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Examiners' Report
June 2016

GCE Physics 8PH0 01

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June 2016

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Introduction

This is the first time that the Pearson Edexcel AS paper 8PH0_01, Core Physics I, has been sat by candidates. Section A of the paper is worth 60 marks and consists of 8 multiple choice questions. This is followed by 6 questions of increasing length comprising of short open, open-response, calculation and extended writing style questions. Section A examines material from the topics Working as a Physicist, Mechanics and Electric Circuits. Section B is worth 20 marks on this paper and examines material from the whole AS specification. It contains two questions worth 11 and 9 marks including a data analysis question based on a core practical (4).

This paper enabled candidates of all abilities to apply their knowledge to a variety of styles of examination questions. Many candidates showed a good progression from GCSE to AS level, with prior knowledge extended and new concepts taught and understood well. Some candidates found the length of some of the calculations to be challenging, often missing out key steps preventing them from scoring more than one or two marks for the interim steps. Some questions were not answered as well as would have been expected by many candidates; this was particularly evident in the open response and the extended writing questions. Candidates that had a sound understanding of the physics involved did not always demonstrate this in their responses due to a lack of precision when applying their knowledge to the context, repeating information given in the stem rather than adding to it and often missing exactly what the question was actually asking.

However, candidates from across all ability ranges always managed to score some marks within these questions.

A proportion of candidates lacked expertise in some areas of basic physics including potential dividers, Newton's laws and moments. Some basic maths skills such as trigonometry and calculation of basic area also appeared to be challenging for many. Power of 10 errors were common and there was not always consideration for the units quoted in the question.

For the calculations the presentation was clear when the correct answer was obtained. There were still many instances of poor presentation, with missing subjects on the left hand side to an equation, missing equals signs and lines of working not strictly following on.

In general, time was not an issue at all with this paper with the vast majority of candidates completing all questions on the paper.

Section A - Multiple choice questions 1-8

For the majority of candidates their performance in the multiple choice items was good and often better than in the rest of section A and section B, with a mean score of 6. A grade candidates tended to score a minimum of 7 whilst E grade candidates scored at a maximum of 4 marks. However, for many candidates the performance with these items was not indicative of their overall performance in the exam.

Question	Subject	Percentage of candidates who answered correctly	Most common incorrect response
1	Kinematics	87	A
2	Momentum	43	C
3	Relationship between the potential difference across a wire and the length of the wire	59	C and D
4	Definition of electromotive force	59	C
5	Units	67	A
6	Displacement-time and velocity-time graphs	69	D
7	Vectors	77	C
8	Potential difference -current graph for a diode	39	D

Question 1

A common risk to candidates with the first question on the paper is that it is rushed and not given the appropriate amount of time. This question required the candidates to think about the effect on an athlete's running time of any acceleration and to consider the difference between instantaneous, maximum and average speeds. The average speed will be affected by any accelerations and the resulting maximum or instantaneous velocities, but considering time = total distance/average speed, it is this value that will ultimately determine the time taken.

Question 2

A fair proportion of candidates chose the change in momentum of the ball without considering the direction, i.e. initial−final momentum, response A, 0.60 kg m s^{-1}. A more significant number chose response C, the final momentum of the ball (−0.30 kg m s^{-1}). Only those realising that the change in momentum was the final momentum – the initial momentum scored the mark.

Question 3

This question examined specification point 42, understanding how the potential difference along a uniform current-carrying wire varies with the distance along it. Candidates were expected to appreciate that the relationship is one of direct proportion and identify the only graph with an increasing line of constant gradient. Therefore, although answered well by most E grade and above candidates, the incorrect responses of C and D were very surprising as this question was recall only.

Question 4

Again, another recall question (specification point 45), however the most common incorrect response of C identifies that some candidates were confusing the definition of potential difference (across a component) with that of electromotive force. A fair number of candidates also chose response B, the definition of electric field strength, a concept they most likely would not have come across yet.

Question 5

This question was answered well with two thirds of candidates scoring the mark. Given that response A was the most common incorrect answer leads to the conclusion that some candidates missed the word 'base' in the stem of the question, opting to choose the SI derived unit of N instead of the base unit for force. Terms such as base, derived, quantity and units are often missed when candidates see 'SI' written in the stem, often opting for the first seemingly appropriate response rather than the correct term.

Question 6

The candidates had to use the two graphs as clues as to the context of the ball's motion. The most common incorrect response of D identifies that most candidates realised that, as the velocity was decreasing, the ball had to be rolling up a slope. The difference between response C and response D is the direction of the displacement. Both involved a ball rolling down a slope, increasing its velocity, but as the displacement continued to increase, the ball had to continue to move away from the initial position. Therefore, only response C had the ball continuing to move away.

Question 7

This vector question was answered well by most candidates. They were given the direction of one of the forces on the plane and told the direction that the plane should move, i.e. the resultant due east. They were therefore required to select the correct direction that the plane should point, i.e. the other contributing vector to the resultant direction. Candidates tend to find the construction of vector diagrams challenging, and as no actual diagram was required here, an element of common sense could be used to select the correct direction.

Question 8

While current - potential difference curves for diodes and other components will have been covered at GCSE for many candidates, the axes provided the biggest stumbling blocks for some, with many failing to observe that this was not the traditional IV graph, but had the potential difference plotted on the vertical axis. Only the more able candidates noticed this and selected the correctly orientated graph of C instead of D.

Question 9

Most candidates managed to score 1 mark for the calculation of the power of the motor. However, most, on seeing the mass and velocity of the block, chose to calculate the kinetic energy. Then, without any consideration of the physical quantities calculation, they proceeded to use the power and kinetic energy together in the efficiency equation scoring a maximum of 1 mark. A few identified that they would have to use a power over a power, or an energy over an energy, to determine the efficiency and then proceeded to use a nominal time of 1 second or a calculated time in order to do this.

Some candidates were heading in the correct direction and attempted a calculation of the gravitational potential energy, but 'g' was often omitted.

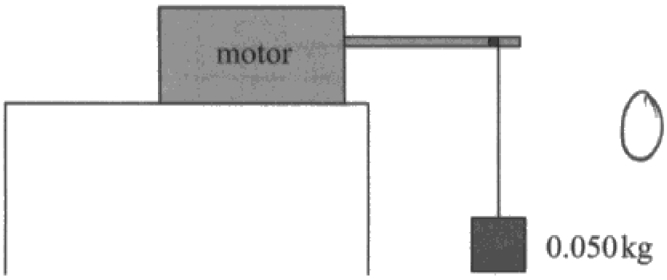
Those candidates that successfully scored full marks were rarely seen to consider the time, dividing what they thought to be the GPE by the electrical power. The difference between energy and power needs to be emphasised and although they can use both in efficiency calculations, they must not use a combination of the two quantities. In general, candidates also need to experience the idea of power in physical situations and not just electrical, as the concept of the power developed by the block as its height increased (every second) was missed by most.

A typical response scoring 1 mark.

9 A motor lifts a block of mass 0.050 kg at a constant velocity of 0.40 m s^{-1}.

The current in the motor is 85 mA and the potential difference across it is 3.0 V.

×10⁻³



0.05×9.81
$= 0.4905$

Calculate the efficiency of the motor.

(3)

$P = VI$ $P = 3 \times 85 \times 10^{-3}$
$= 0.255$

$GPE = mg\Delta h$

$\frac{4 \times 10^{-3}}{0.255} = 1.5$

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

$\frac{1}{2}\, 0.05 \times 0.40^2 = 4 \times 10^{-3}$

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Examiner Comments

The candidate has seen the quantities given in the question and automatically calculated the electrical power supplied by the motor and the kinetic energy of the block.

Without any consideration that one was a power and one was an energy they then went on to use the efficiency equation.

This response only scored the first mark for use of P = VI

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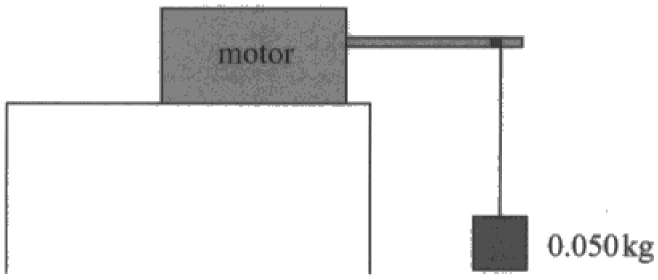
Examiner Tip

Although the efficiency equation can be used with either power or energy, these two quantities must not be used together. In this case as the block was rising at a steady speed and the electrical energy was enabling the block to rise at a speed of 0.40 m s^{-1} or it rose 0.40 m every second. The GPE gained every second was 0.050 x 9.81 x 0.40 = 0.1962 J. Therefore the power developed by the block as it rose was 0.1962 W. This could have then been used with the electrical power supplied to the motor to calculate the efficiency of the motor.

A good response scoring all 3 marks.

9 A motor lifts a block of mass 0.050 kg at a constant velocity of 0.40 m s^{-1}.

The current in the motor is 85 mA and the potential difference across it is 3.0 V.



Calculate the efficiency of the motor.

(3)

Power input = IV
= 85 × 10^{-3} × 3
= 0.255 W

Power output = WD / T

In one second, block has lifted 0.4 m

WD = mgh
= 0.05 × 9.81 × 0.4
= 0.1962

P = WD / T
= 0.1962 / 1
= 0.1962 W

Efficiency = 0.1962 / 0.255
= 0.769

Efficiency of the motor = 0.769

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Examiner Comments
Electrical power and the GPE were calculated and then divided by 1 second to determine the power developed by the block as it rose. The candidate then divided correctly the two powers to obtain the efficiency.

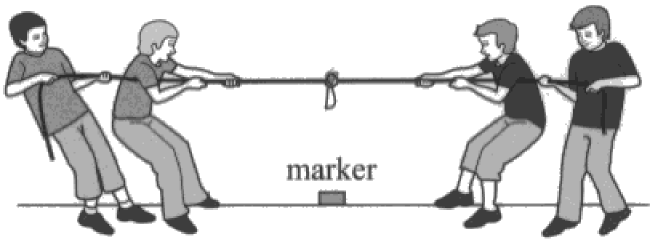
Question 10 (a)

The free-body diagram required the candidates to isolate the child from the rope and from team B and to only describe the forces acting on the child. In comparison to part (b) both teams were stationary and many candidates could not identify the source of the force applied to the left of the child, assuming it must have been due to a pulling force of either team.

Most candidates could correctly label the weight and usually gave a precise enough description of the normal contact force to score a second mark. While many realised that there was a force pulling them to the right, some labels described this as the pulling force of B on team A, or on the rope. Again, as was seen in part (b) the idea of two teams pulling on a rope to create a tension only as big as the smallest applied pulling force was missed by most candidates. Team B may have helped to create the tension but did not directly apply a force onto any members of Team A.

A good response scoring all 3 marks.

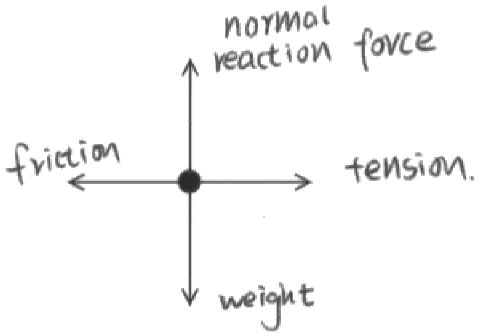
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary.

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



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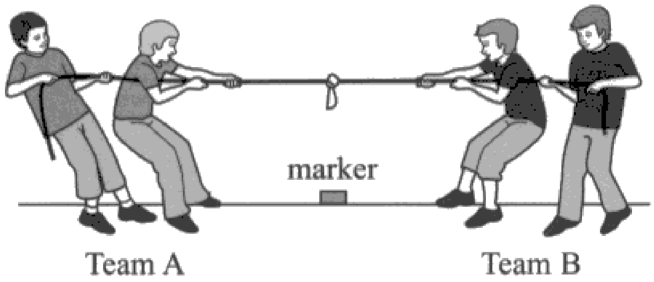
Examiner Comments

Normal reaction force was a bit of a hybrid of normal contact force and reaction force but was good enough to score the mark. Just to note that 'normal' on its own would be insufficient as it really only describes a perpendicular direction and not a physical quantity.

This diagram has 3 out of the 4 forces correctly labelled and scores 2 marks.

