}{15}$

$\Delta x = 5.1\times10^{-4}\times 15$
$= 7.65\times10^{-3}$

Extension = 7.65 m

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Examiner Comments

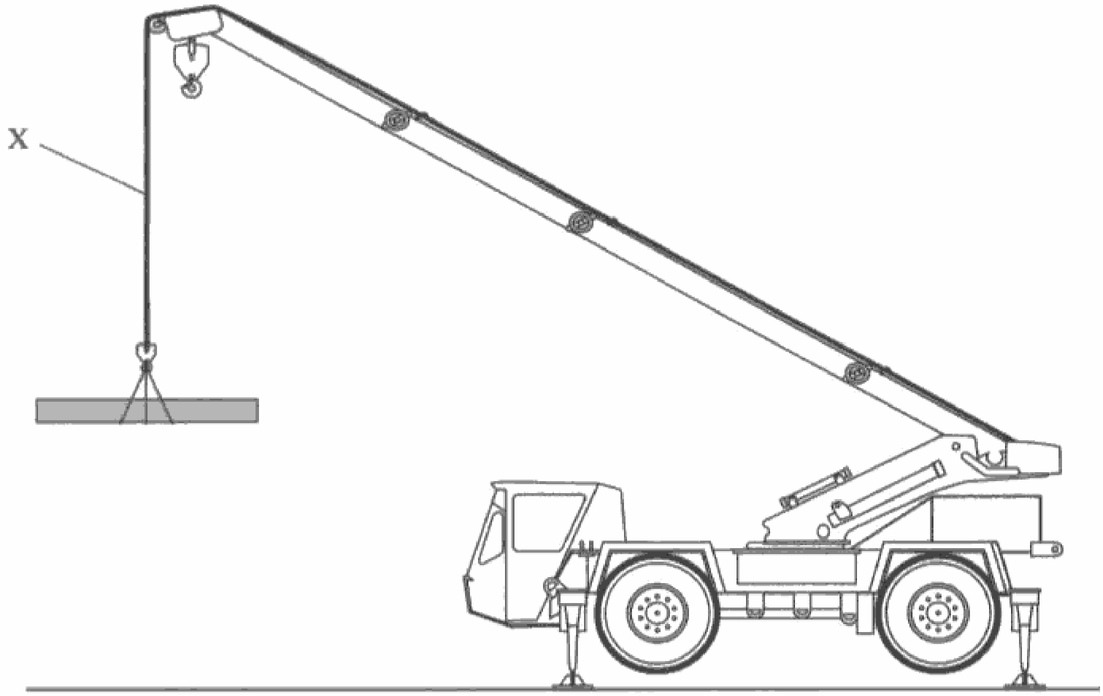
This response shows both unit problems referred to on previous page. The radius has been left as cm, an answer of 13 kPa has become 0.1 GPa and 7.65 x 10^{-3} has become 7.65 m.

ResultsPlus
Examiner Tip

Be sure to remember all the standard prefixes for units from 10^{-9} to 10^{9}, as well as centi.

14 The diagram shows a crane lifting a concrete beam.

mass of beam = 1300 kg
diameter of steel cable = 1.1 cm



(a) Show that the stress in the cable at point X is about 0.1 GPa.

(4)

$\sigma = f/a$

$\sigma = 1300/\pi r^2$

$\sigma = 1300/\pi \times 0.0055^2$

$\sigma = 1300/0.000095$

$\sigma = 13684210.53$

1.3×10^7

(b) The original length of the cable with no load is 15 m.

Calculate its extension when lifting the beam.

Young modulus for steel = 195 GPa

(3)

$E = \sigma / \epsilon$

$\epsilon \times E = \sigma$

$\epsilon = \frac{\sigma}{E}$ $\quad \frac{0.1}{195} = \epsilon$

$0.0005 = \epsilon$

$\epsilon = \frac{\Delta x}{x}$

$\epsilon = 0.0005 = \frac{\Delta x}{15}$

$\Delta x = 7.5 \times 10^{-3}$

0.0075×1000

Extension = 7.5m

ResultsPlus

Examiner Comments

In examples such as this, candidates attempted to find stress from mass / area instead of force / area. This may be another example of confusion between mass and weight.

Question 14 (c)

Only about a fifth of the candidates made a relevant suggestion for part (c), most of them appearing to think that the single piece of steel referred to would be the size of one of the strands in the cable and making the observation that a greater number of strands would be much stronger.

(c) The steel cable consists of six strands each made of thirty seven wires.

Suggest why this is preferred to a single piece of steel.

(1)

This means that there is a larger overall surface area meaning the there is a lower stress on the cable overall as stress = $\frac{F}{A}$

(Total for Question 14 = 8 marks)

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Examiner Comments

Candidates have already completed a calculation for a given set of dimensions as if for a single piece of steel and are now told that the cable is made of smaller parts, but many imagined that they were comparing 1 of these 222 strands with the whole cable.

Although the answer is incorrect, note that this candidate also refers to surface area instead of cross-sectional area.

(c) The steel cable consists of six strands each made of thirty seven wires.

Suggest why this is preferred to a single piece of steel.

(1)

This ~~overall~~ makes the cable relatively flexible in order to store it on the crane. If ~~the same~~ one wire breaks it is also still possible that the other 36 wires are intact and secure the load.

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Examiner Comments

This answer includes both of the points commonly given the mark for this question.

Question 15

All candidates had an idea of this procedure in outline, but they did not all give sufficient detail in their answers. Even so, two thirds gained at least 5 marks for their answer. Most set out their answer in a logical sequence, starting with how the apparatus would be set up, often with a diagram, then detailing the measurements, and concluding with the method of calculation of the Young modulus.

Candidates who described a method of obtaining a value from a single set of readings lost marks for not explaining how to vary the force and for not using a graph. Other candidates described a graph but did not say how to use it to find the Young modulus. Some candidates described the measurements they needed to take but did not say how it would be done, for example mentioning two lengths but not mentioning a ruler. The micrometer screw gauge was sometimes being used to measure area or radius rather than diameter.