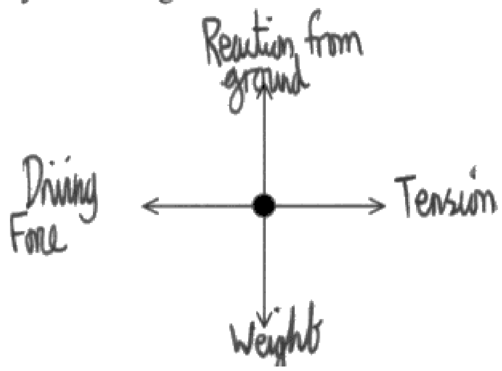
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary.

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



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Examiner Comments

The driving force as a backwards force acting on the child was fairly common as many candidates could not correctly identify that it was friction tht prevented the child from moving forward.

Question 10 (b)

This extended open response question not only assessed the candidates understanding of the context and the physics involved, but also the candidates' ability to go through a logical sequence of steps and linking together the concepts involved.

The responses seen varied greatly in length, however, most candidates managed to score at least 1 mark, usually the minimum for identifying that Team B applied a greater force than Team A to the rope. The question had to be answered mostly in terms of Team A, again, as seen in part (a), candidates found it difficult to isolate one object (in this case Team A) from the system and only discuss the forces acting on that object. Therefore candidates that described what happened to Team B or the rope did not score very highly.

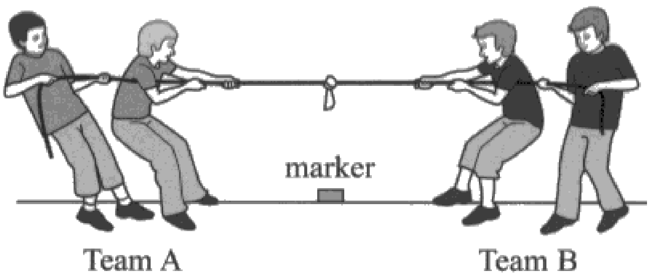
Candidates quoted Newton's laws well, but few could apply them to the context successfully. Just quoting the laws, unless specifically asked to, without applying them to the context will not gain any credit. Describing a law without saying which law they are describing was not sufficient, e.g. 'Team A accelerates due to F = ma' and the minimum that should be seen in such cases would be a reference to Newton's second law or even N2, e.g. 'due to Newton's second law, Team A accelerates'.

Distinguishing between third law pairs of forces and the pairs of forces acting on a body to cause an acceleration became a grey area for many candidates. Discussion of third law pairs in the vertical plane that were correct but not relevant removed the need to award linkage points as any correct physics often had to be searched for within a response. The pull of Team A pull on Team B seem to form a N3 pair according to many candidates again, as mentioned for 10(a) the two teams did not directly apply a force onto each other. Those candidates that could describe a resultant force and an acceleration due to N1 or N2 did not always state which object/team this referred to. With a rope and two teams, the answer had to be precise and only describe the effect on Team A. Ambiguous answers where it was not clear who the resultant force or acceleration was acting on missed out on those marking points. However, many did manage to do this successfully and marking points 4 and 5 were awarded the most frequently for a resultant force on team A and Team A accelerates due to N1 or N2 as well as marking point 6, gaining a significant number of candidates 3 marks (2 for physics and 1 for the linkage of the 2 or 3 physics points made).

In conclusion, these are a style of question that are new to the specification. To gain the 2 available marks for any linkage between the physics points made there would not only have to be sufficient correct physics within a response to link, but the relevance of many of the points made needs to be considered by candidates. A longer response, requiring additional paper is not always the best response. Just as a candidate would plan out an extended response question in, for example, a history exam, the same really is required here with the logical sequence of events and explanations forming the outline of the response.

This response scores 3 marks - 2 for marking points 1, 4 and 5 and 1 for the linkage between the physics points made (structure and lines of reasoning).

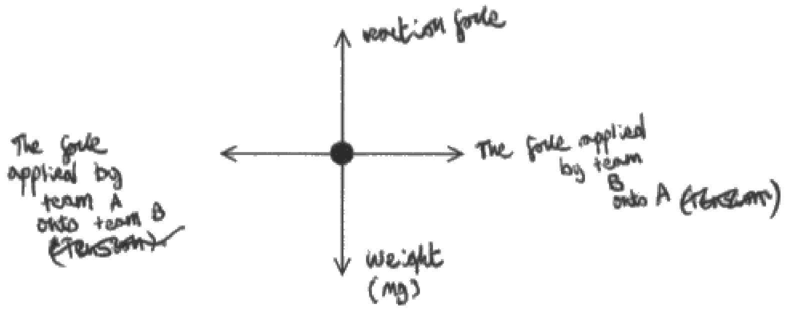
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary. → in equilibrium

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



*(b) Team B wins by pulling Team A over the marker.

By considering the forces on the children and on the rope explain, in terms of Newton's laws, the process by which Team A loses the game.

(6)

Initially they are in equilibrium Newton's first law states that a body will remain in equilibrium or at a constant velocity unless another force acts ont on the body. In order to move over the marker the team B must then apply a force so that $F_{net} \neq 0$ the net force of the system doesn't equal 0. This result in an acceleration due to Newton's second law $\frac{F}{m} = a$. Those are the forces on the children. The forces acting on the rope are tension as a result of being pulled by the teams, the force that the team B applies increases and so they apply a force to the rope according to Newton's third law every applied force has a reaction force of the same magnitude and type so when B applies a force to the rope (Tension), the rope applies a tensile force to team B.

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Examiner Comments

A good example of a shorter but clear response all in terms of Team A. The candidates has identified that there is a tension in the rope (MP1) in line 2. They then described Team A having a resultant force (MP4) and an acceleration due to Newton's third law.

Following on from an incorrect backwards force on their free-body diagram in (a) they described what they think to be a greater forwards force (tension) than backwards force (pulling force). This is the correct line of reasoning, but as the backwards force has been incorrectly identified no credit could be given.

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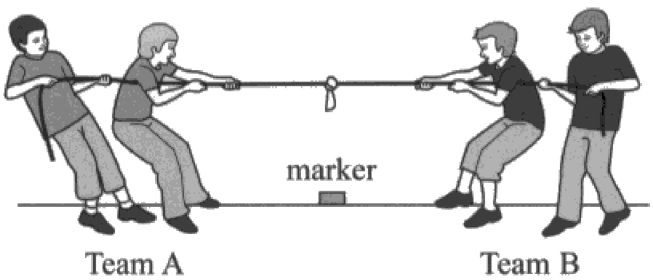
Examiner Tip

The force that Team A applies on the rope is to the left so the force of the rope of Team A (the tension) is to the right. The pulling force and the tension are acting on two different bodies so could not both be included in a free-body diagram or description for just one of the bodies (Team A).

A good response scoring 5 marks, 3 physics marks (for marking points 1, 2, 3 and 5) and 2 for the linkage.

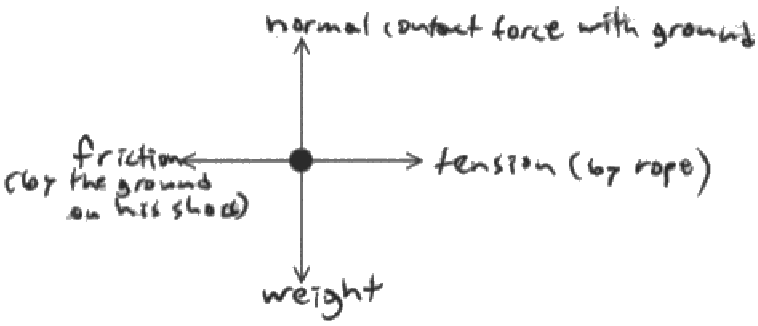
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary.

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



*(b) Team B wins by pulling Team A over the marker.

By considering the forces on the children and on the rope explain, in terms of Newton's laws, the process by which Team A loses the game.

(6)

~~Team A apply a~~ Team B apply a pulling force on the rope towards the right creating a force of tension in the rope horizontally towards the right. Since the boys of team A have their hands on the rope they experience this pulling force of tension towards the right. They also pull the rope towards the left and hence by Newton's third law the rope exterts an equal and opposite force on them pulling them towards the right. The friction between the shoes of boys A and the ground opposes sliding and acts towards the left. Since the tension in the rope towards the right is greater than the sum of the tension in the rope towards the left there's a resultant force on the rope towards the right and by Newton's second law ($\Sigma F = ma$), the rope accelerates towards the right. Since boys in A keep holding the rope A it means the tension they experience is greater than the friction towards the left and by Newton's second law they also accelerate towards the right passing over the marker.

(Total for Question 10 = 9 marks)

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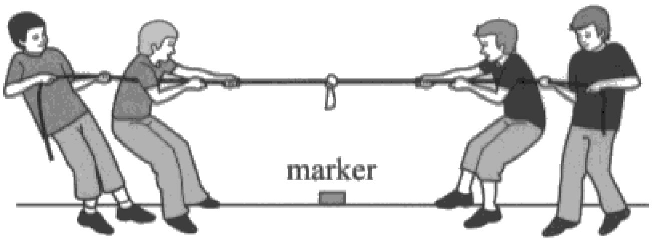
Examiner Comments

The candidate has correctly identified that there is a tension acting on the rope (MP1), they then described the N3 pair of forces resulting in the force on Team A (MP2) in lines 5-7. Following on from a successful free-body diagram, it was then identified that the tension in the rope was greater than the friction (MP3) and finally an acceleration of Team A due to N2 (penultimate line).

There was a little confusion in the middle of the response where the acceleration of the rope was described. The descriptions of the resultant force on the rope and its subsequent acceleration were correctly described but were not relevant to the description for Team A and were treated as neutral comments.

This response scores all 6 marks with all 6 physics points seen and 2 marks given for the linkage between the points, i.e. the structure of the answer and sustained line of reasoning.

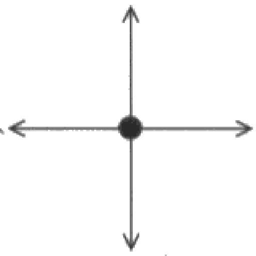
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary.

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



*(b) Team B wins by pulling Team A over the marker.

By considering the forces on the children and on the rope explain, in terms of Newton's laws, the process by which Team A loses the game.

(6)

Team B exert more force ~~on~~ than team A resulting in the tension in the rope increases. ~~As a result~~ Thet tension increases until it is greater than the frictional force that is keeping the children on team A in place. As a result their is an unbalanced or resultant force that is now acting on the children from team A. In accordance with Newton's Second Law the children ~~no~~ of team A accelerate forwards towards the marker. As team A exerts a force on the rope, trying to pull it backwards the rope will exert an equal an opposite reaction on them, in accordance to newton's third law and this will add to the resultant force in the forward direction.

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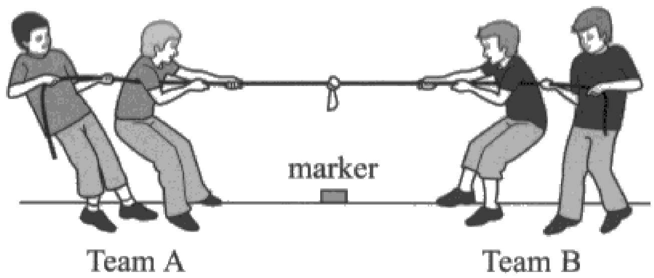
Examiner Comments

Although the description of Newton's third law should have probably been placed earlier within the response, all 6 physics points had been described to give a fairly complete description as to why Team A accelerates to the right and therefore loses the game. There is a clear logical sequence through the points made, leading to the acceleration of A towards the marker, so both linkage marks were awarded.

The physics points were seen in the following order when reading through the response: 6, 1, 3, 4, 5, 2.

A typical response scoring 1 mark. This was given for a reference to the tension in the rope. As only 1 physics mark was awarded there was not enough correct physics to credit any linkage between points made.

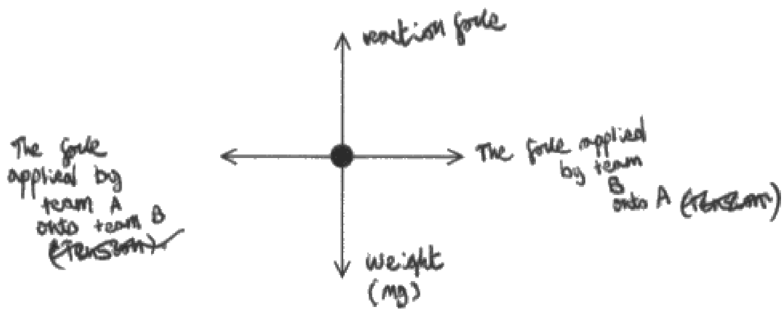
10 In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary. → in equilibrium

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



*(b) Team B wins by pulling Team A over the marker.

By considering the forces on the children and on the rope explain, in terms of Newton's laws, the process by which Team A loses the game.

(6)

Initially they are in equilibrium Newton's first law states that a body will remain in equilibrium or at a constant velocity unless another force acts ont on the body. In order to move over the marker the team B must then apply a force so that $F_{net} \neq 0$ the net force of the system doesn't equal 0. This result in an acceleration due to Newton's second law $\frac{F}{m} = a$. Those are the forces on the children. The forces acting on the rope are tension as a result of being pulled by the teams, the force that the team B applies increases and so they apply a force to the rope according to Newton's third law every applied force has a reaction force of the same magnitude and type so when B applies a force to the rope (Tension). The rope applies a tensile force to team B.

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Examiner Comments

The information at the beginning of the response in describing the rope and teams when stationary, i.e. part (a), the situation has changed now and there is movement so this is not relevant. The rest of the response is in terms of Team B. Some correct Physics is seen with regards to N2 and N3, but is not relevant to the question being asked so could not be credited.

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Examiner Tip

If you are asked to apply Newton's laws to a context, think very carefully as to which object you have to describe. The question in this case clearly mentions Team A right at the end of the question so all of your answer should just be in terms of Team A.

Question 11 (a) and (b)

Moments are a new area to have been added to the AS specification. While it was clear that many candidates could confidently apply the principle of moments, the stumbling block for many was the calculation of the individual moments, using no or incorrect trigonometry, usually for the perpendicular component of the forces. Few candidates attempted to use perpendicular distances, opting to resolve the forces instead.

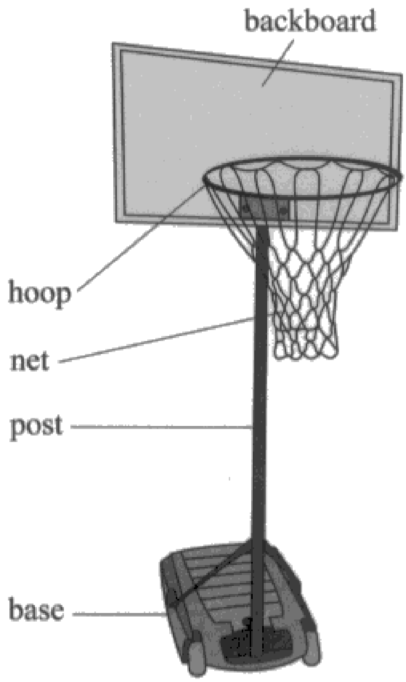
Part (a) required use of W = mg and was answered correctly by nearly every candidate.

Part (b) usually only scored 1 or 2 marks for one correct moment calculated and use of the principle of moments. Only the most able candidates managed to calculate more than one correct moment, others usually missing a distance or direction within their attempts at moments, finding the multi-stage calculation without additional guidance or sub-question parts leading to the application of the principle of moments too challenging.

As not all candidates attempted their answer in terms of moments it needs to be made clear that in a turning situation candidates always refer to moments. It was also evident that additional practice is required by many candidates in resolving forces. Candidates are usually successful in obtaining components of velocity in projectile questions. However, if the forces are in different directions, in this case the wind and weight of the base and post, it is far more difficult to resolve these into components. Usually the wrong angle or trig function was used.

A typical response that scores 2 for (a) and 1 for part (b).

11 A portable basketball set has a base and a post arrangement. The post arrangement consists of a post, backboard, hoop and net. The base can be filled with water to increase stability.



(a) The base has a capacity of 85.0 litres.

Show that the maximum weight of the base is about 870 N.

mass of 1.00 litre of water = 1.00 kg
mass of base when empty = 3.50 kg

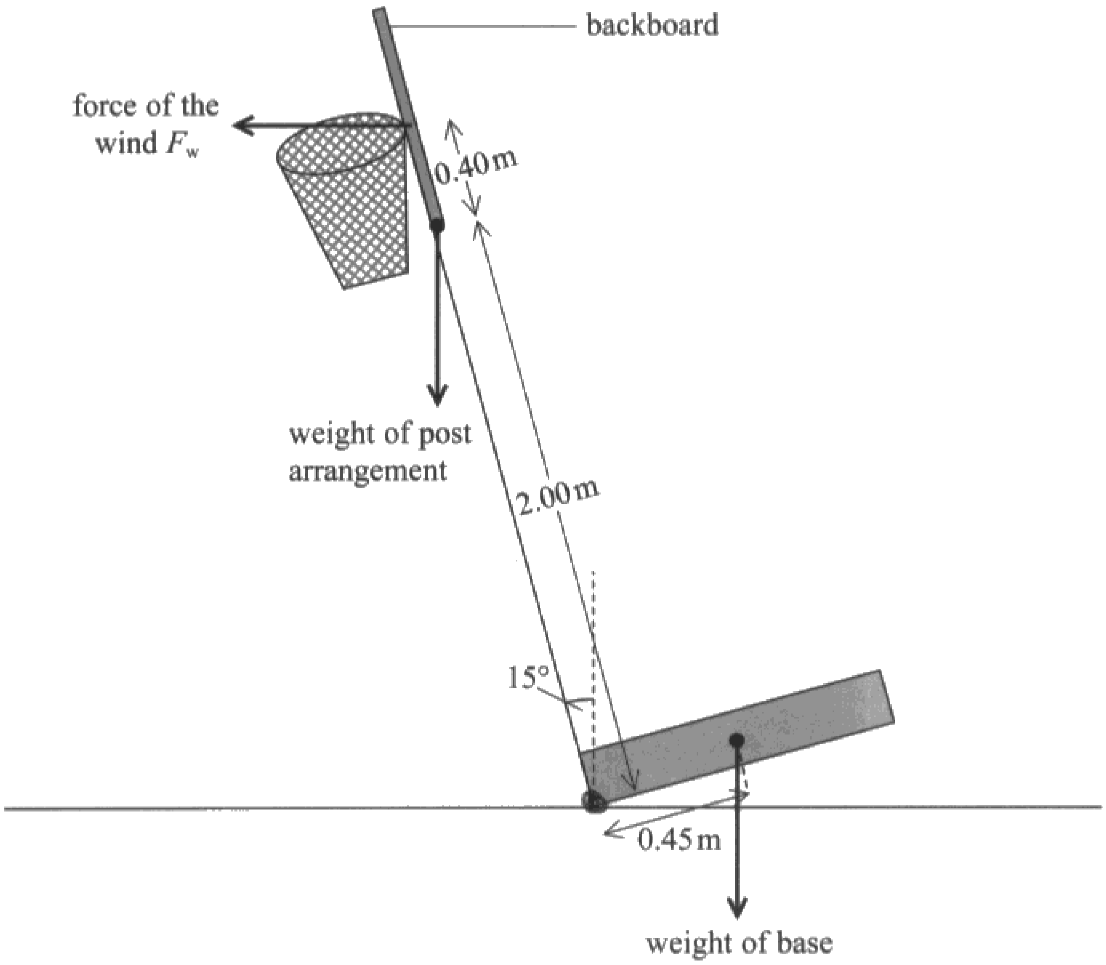
(2)

3.50 + 85 = 88.5 kg

f = mass × gravity   f = mg

f = 88.5 × 9.81 = 868.185 N ≈ 870 N

(b) Due to the large area of the backboard, the basketball set may topple over when the wind blows.



Calculate the minimum force of the wind F_w that will cause the basketball set to be blown over when it is at the angle shown. Ignore the effect of the wind on the base.

weight of post arrangement = 27.0 N

(5)

moment = force x distance from pivot

868.185 x 0.45 = 390.68 Nm - clockwise

27 x 2 = 54 Nm

2 + 0.4 = 2.4

54 + (2.4 x f) = 390.68

2.4 x f = 336.68

f = 336.68 / 2.4 = 140.283 N

Minimum force of the wind F_w = 140.283 N

ResultsPlus

Examiner Comments

No trigonometry has been used at all in this response so the perpendicular components of the forces were not used and no credit could be given for use of the moment equation. The candidate did attempt to apply the principal of moments correctly with their moments and gained credit for MP4 only.

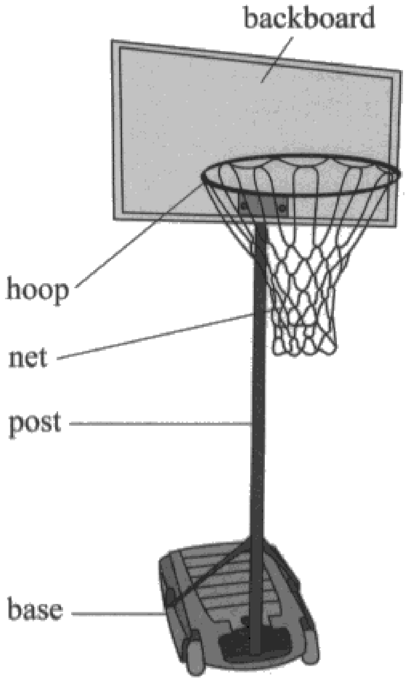
ResultsPlus

Examiner Tip

The equation for the principal of moments is: moment of a force is Fx where the force and the distance must be perpendicular to one another. Forces may need to be resolved into a perpendicular component (to the distance given) to obtain the perpendicular component so always look at the diagram given in case any components are required.

A good response scoring 2 for (a) and 5 for (b).

11 A portable basketball set has a base and a post arrangement. The post arrangement consists of a post, backboard, hoop and net. The base can be filled with water to increase stability.



(a) The base has a capacity of 85.0 litres.

Show that the maximum weight of the base is about 870 N.

mass of 1.00 litre of water = 1.00 kg
mass of base when empty = 3.50 kg

(2)

total mass when full = 3.5 + 85×1

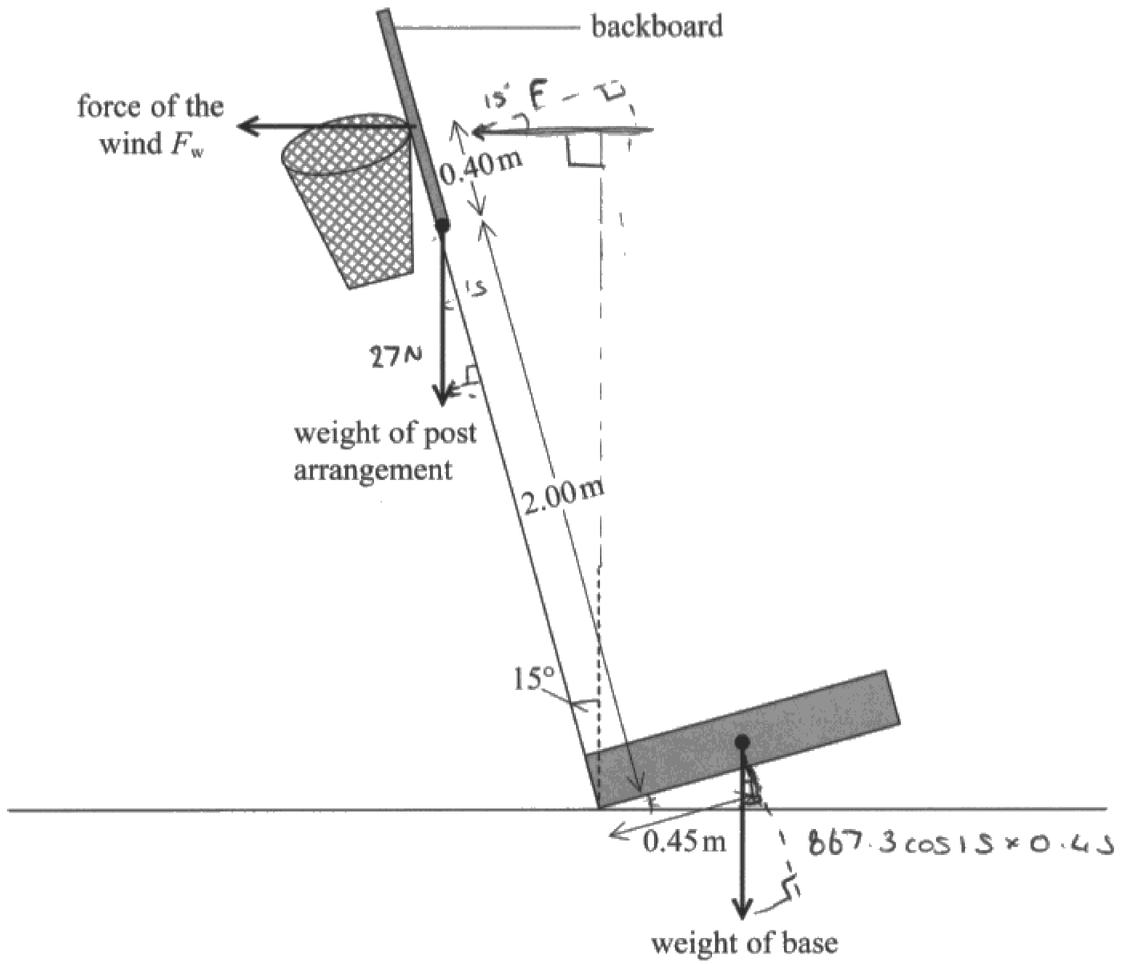
= 88.5 kg

Weight = mg

= 88.5×9.8

= 867.3 N

(b) Due to the large area of the backboard, the basketball set may topple over when the wind blows.