The safety precaution presented no difficulty, but the suggested experimental precautions were not always procedures under a student’s control or they were valid precautions but were not explained. The most frequently mentioned was measuring the diameter more than once, but candidates did not always mention that the measurements should be in different positions and did not explain why it was necessary.

15 You are asked to find the Young modulus for a metal using a sample of wire.

*(a) Describe the apparatus you would use, the measurements you would take and explain how you would use them to determine the Young modulus for the metal.

(8)

First you would use a micrometer to measure the thickness of the wire in different places, you would then work out the average. You would then use a clamp stand and clamp to hold the wire in place.* You would then add weights to the wire at 10g at a time and measure the length and record. When all the results are obtained, you would use the orignal length and minus the length each 10g weight gave to get the extension. From this you would then plot a graph of weight and extension and use the gradient to finds youngs modulus.

* Then measure the length of the wire.

(b) State **one** safety precaution you would take.

(1)

wear safety goggles as the wire may break suddenly.

(c) Explain **one** experimental precaution you would take to ensure you obtain accurate results.

(2)

To obtain accurate results you would repeat the experiment and Plot the results on a another graph as it sould obtain the same youngs modulus if not repeat again.

(Total for Question 15 = 11 marks)

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Examiner Comments

This candidate has the outline of the class practical, but is lacking in some details and also shows imprecise language, using 'thickness' for 'diameter' and 'minus' for 'subtract'. The method for measuring length is not included and the detail of exactly how the graph is used is not given.
Part (c) is a typical response - to repeat the experiment - when candidates can't think of anything else.

15 You are asked to find the Young modulus for a metal using a sample of wire.

*(a) Describe the apparatus you would use, the measurements you would take and explain how you would use them to determine the Young modulus for the metal.

(8)

* Apparatus :-

We would need a wire, a Known mass, a ruler and micrometer. We set the wire horizontally on a table, and we hang the mass by the wire using

* Measurements :-

① we measure the diameter of the wire using micrometer from different ~~place~~ points to get the average and calculate (A).

② we measure the original length of the wire (before hanging the mass) by a ruler.

③ we calculat the force = w = mg.

④ we ~~cut~~ measure the extension of the wire after hanging the mass.

⑤ We calculate $E = \frac{\sigma}{\varepsilon} = \frac{F \cdot x}{A \cdot \Delta x}$

(b) State **one** safety precaution you would take.

(1)

we shouldn't stand below the mass because the wire may be cut.

(c) Explain **one** experimental precaution you would take to ensure you obtain accurate results.

(2)

taking the average radius of the wire after measuring it from different points.

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Examiner Comments

This response includes a diagram, but it does not include the detail, such as a clamp, included in diagrams which gained marks for candidates. Additional details of the measurements are included, but not of how it is set up. This does not mention a graphical mehod for determining the Young modulus.

A relevant precaution is included, but not the required explanation.

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Examiner Tip

When you are asked to 'explain' in the question, you will need to include a reason why something happens or is done.

Question 16 (a) (b)

This question showed that, when applying Newton's laws to describe and explain a novel situation, many candidates do not remember that Newton's first law refers to forces acting on a single body and Newton's third law refers to forces acting on two bodies.

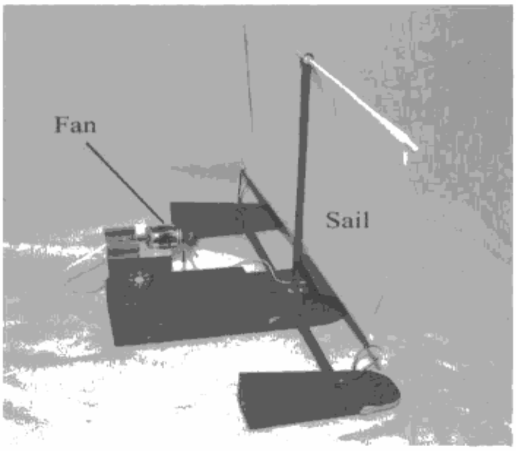
The candidate who demonstrated a correct understanding by getting the first part correct through simply changing the word order from 'force of the fan on the air' to 'force of the air on the fan' and included this in their diagram usually went on to score well in the rest of the question. This was, unfortunately, true for only a small minority. There were signs that candidates were not used to describing a force in this way and many sought to use a recognised name for the force, such as air resistance. Most got no marks for part (a) (i) and 1 mark for the vertical forces on the diagram. Even there, quite a few labelled the upwards force as 'reaction' rather than 'upthrust'.

In part (a) (iii), a sizeable proportion of the candidates applied Newton's first law in a relevant way, even though some did it in reverse order by assuming that, as there was no acceleration, there must be no resultant force. The problem for many was that they explained the lack of a resultant force by attempting to describe a Newton's third law pair of forces of equal magnitude. Another frequently mentioned pair of forces was the force of air on the sail equalling the force of the sail on the fan. Only one of these existed, but at least they were both forces on the boat.

As in previous years, errors in applying Newton's first law included reference to 'external' force but not 'resultant' force or even 'balanced' forces, as well as suggesting that a resultant force of zero means a body 'will not move' in any situation rather than stating that a body remains motionless if it is initially in a state of rest.

Explanations of what would happen in part (b) were rarely clear about the directions involved, and frequently described the boat starting to moving backwards or still remaining at rest.

16 The photograph shows a solar-powered model boat built by some technology students.



This boat has a solar-powered fan attached. The fan blows air towards the sail.

(a) The technology students explain to a physics student that the fan exerts a force on the air and the air then exerts an equal force on the sail to drive the boat forwards. Assume that these two forces are equal for the rest of the question.
The physics student tells them that according to Newton's laws of motion this will not work.

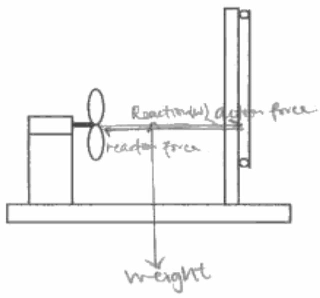
(i) Identify the Newton's third law force that pairs with the force of the fan on the air.