Calculate the minimum force of the wind F_w that will cause the basketball set to be blown over when it is at the angle shown. Ignore the effect of the wind on the base.

weight of post arrangement = 27.0 N

(5)

When ↶ moments > ↷ moments

$F \cos 15 \times 2.4 + 27 \sin 15 \times 2 > 867.3 \cos 15 \times 0.45$

$2.4F \cos 15 + 54 \sin 15 > 390.285 \cos 15$

$2.4 F \cos 15 > 390.285 \cos 15 - 54 \sin 15$

$F > \dfrac{390.285 \cos 15 - 54 \sin 15}{2.4 \cos 15}$

$F > 156.6$ N

Minimum force of the wind F_w = 156.6 N

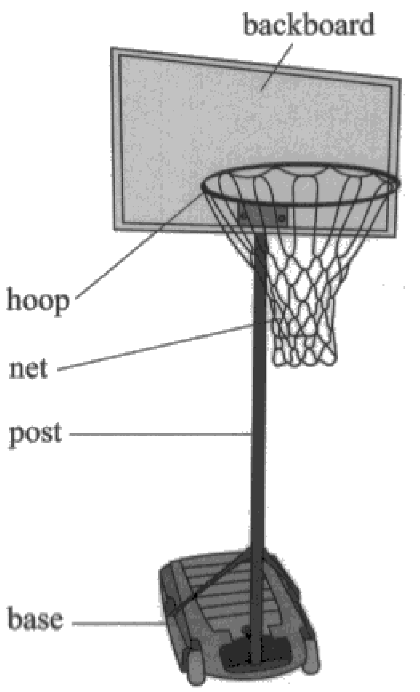
ResultsPlus
Examiner Comments

(a) Although the candidates are given g as 9.81 N kg^{-1}, use of g = 9.8 N kg^{-1} is accepted (but not g = 10 N kg^{-1}).

(b) The candidate has completed the calculation in one step rather than calculating all the individual moments and then adding them together. However, it can be seen that they have added to the diagram, drawing in the parallel and perpendicular components of each force, identifying the 15° angle; a step that clearly helped them to obtain the correct component to use in the moment equation.

This response scores 1 for (a) and 3 for (b).

11 A portable basketball set has a base and a post arrangement. The post arrangement consists of a post, backboard, hoop and net. The base can be filled with water to increase stability.



(a) The base has a capacity of 85.0 litres.

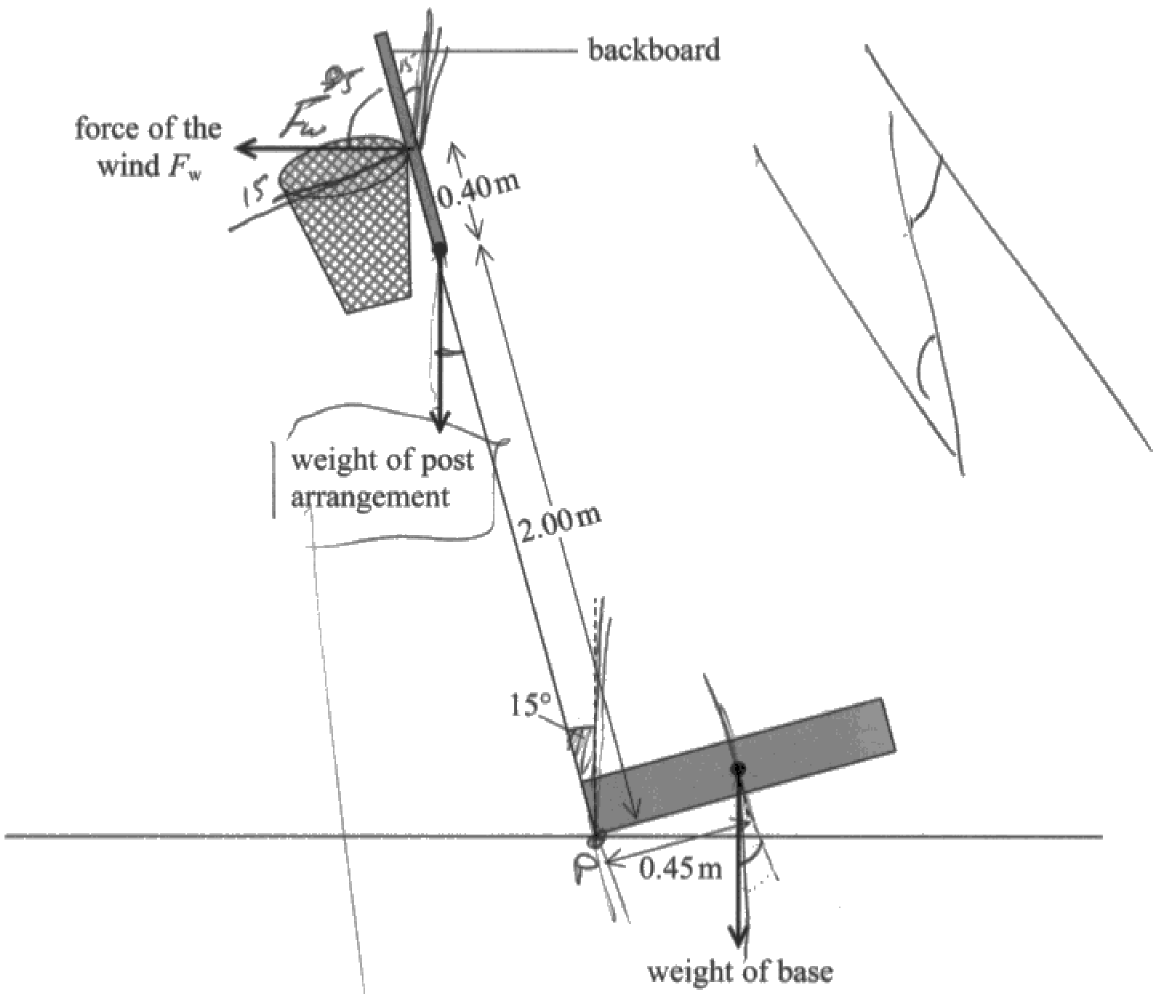
Show that the maximum weight of the base is about 870 N.

mass of 1.00 litre of water = 1.00 kg
mass of base when empty = 3.50 kg

(2)

3.5 × 9.81 + 85 × 9.81 = 867.2 N

(b) Due to the large area of the backboard, the basketball set may topple over when the wind blows.



Calculate the minimum force of the wind F_w that will cause the basketball set to be blown over when it is at the angle shown. Ignore the effect of the wind on the base.

weight of post arrangement = 27.0 N

(5)

0.45 × 867.2 × cos 15 = 418.83 Nm (clockwise)

Anti: 27 × cos 15 × 2 + F_w cos 15 × 2.4

F_w cos 15 × 2.4 + 27 × cos 15 × 2 − 418.83 > 0

F_w ~~cos 15 × 2.4~~ > $\frac{418.83 - (27 \times \cos 15 \times 2)}{\cos 15 \times 2.4}$

F_w > 158.2 N

F_w must be larger than ~~45~~ 158.2. Thus, it can be 158.3 N

ResultsPlus
Examiner Comments

(a) The calculation is set out correctly for (a) but an answer of 867 N and not 868 N was obtained. This may have been due to using 9.8 N kg $^{-1}$ and not 9.81 N kg $^{-1}$ for g. However, as this was not set out in their working no credit can be given for the final answer so just 1 mark for evidence of use of W = mg.

(b) This candidate has calculated the moment of the weight of the base and of the wind correctly but used the wrong component for the weight of the post arrangement in its moment. They have however, applied the principal of moments correctly for their calculated moments and scored MP4 as well.

ResultsPlus
Examiner Tip

You can see how easy it is to calculate the parallel instead of the perpendicular moment. Add to the diagram to help you when resolving forces.

Question 11 (c)

This question was answered well by most candidates, with many giving a logical sequence of points as they justified the increase in the force of the wind. Some responses were a little vague, referring only to the mass with no link to the weight of the base increasing. Others just explained that the density of sand was greater without extending this to the context of moments and mentioning the increase in the weight of the base. Given that two weights were mentioned in the question, candidates had to be clear that they were referring to the weight of the base and not the post arrangement, so 'weight increases' alone was insufficient for the mark (MP2). Again, when there is more than one object in a system, candidates must be clear as to which object they are referring to.

With the majority of candidates scoring 2 marks (MP1 and MP2), only the more able candidates wrote about the clockwise moments increasing and, as is applicable to part (b), in turning situations candidates should be reminded to always refer to moments.

A good, clear response scoring all 3 marks.

The candidate has gone through the logical sequence of describing an increased weight of the base and an increased clockwise moment.

They then described the subsequent increase in the anticlockwise moment. This was not required but demonstrates a good understanding of the physics and is essentially a 4th marking point.

Finally they concluded that the force of the wind would therefore increase.

(c) The base is filled with sand instead of water. The density of sand is greater than the density of water.

State and justify what would happen to the value of F_w calculated in part (b).

(3)

- Density of sand is greater than density of water meaning that the maximum weight of the base is bigger with sand
- The clockwise moment about the base hence is increased
- For the set to topple, the anticlockwise mommend has to increase
- Therefore, the minimum value of Fw has to be bigger

ResultsPlus

Examiner Comments

If the context of the question is moments then candidates will need to refer to a weight and/or a force in order to discuss the toppling effect as this candidate has done.

This response scores 1 mark for identifying that the force of the wind would increase.

(c) The base is filled with sand instead of water. The density of sand is greater than the density of water.

State and justify what would happen to the value of F_w calculated in part (b).

(3)

If the density of sand is more than water then more sand can be put in to the base, therefore it will have a larger mass. ~~and~~ This means that more force will be needed to be applied to the backboard to topple it, therefore F_w would be larger.

ResultsPlus

Examiner Comments

The candidate has identified that the mass of the base would increase, but as this is a moments question, this was insufficient and a reference to the weight increasing was required. No further marks could be awarded as they did not make reference to the clockwise moment increasing.

Question 12 (a)

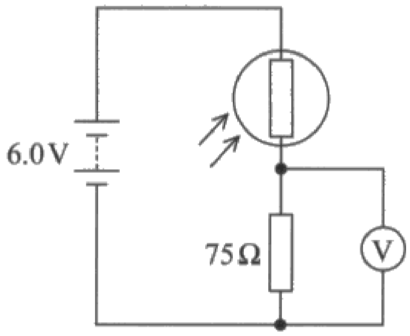
Good attempts at this question were seen for candidates of all abilities, with many giving precise explanations considering all of the factors.

Although not all candidates considered all of the factors leading to an increased p.d. across the fixed resistor, some associated the increased energy being given to the electrons as increasing resistance due to more collisions (as in a filament lamp) resulting in an increased p.d. across the LDR.

A number of candidates were not specific, making statements describing a change in the p.d. across the fixed resistor without stating how it changed. Others just mentioned the light increasing as the lamp moved closer rather than using a more technical term such as intensity, brightness, or less commonly, illumination. The point seen least frequently was the first marking point, the idea that the electrons gain energy from the light, with candidates often jumping from the idea of a greater intensity of light as the lamp moved closer to the LDR to more charge carriers in the circuit.

A typical response scoring all 3 marks.

12 A student set up a circuit containing a light dependent resistor (LDR) in series with a fixed resistor as shown.



(a) As the student moved a lamp towards the circuit she observed the potential difference (p.d.) changing across the fixed resistor.

With reference to the electrons in the LDR explain this observation.

(5)

The Light dependant resistor is made of semiconductors when light hits these semiconductors more charge carri electrons are released into the conductive band which means resistance through the LDR decreases. So when the lamp moves closer to the ~~LB~~ LDR more electrons move up into the conductive band.

Because $R = \frac{V}{I}$ and current must stay constant in a series circuit as R ~~increases~~ decreases As more light hits the LDR the potential difference accross the LDR ~~increases~~ decreases too. Then because $R_t = R$. $V_t = V_1 + V_2$ the Potential difference across the fixed resistor must ~~decrease~~ increase

ResultsPlus
Examiner Comments

Marking points 3, 4 and 5 were awarded.

The candidate has described there being more conduction electrons (line 5), they described the decreasing resistance of the LDR, MP4 in lines 3 and 4 and finally they have stated that the potential difference across the LDR decreases, MP5 in line 7/8.

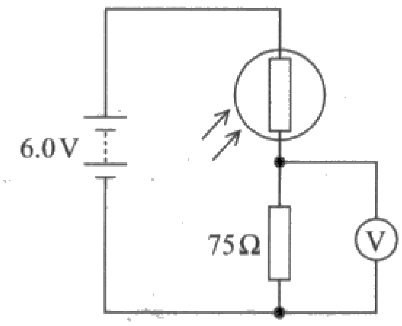
There is an incorrect statement about the current remaining constant but this does not contradict any of the marking points so was treated as a neutral statement and not penalised.

ResultsPlus
Examiner Tip

In a circuit with a variable resistor such as an LDR in series with a fixed resistor, if the resistance of one of the component changes, then the total resistance of the circuit will also change and therefore the current in the circuit will change. The constant in this circuit is the EMF of the cell.The p.d. across each component changes as a result of the change in the resistance.

This response scores all 5 marks.

12 A student set up a circuit containing a light dependent resistor (LDR) in series with a fixed resistor as shown.



(a) As the student moved a lamp towards the circuit she observed the potential difference (p.d.) changing across the fixed resistor.

With reference to the electrons in the LDR explain this observation.

(5)

As the lamp moves towards the circuit the light intensity increases and so the ~~power increases~~. LDR's are made of a a semiconducting material, so there are very few delocalised conduction electrons, however there are a large number of electrons in the valence band, this is when the electron orbits ~~[illegible]~~ overlap and so if sufficient energy is given to them they will become delocalised and escape to the conduction band and as n (the number of charge carriers) has increased according to the equation $I = nAvq$ the current will increase with increasing light intensity and so the resistance will decrease. As ~~voltage~~ potential difference is split in a series circuit in proportion to resistance and as the resistance of the LDR has decreased ~~then~~ the LDR will receive less ~~voltage~~ potential difference and so the voltmeter reading will increase.

ResultsPlus

Examiner Comments

The first marking point was awarded although the origins of the energy that the electrons gain could have been stated clearer as it took a bit of reading to jump from the absorption of energy to a greater intensity in line 9. Otherwise this is a good explanation with 4 good and one slightly weaker physics points made.

Also note that the candidate has referred to the LDR receiving less potential difference in the penultimate line. Again, poor language which would be better written using mostly their words as 'the potential difference across it (the LDR) is ‘less' etc.

Question 12 (b) and (c)

(b) The responses to this question were disappointing. A lot of candidates failed to realise what the potential difference was across, confusing the p.d. across the two components, resulting in the commonly seen answer of 50 Ω. It was only the more able candidates that managed to select the correct p.d. to use in $V = IR$ or construct a potential divider ratio.

(c) This was a difficult question and the responses, across all abilities, were poor. Candidates who generally scored all 3 marks in (b), demonstrating a good understanding of potential dividers, did not generally do much better than their peers on 12(c). In order to gain any credit, the candidates had to identify that the resistance of a parallel circuit is always less than the smallest resistance, with the bulb itself having a resistance as well as the LDR. Failing to realise this set most candidates off in the direction of discussing the path of least resistance that the electrons would take and concluding that as the LDR had a greater resistance in the dark, the bulb would have a greater current and work (as intended).

A far-fetched idea seen on an almost regular basis was the idea that the bulb would light, reduce the resistance of the LDR, switch off the bulb, increase the resistance of the LDR etc. creating a flashing bulb.

Those who correctly identified that the total resistance of the parallel branch would be less than 3 Ω usually went on to correctly describe the circuit not working due to insufficient p.d. across the bulb. The comparison of resistances across the 75 Ω resistor and parallel section of the circuits were not always there.

This response was typical of that seen from many candidates and scores 1 mark for (b) and 0 marks for (c).

(b) When the lamp was at a distance of 10 cm from the LDR, the reading on the voltmeter was 2.4 V.

Calculate the resistance of the LDR at this distance.

(3)

~~10cm/1/0.1m~~ ~~R=V/I~~ 6−2.4 = 3.6v

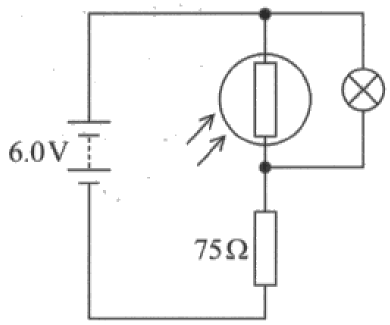
R = V/I I = V/R I = 2.4/75 = 0.032A

R = V/I R = 6/0.032 = ~~187~~ 187.5

Resistance of the LDR = 187.5 Ω.

(c) The student wants to modify the circuit so that a light bulb lights up when the room goes dark.

She modifies the circuit as shown below. When working normally the resistance of the light bulb is 3 Ω and the p.d. across it is 3 V.



Explain, without further calculation, whether this circuit would work as intended.

(3)

~~yes the circuit could~~ ~~as~~ No the circuit could not work as intended because even when light the lightbulb would turn on. this is because the resistance of the LDR with a light low away is still much higher than the resistance of bulb therefore the current would flow through the bulb lighting it up as this is the path of least resistance.

ResultsPlus
Examiner Comments

(b) The candidate scored 1 mark for using $V = IR$ to determine the correct current in the circuit but then used the EMF of the cell rather than the p.d. across the LDR with Ohm's obtaining the wrong answer.

(c) Firstly the candidate confused this circuit with the circuit in part (a) and discussed the distance of the lamp from the LDR. Secondly, although they correctly identified that the resistance of the LDR would be higher than that of the bulb, they then discussed the current through the bulb as being sufficient to light it as this is the 'path of least resistance'. There was nothing to credit at all in this response.

This response scores 3 for (b) and 2 for (c)

(b) When the lamp was at a distance of 10 cm from the LDR, the reading on the voltmeter was 2.4 V.

Calculate the resistance of the LDR at this distance.

(3)

~~10cm~~ ~~R~~ 6-2.4 = 3.6v

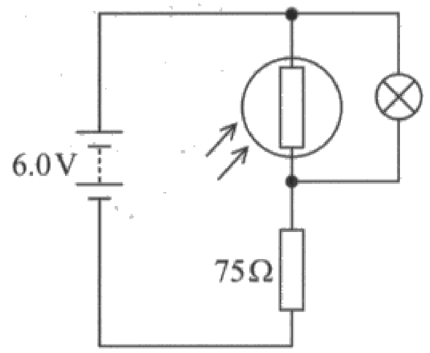
$R = \frac{V}{I}$ $I = \frac{V}{R}$ $I = \frac{2.4}{75} = 0.032A$

$R = \frac{V}{I}$ $R = \frac{6}{0.032} =$ ~~187~~ 187.5

Resistance of the LDR = 187.5 Ω.

(c) The student wants to modify the circuit so that a light bulb lights up when the room goes dark.

She modifies the circuit as shown below. When working normally the resistance of the light bulb is 3 Ω and the p.d. across it is 3 V.



Explain, without further calculation, whether this circuit would work as intended.

(3)

~~yes the circuit would~~ ~~as~~ No the circuit would not work as intended because even when light the lightbulb would turn on. This is because the resistance of the LDR with a light lamp away is still much higher than the resistance of bulb therefore the current would flow through the bulb lighting it up as this is the path of least resistance.

ResultsPlus
Examiner Comments

(b) Correct calculation using the potential divider equation and the answer was quoted to 2 significant figures (the minimum acceptable number of sf as given on the mark scheme).

(c) Correct identification that the total resistance of the parallel circuit would never be greater than the individual resistance (stated) and then applied to the circuit. The two resistances of 3 Ω and 75 Ω have been stated but not compared so no MP2 but the candidate has described the voltage across the lightbulb as being very low and not lighting up scoring MP3.

ResultsPlus
Examiner Tip

When two resistors are in parallel the combined resistance is always less than the smallest resistance.

This combined resistance can then be treated as though there are two resistors in series as in part (a) and you can think about how the EMF from the cell will be divided between the 'components'.

Question 13 (a)

This question was generally answered well, mostly by the more able candidates, with the less able candidates failing to score any marks. The idea that, for 3 marks, two stages would have to be carried out threw many candidates, often stopping mid calculation.

There were many routes that the candidates could take to reach the final breaking distance at the higher speed due to the data given in the stem of the question. The original intention had been that candidates would use an energy conservation method, a route that would involve unknown quantities and algebra, i.e. using KE and work done, however, the suvat method using equations of motion was the most common and the most successful. The vast majority of candidates could successfully substitute correctly for u and v, obtaining a correct negative deceleration and then confidently use this value with u and v substituted into $v^2 = u^2 + 2as$ to obtain a value close to the 'show that' value of 190 m. Although candidates that omitted any negative signs but still ended up with a positive distance were penalised, unlike on previous examinations for 6PH01 and WPH01, this was rare and it was encouraging at the quality of the working seen.

As this was a ’show that’ question there were the candidates that, using a series of calculations ended up at the correct answer, usually because the same method was effectively used twice so errors tended to cancel out. Where there was no basis or evidence of any physics used, no credit could be given for such responses, even if the candidate obtained the typical value of 194 m. Less able candidates tried the proportionality route but, without any application of the physics involved, could not reach the 'show that' value due to the relationship being that the distance is proportional to the square of the speed and not of direct proportion.

A clear response scoring all 3 marks.

(a) The braking distance of a road train travelling at 15 m s^{-1} is 70 m.

Assuming that the same braking force is applied at all speeds, show that the braking distance of a road train when travelling at 25 m s^{-1} is about 190 m.

(3)

u = 25   15 $v^2 = u^2 + 2as$

v = 0   0 $0 = 15^2 + 2(70) \times a$

s = ?   70 $a = -1.6\ \text{ms}^{-2}$ (A)

a = −1.6

$0 = 25^2 + 2(-1.6) \times$ distance

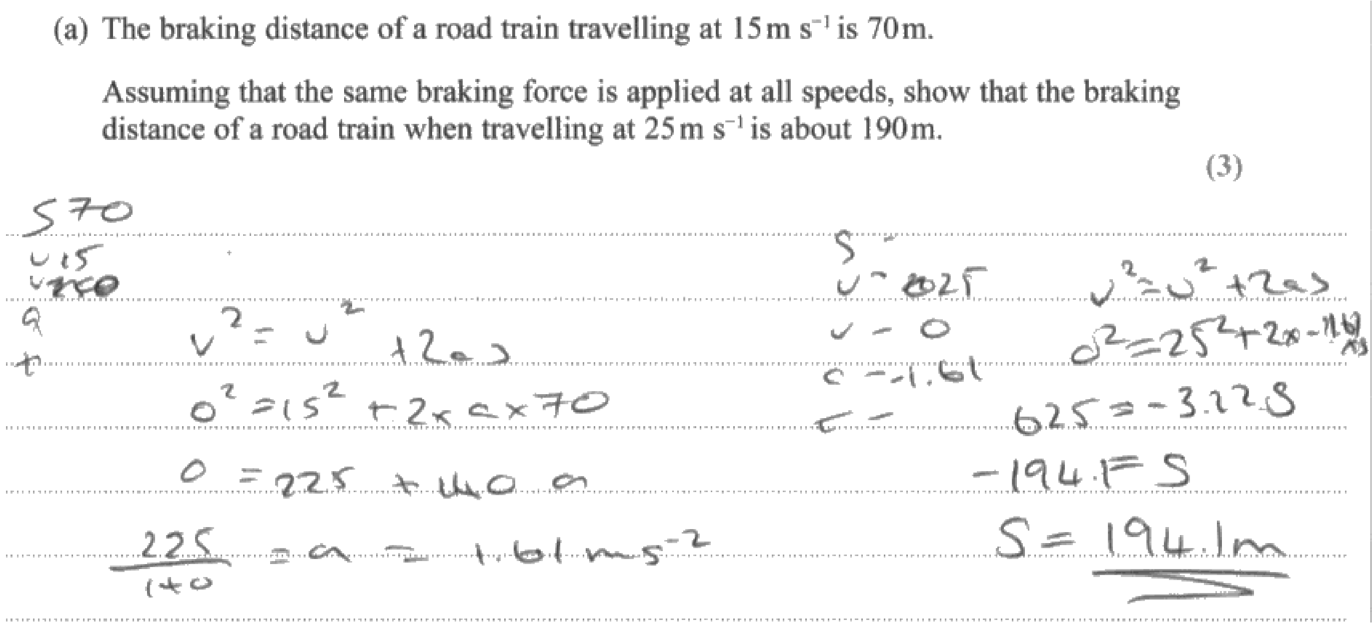
braking distance = 194.4 m

194.4 ≈ 190 m

ResultsPlus
Examiner Comments

This candidates opted to use equations of motion, calculating the deceleration and then substituting this negative value back into $v^2 = u^2 + 2as$ to calculate the stopping distance and obtain a value that, to 2 sf rounds to the show that value of 190 m.