(1)

When there is a force acting on a body (air), ~~the body air~~ an opposite and equal reaction force would be exerted ~~on the body~~ ~~act on the~~ on the first body (fan).

(ii) The boat is placed in the water and the fan switched on. The boat remains at rest.
Add labelled arrows to the diagram below to show the **four** forces acting on the boat in this situation.

(2)



*(iii) Use Newton's laws of motion to explain why the boat does not move horizontally.

(3)

As shown on the graph, the action force exerted by the fan ~~acted~~ acts on the sail, the the sail exerts back a reaction force, by the ~~laws~~ Newton's third law of motion. The reaction ~~fo~~ force cancells out the action force ~~F~~ So the net force (horizontal) in the object is 0 and no horizontal movement is ~~observe~~ observed.

(b) The physics student suggests that the boat is more likely to work if the fan is reversed to point in the opposite direction.

Explain this suggestion.

(2)

The fan exerts ~~a~~ force on the air and the air exerts back a reaction force on the fan. Since they are not on the same body, the ~~fan~~ boat tends to move in the opposite direction to ~~the~~ the direction where the fan exerts force.

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Examiner Comments

This candidate identifies that a force acts on the fan, but does not say that it is exerted by the air.

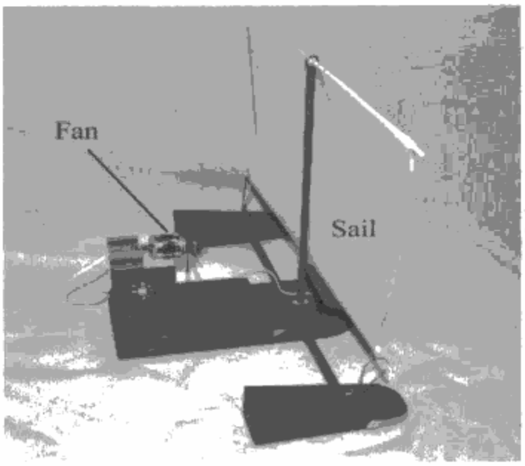
An upwards reaction force is used in the diagram instead of upthrust and the horizontal forces are not clear.

In part (iii) the candidate refers to the two forces in a Newton third law pair as cancelling out - missing the point that they act on separate bodies. This answer also says that with zero net force there is no movement instead of saying it will not start to move.

ResultsPlus
Examiner Tip

Remember - for Newton's third law, the forces act on different bodies and for Newton's first law the forces act on a single body.

16 The photograph shows a solar-powered model boat built by some technology students.



This boat has a solar-powered fan attached. The fan blows air towards the sail.

(a) The technology students explain to a physics student that the fan exerts a force on the air and the air then exerts an equal force on the sail to drive the boat forwards. Assume that these two forces are equal for the rest of the question. The physics student tells them that according to Newton's laws of motion this will not work.

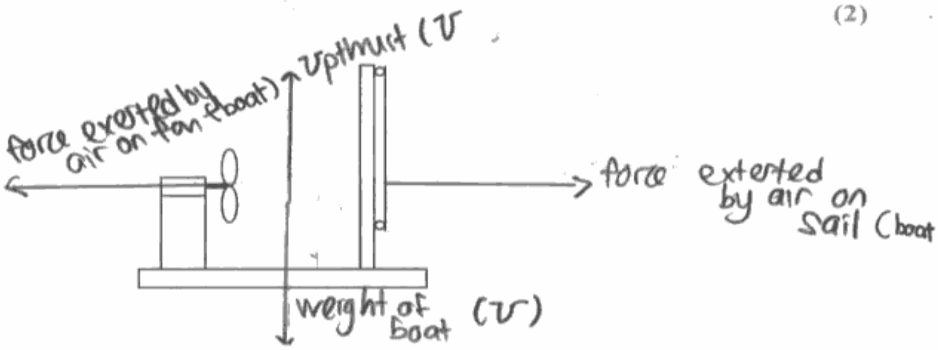
(i) Identify the Newton's third law force that pairs with the force of the fan on the air.

(1)

the ~~air~~ force exerted by the air on the fan.

(ii) The boat is placed in the water and the fan switched on. The boat remains at rest. Add labelled arrows to the diagram below to show the **four** forces acting on the boat in this situation.

(2)



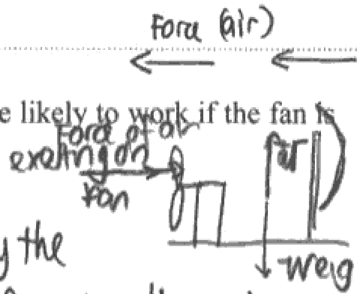
*(iii) Use Newton's laws of motion to explain why the boat does not move horizontally.

(3)

~~According to Newton's first~~, IN this case the force exerted by the air on the sail is at the opposite direction of the force exerted by the air on the fan, ~~therefore~~ these 2 forces are equal and opposite in direction, hence the resultant force at the ~~vertical~~ horizontal direction is 0. $\Sigma F = 0$ therefore the boat stays at rest according to Newton's First Law of motion.

(b) The physics student suggests that the boat is more likely to work if the fan is reversed to point in the opposite direction.

Explain this suggestion.



New diagram of forces not acting on the sail

(2)

If that is the case the force ~~of the~~ exerted by the fan on the air is reversed, and the air will ~~exerted~~ exert and equal and opposite force on the fan (boat) hence the resultant force forward is not zero, cause no other resistive forces $\therefore \Sigma F > 0$ $\Sigma F = ma$, hence the boat will move with a ~~constant~~ acceleration.

ResultsPlus
Examiner Comments

This is an example of a response gaining full marks, demonstrating that, once the diagram is correct, explaining the rest of the situation is much more straightforward.