An example of a response that scored 2 marks and is an example to demonstrate that, although the correct final answer may be obtained, it does not guarantee full marks if the method is incorrect or stages are omitted.



(a) The braking distance of a road train travelling at $15\,m\,s^{-1}$ is 70 m.

Assuming that the same braking force is applied at all speeds, show that the braking distance of a road train when travelling at $25\,m\,s^{-1}$ is about 190 m.

(3)

ResultsPlus

Examiner Comments

All the substitutions in the initial equation are correct but a negative value of the deceleration should have been obtained. Although a negative acceleration was listed on the right and then used, the candidate made an arithmetic error when moving the 25^2 to the left and forgot to make it negative, cancelling out the negative acceleration. Instead a negative distance was calculated and the minus sign then just vanished. Therefore due to the incorrect use of the negative sign in candidates' substitutions one of the marking points could not be awarded.

This response scores just 1 mark.

(a) The braking distance of a road train travelling at 15 m s^{-1} is 70 m.

Assuming that the same braking force is applied at all speeds, show that the braking distance of a road train when travelling at 25 m s^{-1} is about 190 m.

(3)

$F = ma$ $\quad Fv = \text{Power}$

$F \times d =$

$\frac{70\text{m}}{15\text{ms}^{-1}} = 4.67 \text{ seconds}$

$\frac{25}{15} = \frac{5}{3}$ $\quad 4.67 \times \frac{5}{3} = 7.783$

$\frac{190}{25} = 7.6 \text{ seconds}$ $\quad 4.67 \times \frac{5}{3} = 7.783$

$v = \frac{d}{t}$ $\quad 25 \times 7.783 =$ 195m

ResultsPlus

Examiner Comments

The candidate has used an incorrect formula to determine the time to break. They should have used the equation for the average speed i.e. (u + v)t/2. However they then scaled up the time correctly as there is a linear relationship between the speed and the time and then used this in the same incorrect formula to determine the breaking distance. The error of not using the correct equation twice, i.e. the factor 1/2 has cancelled so the final answer obtained was correct.

This response scored only 1 mark due to the error of physics made and is another example of a correct answer in show that questions not necessarily scoring full marks.

ResultsPlus

Examiner Tip

speed = distance /time may only be used in situations where the object is moving at a constant speed. Where there is an acceleration or a deceleration, the equation is only true with the average speed and can be re-written as: average speed = ½(u + v) = total distance/time

Question 13 (b)

This question was answered better than 13(a) and although it contained two steps to be answered correctly, the less able candidates that forgot to convert the speed in km h^{-1} to m s^{-1} could still score 1 mark for use of the correct equation of motion. About half of E grade candidates scored all 3 marks rising to over 90% at the top end of the ability range with most marks lost due to an incorrect unit conversion, usually with the time factor multiplied and not divided in the conversion.

This response scored 3 marks.

(b) A car accelerates uniformly at 3.7 m s^{-2} as it passes a stationary road train.

The initial speed of the car is 30 m s^{-1} and it reaches the speed limit of 130 km h^{-1} as it passes the front of the cab.

Calculate the length of the road train.

(3)

s = ? $\quad$ 130 km h^{-1} = 36.1 m s^{-1}

u = 30

v = 36.1 $\quad$ $36.1^2 = 30^2 + 2 \times s \times 3.7$

a = 3.7 $\quad$ 1303.21 = 900 + 7.4s

t $\quad$ 403.21 = 7.4 s $\quad$ $s = \frac{403.21}{7.4} = 54.49$

Length of the road train = 54.49 m

ResultsPlus

Examiner Comments

No working out shown for the unit conversion but the candidate has successfully converted from km h^{-1} to m s^{-1} obtaining a final speed of 36.1 m s^{-1}. This was then used correctly in $v^2 = u^2 + 2as$ to obtain the distance over which the acceleration took place, i.e. the length of the road train of 54.49m.

This response scored just 1 mark.

(b) A car accelerates uniformly at $3.7\,\text{m s}^{-2}$ as it passes a stationary road train.

The initial speed of the car is $30\,\text{m s}^{-1}$ and it reaches the speed limit of $130\,\text{km h}^{-1}$ as it passes the front of the cab.

Calculate the length of the road train.

(3)

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

u 30 $130^2 = 30^2 + 2 \times 3.7 \times s$

v 130 $\frac{130^2 - 30^2}{2 \times 3.7} = s$

A 3.7 $s = 2162.162\,\text{m}$

T

Length of the road train = 2162 m

ResultsPlus
Examiner Comments

Only arking point two was awarded for use of the correct equation of motion, as no unit conversion for the final speed was made.

Question 13 (c)

This question required an understanding of the difference between efficiency and energy usage. It was poorly answered, with very few candidates recognising the significance of air resistance in their answer. The most common mark to award was marking point two for some description of greater fuel use at higher speeds. This was usually without justification, i.e. a reference to air resistance (MP1) and without an explicit link to the statement given with a comparison between the amount of fuel used (fuel economy) and the efficiency.

This question was found to be the most difficult on the paper by candidates, with a lack of clarity in some explanations letting candidates down. The phrasing was such that it was not clear if more fuel was required when accelerating or when at steady speed. Answers were often given in general terms and there was confusion as to the understanding of the concept of efficiency of the engine in that many thought that it was to do with the quantity of kinetic energy used rather than produced as a result of the conversion of chemical energy into kinetic energy in the engine.

This response scores 2 marks.

(c) One region of Australia decided to trial the removal of the speed limit on some roads.

The following statements were made in an online forum discussing this issue.

Comment

"If a car was going faster, it would have better fuel economy. A lot of modern cars have engines that are more efficent at 200 km h^{-1} than at 100 km h^{-1}."

Reply

"You confuse efficiency with fuel consumption. You cannot get better fuel economy at higher speeds."

Justify the statement in the reply.

(3)

Fuel economy refers to the ~~am~~ distance that can be covered ~~m~~ using a certain amount of fuel whereas efficiency only refers to how effectively ~~a~~ input energy is transfered into useful energy. this ignores the fact that as the car's speed increases, things like wind resistance also increase, reducing fuel economy

ResultsPlus

Examiner Comments

This response gained marking point one for identifying that the drag (called wind resistance but accepted) increased at higher speeds and for making a statement that compared the efficiency to fuel economy. This third marking point was similar to the second alternative answer under additional guidance on the right in the mark scheme.

This response scores all 3 marks.

(c) One region of Australia decided to trial the removal of the speed limit on some roads.

The following statements were made in an online forum discussing this issue.

> Comment
>
> *"If a car was going faster, it would have better fuel economy. A lot of modern cars have engines that are more effecent at 200 km h^{-1} than at 100 km h^{-1}."*
>
> Reply
>
> *"You confuse efficiency with fuel consumption. You cannot get better fuel economy at higher speeds."*

Justify the statement in the reply.

(3)

A The force of drag increases as the square of the speed. The engine must therefore work 4x harder at 200 kmh^{-1} as opposed to 100 kmh^{-1}. The engine may be more efficient so more of the energy input is converted to rotational output of the wheels, but the much greater force of drag means the engine will need more than twice the fuel to double the speed so the fuel economy will not increase.

(Total for Question 13 = 9 marks)

- Fuel consumption = Fuel used per unit time
- Fuel economy = Fuel used per distance travelled

ResultsPlus

Examiner Comments

The candidate clearly appreciates that at a greater speed the drag force is greater (MP1) this was then linked to the cars requiring a greater amount of fuel at the greater speed. They then concluded that although the efficiency of engine may increase, because more fuel is needed then the fuel economy would not increase, i.e. a comparison between all three quantities mentioned in the reply statement.

Question 14 (a)

Most candidates were able to pick up full marks in part (a) for successfully carrying out these short calculations.

The unit conversion from W h to J in part (i) was a show that style question and caused little problem for most.

Part (ii) required use of V = W/Q and could use either the energy in J, calculated in part (i), or the energy in W h given in the stem. Few candidates that used W h included a correct unit of Ah, usually using coulombs or omitting the unit. Units in general were probably the greatest source of error in part (ii) with omitted units or the use of amps rather than coulombs most frequently seen.

The common route to calculate the time was to use time = charge/current followed by a conversion from seconds to hours as the question requested, although this was missed by some. Again some candidates chose to use the information given in the stem of the question as the basis for their calculation, this time creating a shorter calculation as a time conversion was not required as the energy was originally given in W h.

Question 14 (b)

Many candidates only managed to pick up 1 mark here, with the more able candidates tending to get a second mark. The most common correct point to award was for a longer charging time for the replacement charger. From here some candidates went on to discuss a reduced heating effect linked to a lower current. This mark was not always awarded as candidates that calculated the resistance of the new charger often stated that a greater resistance would cause a greater heating effect, negating the earlier mark awarded for a reduced effect as it was contradicted. Few candidates identified that the charge supplied by both chargers would be the same, often only scoring this mark by way of evidence in a calculation, i.e. candidates that chose to calculate the charging time would have used the same charge for calculations for both chargers with the formula $Q = It$. The idea that the new charger may have to provide a greater current of 1 A which could cause damage was rarely seen, with candidates not having the confidence to use information that had not been stated in the stem of the question.

One of the best responses scoring (a)(i) 1, (ii) 2, (iii)3, (b) 2 marks.

14 A mobile phone is powered by a lithium-ion battery. The information shown is taken from the battery.

3.82 V
6.91 W h

(a) (i) The watt-hour (W h) is an alternative unit for energy.

Show that the maximum energy that can be stored by the battery is about 25 kJ.
1 W h = 3600 J

(1)

3600 × 6.91 = 24876
= 24.9 KJ (3SF)
= 25 KJ (2SF)

(ii) Calculate the maximum charge that the battery can provide.

(2)

~~M~~:
$3.82 = \frac{25000}{Q}$

= 6544.5...

Maximum charge = 6500 C (2SF)

(iii) The mobile phone 'runs out of charge'.

Calculate the minimum time taken, in hours, for the battery to fully recharge.

charging current = 0.90 A

(3)

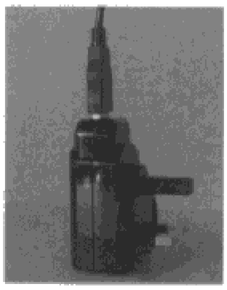
$0.9 = \frac{6544.5}{t}$

t = 7221 sec

Minimum time = 2.0 (2SF) hours

(b) The mobile phone in part (a), when purchased, was supplied with a charging plug marked 1 A, 5 V. The mobile phone owner lost the original charging plug and replaced it with a charging plug marked 0.5 A, 5 V.

original charging plug
1A, 5 V



replacement charging plug
0.5A, 5 V

By evaluating the information given, discuss the suitability of using the replacement charging plug for this mobile phone. Include references to possible benefits, disadvantages and risks associated with using the replacement charging plug.

(4)

It would not heat up as much as the current is lower so is less likely to melt and potentially safer, yet it will take longer to charge as the current is less, $I=\frac{Q}{t}$. But it may be more efficient as less energy is dissipated in heat, more transferred to electricity, due to the lower current. ~~Therefore~~ It has the same voltage so could give each unit of charge the same energy.

ResultsPlus
Examiner Comments

All three calculations carried out in part (a) scoring full marks.

A mark was awarded in part (b) for identifying that for a lower current there will be a reduced heating effect. 'Less likely to melt' in lines 2/3 is not sufficient for a description of a reduced heating effect but combined with 'less energy dissipated as heat' in line 6 scores the mark (MP3). A mark was awarded as well (MP2)for 'taking longer to charge' in line 4.

A very good response that scored (a)(i) 1 (ii) 2 and (iii) 3 and (b) 3 marks.

14 A mobile phone is powered by a lithium-ion battery. The information shown is taken from the battery.

3.82 V
6.91 W h

p.d ← 3.82 V

E ← 6.91 W h → PE

(a) (i) The watt-hour (W h) is an alternative unit for energy.

Show that the maximum energy that can be stored by the battery is about 25 kJ.
1 W h = 3600 J

(1)

6.91 Wh = (6.91 × 3600) J = 24876 J
= 24.9 kJ (about 25 kJ)

(ii) Calculate the maximum charge that the battery can provide.

(2)

$V = \frac{W}{Q}$

$Q = \frac{W}{V} = \frac{24876}{3.82}$ = ~~6512 C~~ $\frac{24900}{3.82} = 6518\ C$

Maximum charge = 6520 C ~~6512 C~~ (3 s.f)

(iii) The mobile phone 'runs out of charge'.

Calculate the minimum time taken, in hours, for the battery to fully recharge.

charging current = 0.90 A

(3)

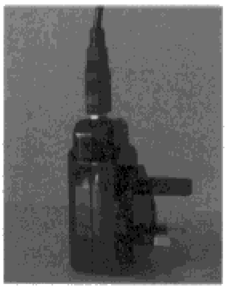
$I = \frac{Q}{t}$

$t = \frac{Q}{I} = \frac{6518}{0.90} = 7242\ s = \frac{7242}{3600}\ hrs = 2.0\ hrs$

Minimum time = 2.0 hours
(2 s.f.)

(b) The mobile phone in part (a), when purchased, was supplied with a charging plug marked 1 A, 5 V. The mobile phone owner lost the original charging plug and replaced it with a charging plug marked 0.5 A, 5 V.

original charging plug
1A, 5V



replacement charging plug
0.5A, 5V

By evaluating the information given, discuss the suitability of using the replacement charging plug for this mobile phone. Include references to possible benefits, disadvantages and risks associated with using the replacement charging plug.

(4)

Original plug has a power of 5W (P=VI=1×5=5W)
Replacement plug has a power of 2.5W (P=VI=0.5×5=2.5W)
This means the replacement plug will provide just half as much energy per second to the phone than the original plug. They will both provide the same total amount of charge to the battery, but the phone will take twice as long "to charge" with the replacement plug. as the rate of energy transfer is halved.
However, possible advantages of the replacement plug include: it uses half the current, so half as much heat will be dissipated in the wire, leaving a greater percentage of power available to charge the phone. It will be more efficient than the original plug and heat up less, making it less dangerous to use. Despite this, since it is not matched to the phone exactly, it could cause damage to components within the phone. or not charge it at all.

(Total for Question 14 = 10 marks)

TOTAL FOR SECTION A = 60 MARKS

Examiner Comments

Full marks for the calculations in part (a).

(b) 3 marks were awarded in part (b) for marking points 1, 2 and 3. The same charge supplied to each battery was identified, as was a greater charging time and less (half as much) heat dissipated. The candidate nearly went on to score a 4th mark but they did not justify their final statement regarding damage to the phone fully by identifying that the battery could try to draw a greater current from the cell to cause this damage.

Question 15 (a)

Due to the assessment of the practical aspect of the course being moved from the classroom to the examination, in this first instance, this question was disappointing with over half of all candidates failing to score. It can be said that the quality of responses will improve as teachers and candidates become used to the variety of ways that practical skills and knowledge of core practicals are examined. However, it may be useful for centres to look at past papers for units WPH03 and WPH06, the written papers for international centres assessing candidate's knowledge and understanding of experimental procedures and techniques, to train their candidates about the style of such questions for this new specification.

Candidates were required to make a comparison between the given equation and y = mx + c to show that a graph of v against d^2 would produce a straight line through the origin. Those who did not make reference to y = mx + c struggled to get beyond 1 mark, usually for identifying the constants in the equation. Attempts at explaining the passing of the line through the origin were variable and, in the majority of cases, it was only those that made reference to the 'c' term in the equation that scored the mark. Many candidates made references to proportion as a justification for the graph being a straight line. Although true, this was not using the given equation to show us why they are in direct proportion etc. hence the requirement to comment on the constants in the equation and link this to the equation of a straight line.

This response scored 2 marks.

(a) To determine the viscosity η, the student used the equation $v = \dfrac{d^2 g(\rho_b - \rho_f)}{18\eta}$

where ρ_b = density of the material of the ball bearing

ρ_f = density of the fluid.

Explain why a graph of v on the y-axis and d^2 on the x-axis should be a straight line through the origin.

(3)

ρ_b, ρ_f, g and η are all constants, meaning they make a constant gradient function together. This means that the line will be straight. Since there is no y-intercept term, the graph should pass through the origin as when v = 0 d^2 should be 0.

ResultsPlus
Examiner Comments

All of the quantities that are constants have been identified (MP2). The candidate has managed to score the third mark without making reference to the equation of a straight line. They have however described the alternative description on the mark scheme that is when d^2 = 0, then v = 0 and the line will pass through the origin.

ResultsPlus
Examiner Tip

If you are asked justify a linear graph and are given an equation, always compare the equation you have been given to y = mx + c. Identify the variables to be plotted on the x and the y-axes as well as any constants in the equation and the y-intercept. It is the most straightforward way to score the marks for such a question.

This response scores all 3 marks.

(a) To determine the viscosity η, the student used the equation $v = \frac{d^2 g(\rho_b - \rho_f)}{18\eta}$

where ρ_b = density of the material of the ball bearing

ρ_f = density of the fluid.

Explain why a graph of v on the y-axis and d^2 on the x-axis should be a straight line through the origin.

(3)

If $v = \frac{d^2 g(\rho_b - \rho_f)}{18\eta}$ and $y = mx + c$, then $v = y$ and $mx = \frac{d^2 g(\rho_b - \rho_f)}{18\eta}$

~~so the~~ and $+c = 0$, so the line should pass through the origin ~~at~~ (0,0) as the y intercept is 0. & $mx = d^2 \frac{g(\rho_b - \rho_f)}{18\eta}$ so ~~the~~ gradient $m = \frac{g(\rho_b - \rho_f)}{18\eta}$ is made up of constant figures, so the only thing changing is d^2 the x variable making the graph a straight line. (as the gradient is constant)

ResultsPlus

Examiner Comments

The candidate has made comparisons between the given equation and the equation for a straight line, highlighting the values to be used in the gradient and identifying them to be constant. The candidate, as they compared the equation to y = mx + c, only had to state that c = 0 so the line went through the origin to gain the third mark.

Question 15 (b) and (c)

This question produced the greatest range of scores on the paper with the vast majority scoring from a minimum of 1 mark for the graph to the more able candidates scoring all 8 marks. As seen with Q15(a), a small amount of training is required by candidates so that the marks scored reflect their practical and mathematical skills. Marks lost tended to be through carelessness rather than through a lack of understanding of the question.

15b (the plotting of the graph)

Marking point 1:

While units were generally included, this mark was most commonly not awarded due to missing powers of 10. Only the occasional candidate omitted any labelling or plotted the graph the wrong way round. Both of which prevent MP1 from being awarded.

Marking point 2:

To obtain the mark for scaling, at least 50% of the graph paper supplied must be used, for both axes. In addition to this a sensible scale must be used. In this case scales that used cm squares to go up in 4s were not thought to be sensible and candidates were then prevented from scoring MP2 (for scale) and MP3 for plotting.

Marking point 3

(plotting): All points must be plotted correctly to within half a small square. The plotting point must be visible hence a tiny dot that can barely be seen and could not be identified as a plotted point negated this mark. As would a very large, thickly drawn x or +, that covers such a large area that examiner cannot easily decipher where the point was plotted.

Marking point 4:

(line of best fit) The graph did not have to go through the origin or a set point, however it was expected that candidates would draw a thin line with an even distribution of the points through/around it. A line that is too thick may prevent the candidate from scoring the mark. Some candidates clearly had not brought a long enough ruler to the exam and some lines of best fit consisted of two not exactly parallel lines joined together again negating the mark. Please encourage your candidates to bring 30 cm rulers into the exam rather than 15 cm rulers.

15c (analysis of the graph to obtain a value for the viscosity and the selection of the fluid using this value).

Marking point 1:

the vast majority of candidates could use the graph by either calculating a gradient or more commonly taking a pair of values from the graph to use in the equation. Not all candidates used a triangle that used at least 50% of the drawn line or selected points from at least 50% the way along their line. Some candidates took values straight from the table. In the majority of cases, assuming that these values were large enough, this could still lead to the candidate scoring full marks. However, if these points lay more than half a square from their line then MP1 for use of the graph could not be awarded.

Marking point 2:

this was the most frequently awarded mark as candidates that had used a small triangle or low value pair of points from the graph could still get the mark for substitution into the correct formula. Powers of ten were not penalised here but only the more able candidates remembered to use them in their calculations.

Marking point 3:

due to the omission of the powers of ten from the graph in the calculation of the gradient many candidates obtained a value a factor of 10^3 too high and did not score this mark.

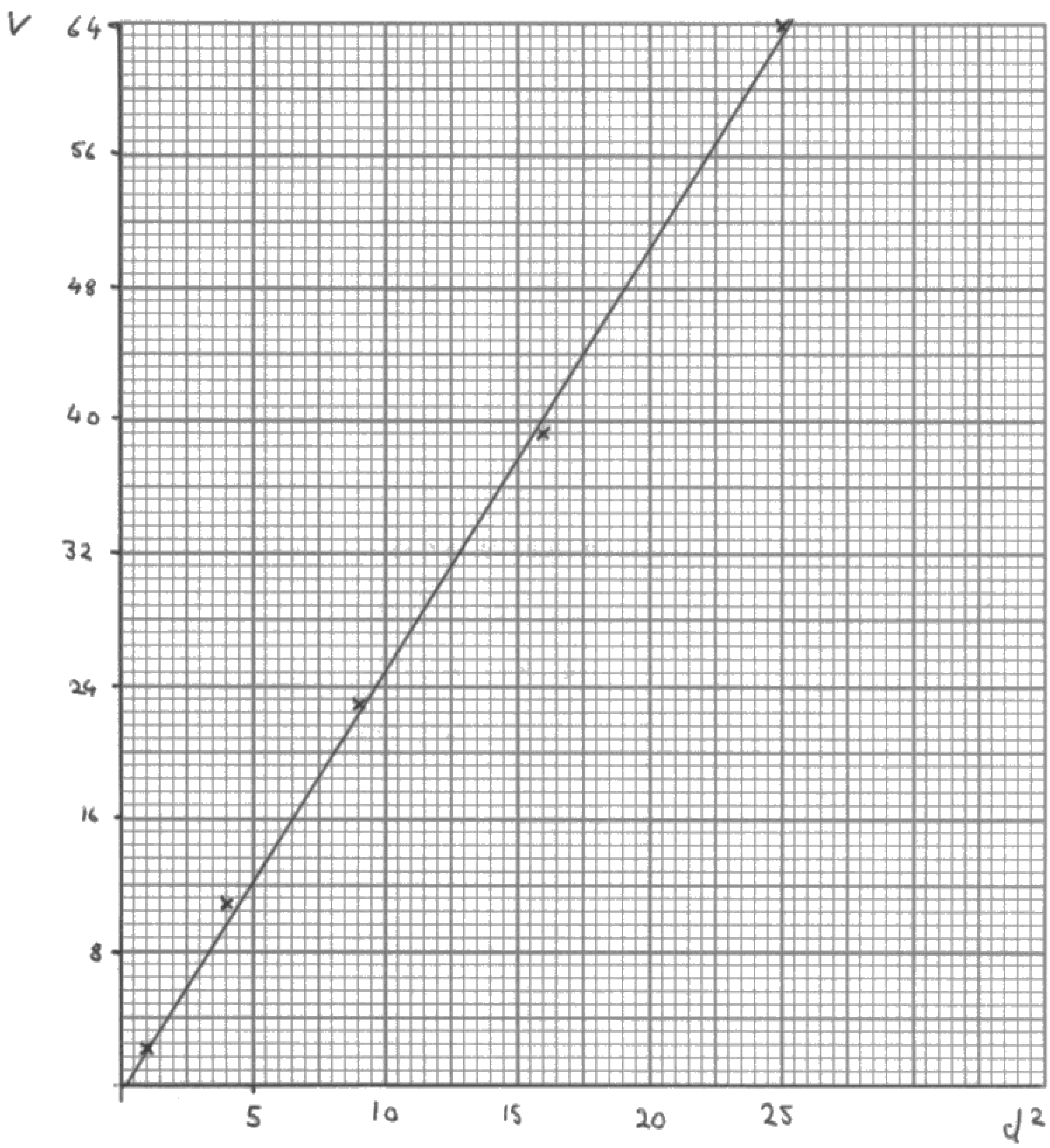
Marking point 4:

while most candidates realised that the fluid was corn syrup, only those with a value of the correct order could score this mark. Some candidates, on realising that the calculated value for the viscosity was a factor of 10^3 too high in comparison to the values in the table, either re-wrote their answer without any justification as to why or they divided by 1000, without any justification. This was noticed, and although it may have allowed the candidate to score MP4 for their choice of fluid from the table, it still didn't allow them to score the mark for the calculated viscosity as there was no justification for this last minute power of 10 change.