Question 16 (c)

Part (c) was completed correctly by two thirds of the candidates, and about a third scored zero. Where there were problems, they were usually in rearranging the equation for density or with converting between grams and kilograms. A few made things a bit more complicated by including *g* in their calculations. It is perhaps being charitable to suggest that the rest realised *g* would cancel, but they didn't tend to use it in any case.

(c) Calculate the volume of water, in m^3, which must be displaced so that the boat will float.

mass of boat = 130 g = 0.13 kg
density of water = 1000 kg m^{-3}

(2)

Density = mass x volume

volume = $\frac{\text{density}}{\text{mass}} = \frac{1000}{0.13} = 7692.3$

Volume = 7692.3 m^3

ResultsPlus
Examiner Comments

The correct formula is given in the paper, so there is no reason to get it wrong.

ResultsPlus
Examiner Tip

Be realistic about how good you are at remembering equations and check them when you aren't sure. It will only take a few seconds and is better than losing all the marks.

(c) Calculate the volume of water, in m^3, which must be displaced so that the boat will float.

mass of boat = 130 g
density of water = $1000\ kg\ m^{-3}$

(2)

~~Upthrust = mass of water displayed~~ 130g = 130000

$Density = \frac{mass}{volume} = \frac{130 \times 10^3}{1000} = 130$

$Volume = \frac{mass}{density}$

Volume = $130 m^3$

(Total for Question 16 = 10 marks)

ResultsPlus
Examiner Comments

This is another example of conversion between units going wrong. Other candidates said 130 g = 1.3 kg.

ResultsPlus
Examiner Tip

Remember - 1 kg = 1000 g

Question 17 (a) (i)

It is a bit surprising that as many as 10% had a problem with the initial calculation, especially given the pattern in the table, but a few managed to multiply distance and time or have their decimal point go astray.

Temperature / °C	Time taken / s	Average speed / m s^{-1}
26.5	4.2	0.019
35.5	2.4	0.033
42.5	1.5	0.12
50.0	1.2	0.067
61.5	0.5	0.160

V=st·
0·08 1·5

(a) (i) The table shows the average speed of flow for four of the temperatures. Calculate the missing value and enter it in the table. The distance between the markers is 0.080 m.

(1)

V=st   0·080m × 1·5s = 0.12ms^{-1}

ResultsPlus

Examiner Comments

There were few errors in this question, but this is one which was sometimes seen. The pattern in the table should have shown that something was wrong.

The student records the following results.

Temperature / °C	Time taken / s	Average speed / m s^{-1}
26.5	4.2	0.019
35.5	2.4	0.033
42.5	1.5	0.533
50.0	1.2	0.067
61.5	0.5	0.160

(a) (i) The table shows the average speed of flow for four of the temperatures. Calculate the missing value and enter it in the table. The distance between the markers is 0.080 m.

(1)

$s = d/t$ $s =$ ~~[illegible]~~ 0.533 m s^{-1}

ResultsPlus
Examiner Comments

A few candidates were out by a power of 10, but, again, looking at the pattern in the table should have suggested that it was worth checking.

Question 17 (a) (ii-iii)

A surprising number mis-plotted the point, placing it precisely on 0.05 m s^{-1}, which is out of the half a square tolerance. Most drew a sensible curve missing at least one point, but those who drew a straight line ignoring the final point were also given credit. Those who tried to draw a curve passing through all of the points could not achieve a best fit line. Overall, few failed to get at least 1 mark for the graph and a great many got 2.

Most candidates observed that viscosity decreased with temperature, but they did not always refer to the results to justify this by reference to the increased speed.

The student records the following results.

Temperature / °C	Time taken / s	Average speed / m s^{-1}
26.5	4.2	0.019
35.5	2.4	0.033
42.5	1.5	0·053
50.0	1.2	0.067
61.5	0.5	0.160

(a) (i) The table shows the average speed of flow for four of the temperatures. Calculate the missing value and enter it in the table. The distance between the markers is 0.080 m.

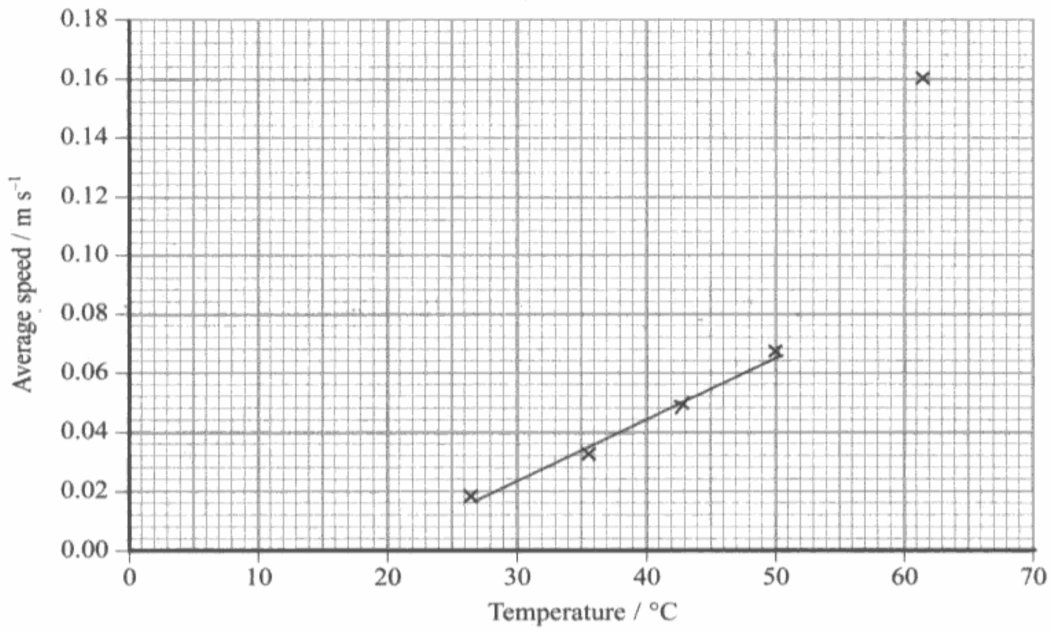
(1)

speed = $\frac{0·080}{1·5}$

= 0·053

(ii) Add this point to the graph below and draw a best-fit line for the student's data.

(2)



(iii) Use these results to explain how the viscosity of glycerol varies with temperature.

(2)

The viscosity of glycerol decreases as the temperature increases and vice-versa

ResultsPlus
Examiner Comments

This point has been plotted outside the half a square tolerance.
The variation of viscosity with temperature has been *described* but not *explained*, especially with reference to the results, as instructed.

ResultsPlus
Examiner Tip

Plot points as accurately as possible - not just to the nearest simple position. The allowance is only half a small square.

Make sure you take note of the command word in the question. Remember that if you aren't using a word like because, you probably aren't explaining.

The student records the following results.

Temperature / °C	Time taken / s	Average speed / m s^{-1}
26.5	4.2	0.019
35.5	2.4	0.033
42.5	1.5	0.053
50.0	1.2	0.067
61.5	0.5	0.160

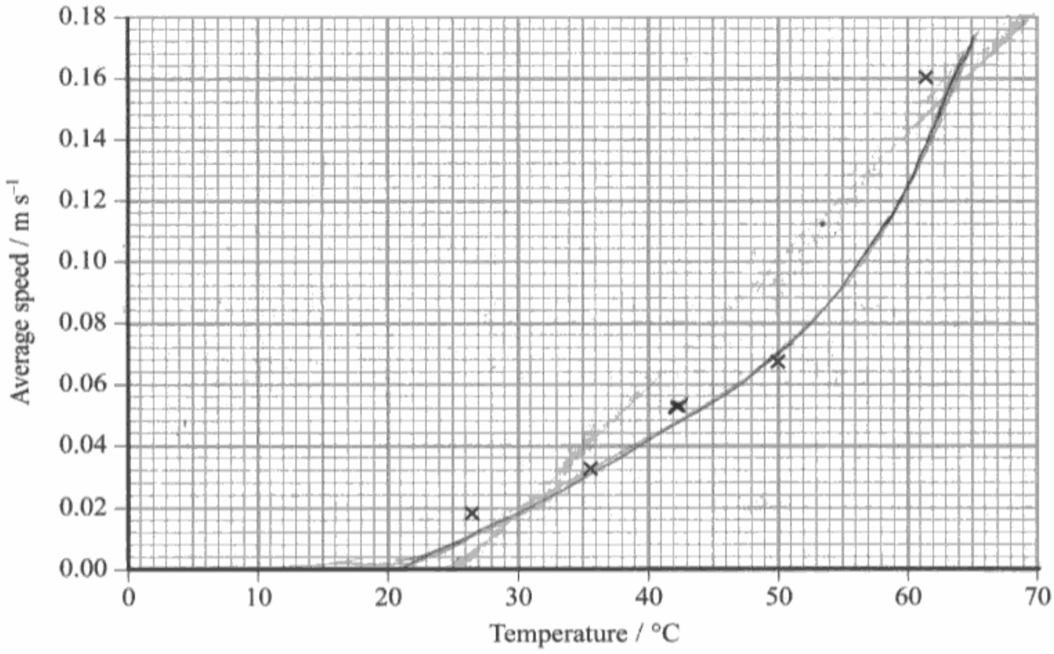
(a) (i) The table shows the average speed of flow for four of the temperatures. Calculate the missing value and enter it in the table. The distance between the markers is 0.080 m.

(1)

$s = \frac{d}{t} = \frac{0.08}{1.5} = 0.053\ ms^{-1}$

(ii) Add this point to the graph below and draw a best-fit line for the student's data.

(2)



(iii) Use these results to explain how the viscosity of glycerol varies with temperature.

(2)

the viscosity (measurement of how easy the fluid flows) varies because there is a drastic increase in the average speed, suggesting the ease of flow has increased, as the temperature increased.

ResultsPlus
Examiner Comments

The plot and graph both got the mark.
In this case the change in speed has been used as evidence for an answer, but there is no clear statement that *viscosity* has decreased.

Question 17 (b)

Despite candidates' obvious familiarity with describing laminar and turbulent flow and drawing both, quite a few candidates managed to drop one of these marks. The missing mark was most frequently for lack of precision in describing laminar flow. This was often just 'smooth' or there was reference to a constant velocity, rather than a constant velocity at a point. A constant velocity throughout a fluid misses the point of the description of lamina with increasing speeds from the edge to the centre and also precludes flow around a bend. Some diagrams for turbulent flow were unrealistic scribbles or sets of little curved arrows with no sense of how the liquid could actually go anywhere.

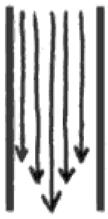
Candidates usually stated that turbulence would decrease the rate of flow, although they often attributed it to increased friction with the sides of the container. A lot of candidates have a fixed association of turbulent flow with high speed, some coming up with mutually opposing ideas of increased turbulence meaning the liquid was flowing at a high speed so there was more friction resulting in a slower flow.

(b) This experiment depends on the flow remaining laminar and not becoming turbulent.

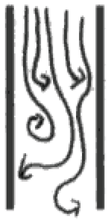
(i) Explain these **two** terms and complete the diagrams to illustrate each type of flow through a vertical tube.

(4)

laminar flow usually occurs at low speeds. Streams of fluid are moving in one direction. Stream toward the center is travelling fastest.



turbulent Very chaotic. Usually occurs at high speed. Streams of fluid are moving in lots of different directions.



(ii) Explain the effect turbulence would have on the rate of flow.

(2)

Turbulence would decrease the rate of flow, as there would be masses of friction between streams slowing it dam.

ResultsPlus
Examiner Comments

The diagrams are fine, but the descriptions both lack precision and detail. General references to direction are not sufficient because laminar flow around a bend is quite possible.

The answer to part (ii) was a relatively rare example of one gaining both marks.