This response scores 0 for the graph (part b) and 2 for the analysis of the graph (part c) and was typical of responses from those who may have just missed out on obtaining an E grade.

Plot the graph of v against d^2.

(4)



(c) The table shows the viscosity of some different fluids.

Fluid	Viscosity at room temperature / Pa s
castor oil	1.0
glycerol	1.2
corn syrup	1.4
honey	1.9

Use the graph to deduce which fluid the student used.

density of ball bearing = 8000 kg m^{-3}
density of fluid = 1260 kg m^{-3}

(4)

$\frac{64}{25} = 2.56 \quad 2.56 = \frac{9.81(8000-1260)}{18n}$

$n = \frac{9.81(8000-1260)}{46.08}$

$n = 1.4\,?\,4$

corn syrup

ResultsPlus

Examiner Comments

Working through the marking points:

(a)

MP1: no units or powers of 10 for the labelling of the axes so no mark.

MP2: Scale for the velocity axis goes up in 4s for each cm square so is not thought to be a ‘sensible scale’ so no mark.

MP3: cannot be awarded as points cannot be checked using such a scale.

MP4: one point sits on the line, three above the line and one below. This is not the line of best fit so no mark.

(b)

MP1: (25, 64) used as a pair of points from the graph. Although this point does not sit on the line it is close enough. As the line goes through the origin taking a pair of points from the line and using them in the formula, or in this case dividing them, is equivalent to a gradient. The point is far enough along the line to make a large triangle (had the gradient been taken) so the mark was awarded.

MP2: mark awarded for correct substitution into the equation. Power of 10 errors not penalised.

MP3: calculated answer 10^3 too large so no final answer mark.

MP4: the candidate has selected corn syrup, but as they do not have a value to base this on, no credit can be given.

ResultsPlus

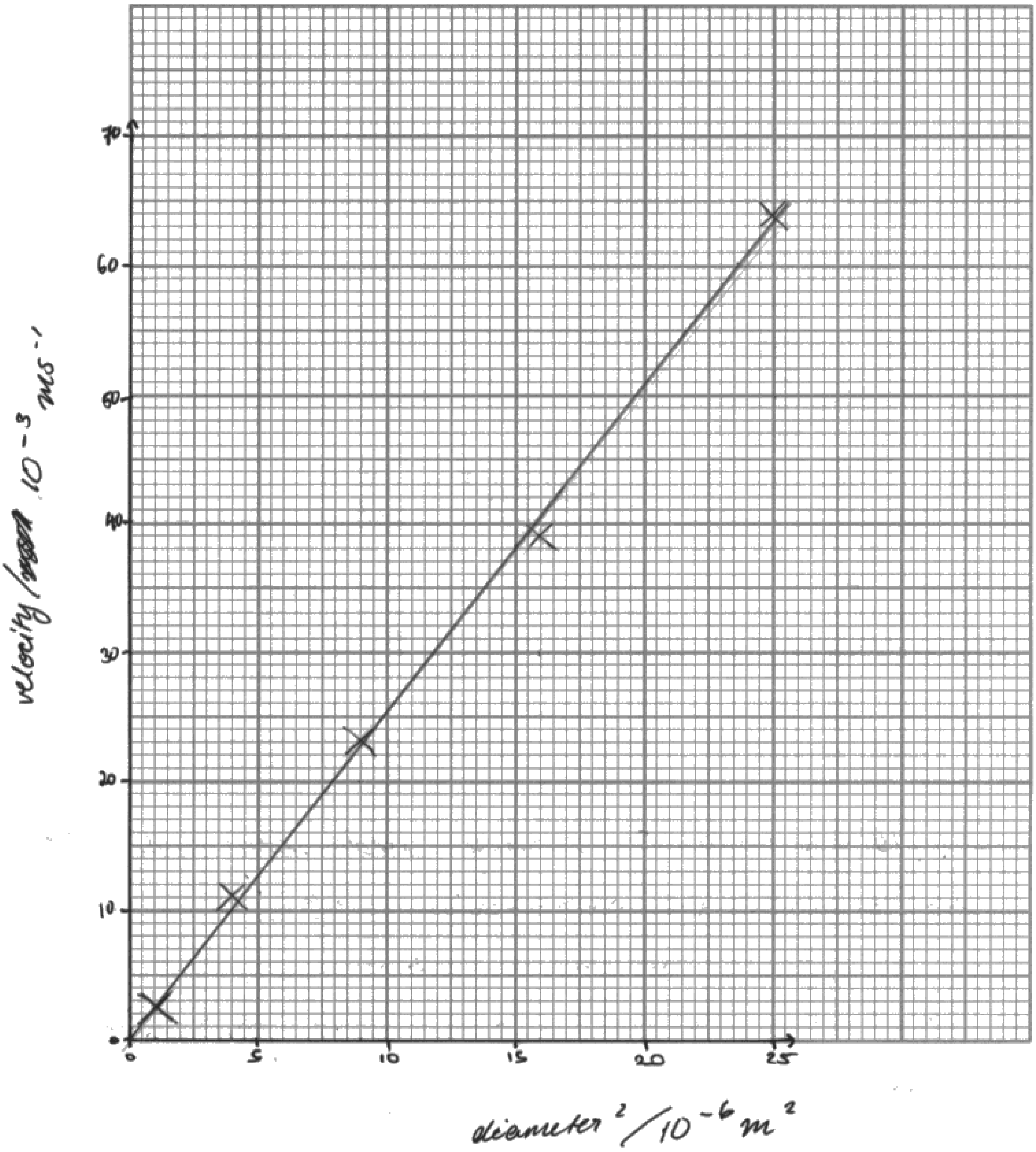
Examiner Tip

Please remember to label axes with quantities, units and any scaling factors, use scales that do not go up in 3, 4 or 7 and to remember to use any powers of 10 given when you are using values from the graph in calculations.

This response scores 4 for (b) and 4 for (c) and demonstrates how taking care to make sure a few small steps are included gives candidates access to more marks with really no greater demand.

Plot the graph of v against d^2.

(4)



(c) The table shows the viscosity of some different fluids.

Fluid	Viscosity at room temperature / Pa s
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honey	1.9

Use the graph to deduce which fluid the student used.

density of ball bearing = 8000 kg m^{-3}
density of fluid = 1260 kg m^{-3}

(4)

$V = \frac{d^2 g(\rho_b - \rho_f)}{18\eta}$ $\quad \frac{V}{d^2} = \frac{g(\rho_b - \rho_f)}{18\eta}$ $\quad \frac{V}{d^2} = \text{gradient} = \frac{64.0 (\times 10^{-3})}{25 - 0 (\times 10^{-6})}$

$= 2.56 \times 10^3$

$10^3 \times 2.56 \times 18\eta = g(\rho_b - \rho_f)$ $\quad g = 9.81$ $\quad \rho_b = 8000 \text{ kgm}^{-3}$

$46.08\eta = 9.81(8000 - 1260) \times 10^{-3}$ $\quad \rho_f = 1260 \text{ kgm}^{-3}$

$\eta = ~~78323.04~~ \; 66119.4 \times 10^{-3}$

$\therefore \eta = 1434.88 \times 10^{-3}$

$= 1.43 \text{ Pa s}$ $\quad \therefore$ they used corn syrup

ResultsPlus
Examiner Comments

(a) Labelling, scaling, plotting all correct. Line of best fit may not be the best but is better than that of the previous candidate with two points on the line, one below and two above (by smaller distances than the point below).

(b) (25, 64) used again. Again not quite on the line but close enough to be considered for MP1, use of the graph. Most importantly this candidate has remembered to include the powers of 10 in their calculation so the value obtained is correct and credit can be given for the choice of corn syrup.

ResultsPlus
Examiner Tip

Remember powers of 10 every time!

Question 16 (a)

Candidates were generally not able to hit the key word or concept that there are applications needing a greater thickness compared with the limitation of a single-atom layer graphene, hence the difficulty in manufacture. Although some reasonable ideas were often seen, if these were not linked to the significant point that graphene was only 1 atom thick no credit could be given.

Although reference was given to the strength and breaking stress, very few demonstrated an understanding of the terms strength and stress and made the point that the graphene could fracture at a lower forces. Many candidates concentrated on the economic arguments or the larger abundance of iron ore compared to graphene.

1 mark scores for MP1.

16 In 2010, Andre Geim and Konstantin Novoselov were awarded the Nobel Prize in Physics for producing, identifying and studying graphene.

Graphene is a form of carbon which exists only as a single atomic layer of graphite. It has a breaking stress of 130 GPa compared to 0.5 GPa for steel. Some scientists claim that graphene is the strongest material ever measured.

(a) Explain why graphene, despite its greater strength, is unlikely to replace steel in many applications.

(2)

It is only a single atom thick, which means that it could not be used when thicker material is needed. Steel is very malleable and easy to manipulate in is therefore easier to make things out of than graphene. Steel is harder than graphite and therefore may be more useful in certain situations. Graphene is significantly harder to create than steel and would be hard to mass produce.

ResultsPlus

Examiner Comments

The candidate has the idea that most applications would need the thickness to be greater than one atom.

As was commonly seen the candidate then went on to discuss familiar properties. In this example they described the hardness of graphene, a property not mentioned in the stem or one that candidates would be expected to know anything about for this material.

This was one of the best responses seen and scored both marks.

16 In 2010, Andre Geim and Konstantin Novoselov were awarded the Nobel Prize in Physics for producing, identifying and studying graphene.

Graphene is a form of carbon which exists only as a single atomic layer of graphite. It has a breaking stress of 130 GPa compared to 0.5 GPa for steel. Some scientists claim that graphene is the strongest material ever measured.

(a) Explain why graphene, despite its greater strength, is unlikely to replace steel in many applications.

(2)

because graphene can only exists in single layers meaning despite its greater breaking stress it will be able to withstand much less force as it can only exist in single layers as $\sigma = \frac{F}{A}$ and area of one layer of graphene is extremely ~~steel~~ small so $\sigma \times A = F$ so the force is much smaller than the force steel can withstand as ~~steel~~ steel can have a much larger area

ResultsPlus
Examiner Comments

The candidate has understood that although the breaking stress is large, because stress = force/area and the (cross sectional) area is very small, the breaking force will be less than that of steel. The first marking point has not been described quite as precisely but the candidate has made a comparison of the area of graphene to that of steel, accepting area to be the cross sectional area.

Question 16 (b)

A difficult calculation to be carried out in one step which only the most able candidates were able to do. It appeared as though the majority of candidates had not read the question and automatically assumed that the pencil line should be treated as a wire with the diameter of an atom.

Many candidates limited their score to the third marking point as they used a circular cross section and didn't take into account the number of layers of graphene. Therefore πr^2 was seen in most responses with 7.92 x 10^{-14} Ω m the most common answer, scoring a maximum of 1 mark if the working out had been shown. This was just for use of the resistivity formula with a dimensionally correct quantity to represent the area.

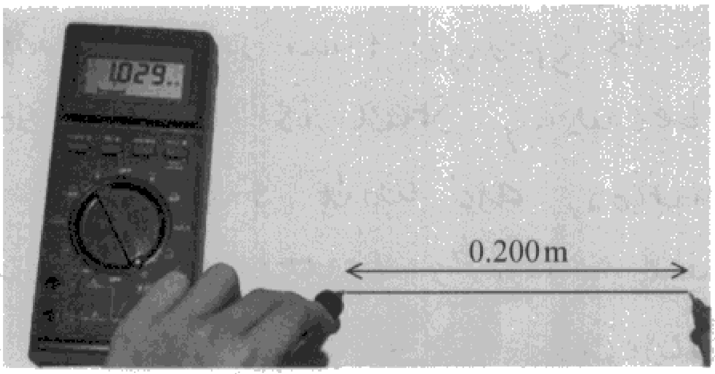
It is perhaps worth reminding candidates that when data is given in questions, particularly in digit form