(b) This experiment depends on the flow remaining laminar and not becoming turbulent.

(i) Explain these **two** terms and complete the diagrams to illustrate each type of flow through a vertical tube.

(4)

laminar flow that was parallel streamlines with no abrupt change of direction

turbulent Flow that has abrupt changes of speed and direction, resulting in eddies.

(ii) Explain the effect turbulence would have on the rate of flow.

(2)

The more turbulence there is, the slower the rate of flow.

ResultsPlus

Examiner Comments

Part (i) is satisfactory in all aspects, but in part (ii) the effect is described but not explained.

Question 17 (c)

In the final part, very few addressed the idea that this point was the *most likely* to be incorrect. The best answers tended to be those that pointed out that a candidate would have a shorter time to react to the faster moving glycerol, but they rarely referred to the reaction time as a percentage of the measured time.

(c) The student thinks that the value measured for 61.5 °C is the most likely point to be incorrect based on the technique described at the start of the question.

Explain why this should be so.

(2)

The value measured at 61.5°C appears to be an anomaly as it doesn't go along with the pattern and isn't near the line of best fit

ResultsPlus
Examiner Comments

This answer attempts to identify the value as the most likely to be incorrect based on the results, and on a particular interpretation of the results, rather than on the technique as stated in the question.

ResultsPlus
Examiner Tip

A best fit line does not have to be a straight line.

(c) The student thinks that the value measured for 61.5 °C is the most likely point to be incorrect based on the technique described at the start of the question.

Explain why this should be so.

(2)

Human error, because of the reaction time to use the stop watch. They ~~distance known distance~~ could have repeated the experiment if the results show anomalies, to make the results reliable.

ResultsPlus

Examiner Comments

This response refers to the technique and identifies reaction time as a factor, but that would apply to all the results and this does not say why it is the *most likely*.

Question 18 (a-d)

Most candidates scored up to between 4 and 6 for the first three calculations in this question, possibly getting a sensible assumption, and then failed to score more than the occasional mark for the time of flight in the rest.

Using the gradient of the graph presented little difficulty, although a fair few candidates chose a ridiculously small triangle (e.g. 1.0 N / 0.1 cm) and got an answer of 1000 N m^{-1}, which was that stated in the question. They failed to show the required extra significant figure for the mark and were outside the required range.

Many candidates calculated the energy correctly by calculating force first or by using $\frac{1}{2}kx^2$, but some tried to use the area under the graph or values from the graph and so were an order of magnitude out in both force and extension.

Even where candidates went wrong with energy, they sensibly used the 'show that' value of 1 J and correctly found the speed. There were some errors using grams or with the square root.

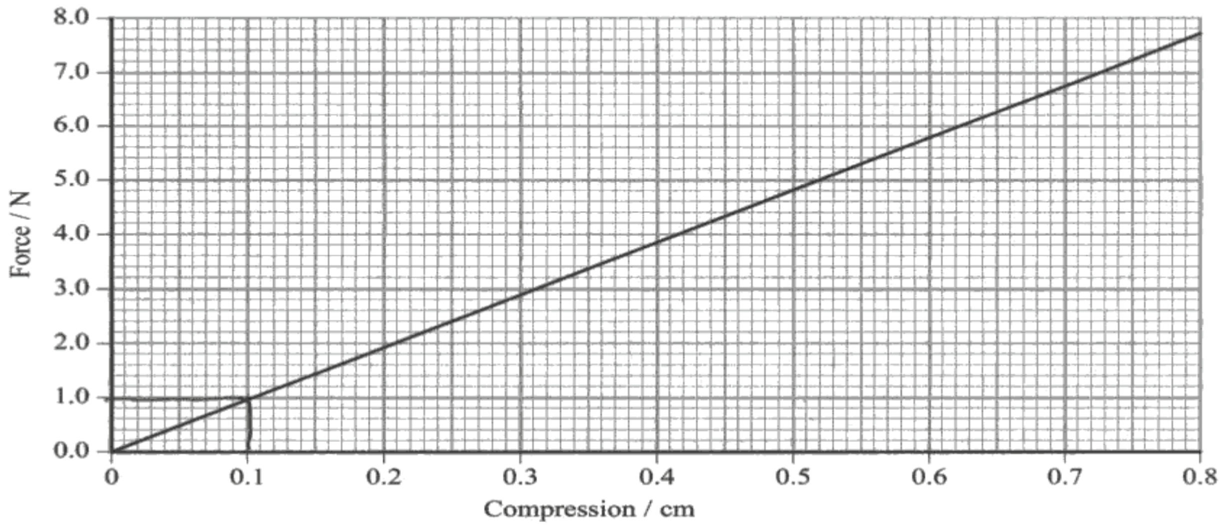
The expected assumption was a statement of conservation of energy applied to the calculation, but a more frequent answer was related to air resistance, which was only of major relevance after the launch of the device. Lack of friction in the mechanism of the gun was seen fairly often and was acceptable.

In six sittings of this module examination, this was the fifth projectile calculation. Candidates have found questions requiring the calculation of the range for a projectile launched at an angle to the horizontal the easiest, being well-practised in this approach, although many still encounter some difficulties. This is the second involving a horizontal launch (see January 2010 for the other), and candidates seemed far less familiar with this trajectory. Perhaps because they did not have to calculate components, most failed to establish the relevant *suvat* quantities for horizontal and vertical motion and treat them independently until combining the calculated velocities at the end. They frequently treated 15 m s^{-1} as a vertical initial velocity or, when they identified it as the initial horizontal velocity, still applied an acceleration of 9.81 m s^{-2}. Others treated 3.0 m as a vertical distance. Even for those who divided the distance by the speed to find time, it was not always apparent that this was part of a planned calculation leading on to finding the vertical component of velocity.

Some good answers had a sketch of the trajectory and separated lists for vertical and horizontal motion, which made it easier for the candidates to complete the calculation methodically. Some candidates took 20cm from part (ii), assumed a straight line flight and applied trigonometrical functions to the triangle they produced, even though it sometimes involved mixing speed and distance for the two sides.

The situation in part (d) (ii) was not clear to most candidates, a number calculating the circumference or even the area of the disc. It was again the case that a simple diagram made the situation much clearer.

A force-compression graph for the spring is shown.



(a) Show that the force constant for the spring is about 1000 N m^{-1}.

(2)

$k = \frac{F}{x} = \frac{1\ \text{N}}{0.001\ \text{m}} = 1000\ \text{N m}^{-1}$

ResultsPlus

Examiner Comments

This uses a very small triangle for gradient in part (a) and does not produce sufficient significant figures.

ResultsPlus

Examiner Tip

Always use the biggest possible traingle for gradients. In 'show that' questions you are expected to show an extra significant figure.

(b) The spring is 6.3 cm long. When it is compressed in the gun, the length of the spring is reduced to 1.6 cm.

Assuming that the spring obeys Hooke's law throughout the compression, show that the energy stored in the spring before firing the gun is about 1 J.

(2)

Energy stored = $\frac{1}{2} F x$ = ~~[crossed out]~~

$= \frac{1}{2} \times 7.7 \times 0.8 \times 10^{-2}$

$= 0.0308$ J

ResultsPlus
Examiner Comments

This uses the correct formula for energy in part (b), but uses values from the graph only despite the extension referred to falling well outside its range.

(c) The disc and spring have a combined mass of 9.4 g.

(i) Show that the maximum speed at which they can be fired is about 15 m s^{-1}.

(2)

$s = ut + \frac{1}{2}at^2$ $(u = 0)$ so $s = \frac{1}{2}at^2$

$F = ma$ so $s = \frac{1}{2}\frac{F}{m} \times t^2$ $s = \frac{1}{2} \times \frac{1000}{9.4\times10^{-3}} \times$

$a = F/m$

(ii) State an assumption that you have made.

(1)

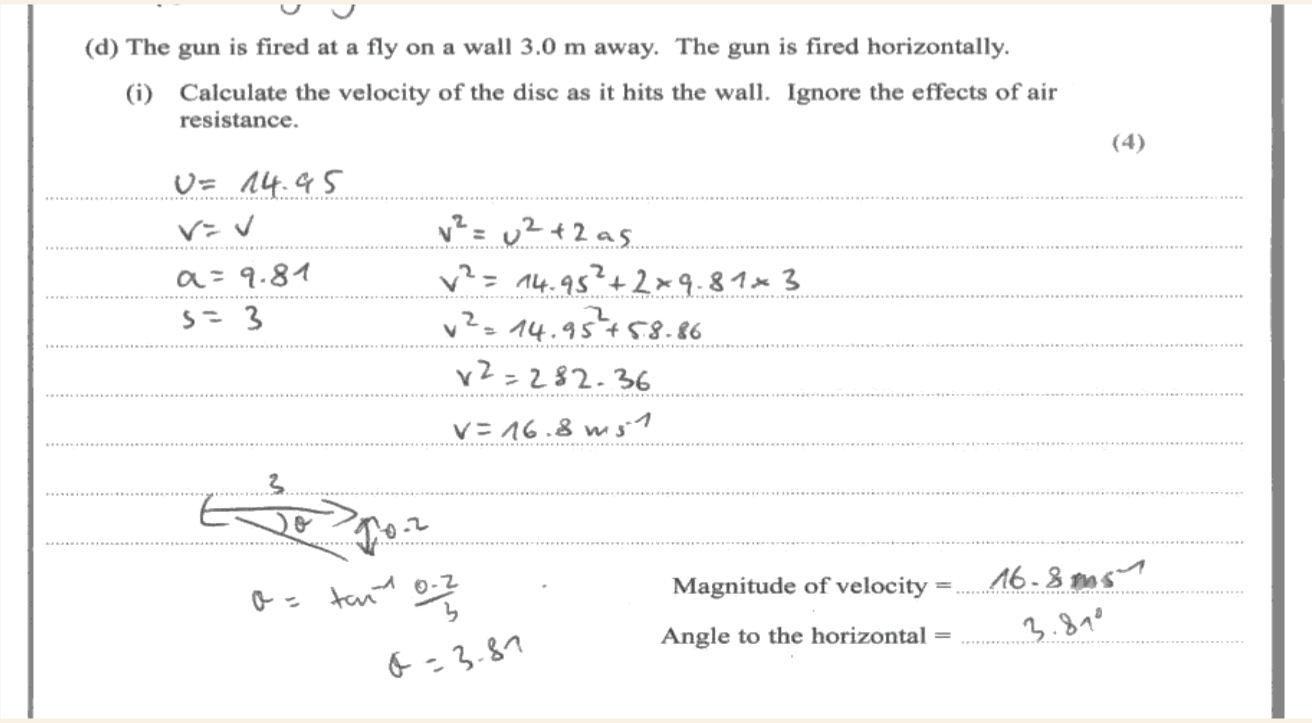
we have made that the air resistance is 0.

ResultsPlus
Examiner Comments

This candidate attempts to use force to find acceleration and then speed, but stops when the lack of important data makes it impossible. Candidates should be prepared to meet conservation of energy problems.
In part (ii), air resistance will only have a significant effect after the launch.

ResultsPlus
Examiner Tip

Practise questions involving conservation of energy and be aware of the forms involved in this module - kinetic energy, gravitational potential energy and elastic potential energy.



(d) The gun is fired at a fly on a wall 3.0 m away. The gun is fired horizontally.

(i) Calculate the velocity of the disc as it hits the wall. Ignore the effects of air resistance.

(4)

u = 14.95

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

a = 9.81 $v^2 = 14.95^2 + 2 \times 9.81 \times 3$

s = 3 $v^2 = 14.95^2 + 58.86$

$v^2 = 282.36$

$v = 16.8\ ms^{-1}$

$\theta = \tan^{-1} \frac{0.2}{3}$

$\theta = 3.81$

Magnitude of velocity = $16.8\ ms^{-1}$

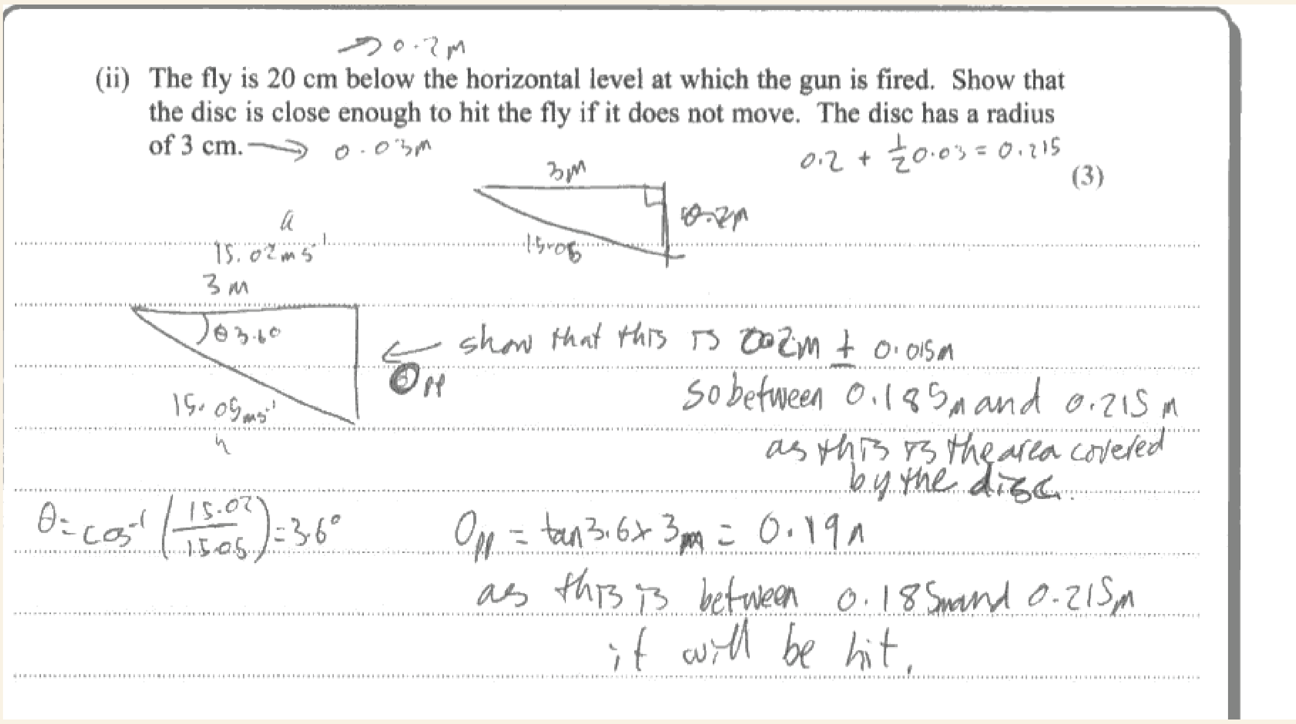
Angle to the horizontal = 3.81°

ResultsPlus Examiner Comments

This is a typical response showing confusion between horizontal and vertical motion. In this case a horizontal initial velocity and distance are subject to a vertical acceleration. The angle is then found from the vertical drop (from part (ii)) and the horizontal distance. Others used the horizontal distance of 3 m but with an initial vertical velocity of zero.

ResultsPlus Examiner Tip

Clearly identify horizontal and vertical quantities in projectile problems. For the horizontal component the acceleration is assumed to be zero and for the vertical component the acceleration is *g*. You will usually start by finding time, so practise doing this for launch angles to the horizontal between zero and 90 degrees.



(ii) The fly is 20 cm below the horizontal level at which the gun is fired. Show that the disc is close enough to hit the fly if it does not move. The disc has a radius of 3 cm. **(3)**

ResultsPlus

Examiner Comments

In this answer the result is calculated by assuming the flight path is a straight line, and even then the triangles contain a mixture of distance and speed for the lengths of the sides. Radius has also been misinterpreted because it is halved to make the comparison.

Question 18 (e)

In the final part, just over half gained the mark. Those who didn't sometimes described properties relating to the properties of the disc's material, which wouldn't have been affected by the shape. More worrying were those who stated that a solid disc would have a greater mass and therefore experience a greater gravitational force, or be 'heavier', making it fall more quickly. Some revision of the 'Galileo experiment' may be needed here.

Despite this question simply requiring a suggestion, such as 'less air resistance', for only one mark, a great many candidates answered it as if they had been asked to *explain* the advantage. They gave very good, detailed and logically set out explanations, often in three stages. It was most encouraging to read these and, as it was the last question, they clearly did not suffer a time penalty for spending longer than intended on this part. It would probably be beneficial, however, to review the command words such as *state*, *describe*, *explain* etc before the next examination.

(e) Suggest an advantage of the disc used over a solid disc.

(1)

The disc is lighter than a solid disc so it won't be affected as much by forces such as weight.

ResultsPlus

Examiner Comments

A large proportion seem to think that, after launching at the same speed, objects with greater mass will travel a smaller distance because of their greater weight. The use of the terms lighter and heavier is imprecise in this context as it may be intended to refer to mass but is usually interpreted via the force exerted by an object on a person holding it and is therefore more related to weight.

ResultsPlus

Examiner Tip

Remeber Galileo. If air resistance and upthrust are neglected, all objects are subject to the same vertical acceleration.

(e) Suggest an advantage of the disc used over a solid disc.

(1)

A disc is malleable, a solid disc would be brittle.

ResultsPlus
Examiner Comments

There is no reason to suppose that two discs made of the same material would differ in this way.

(e) Suggest an advantage of the disc used over a solid disc.

(1)

Smaller surface area and ∴ less air resistance ∴ travels faster for longer.

ResultsPlus
Examiner Comments

This is a typical response for this question. It not only suggests an advantage but explains it.

Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx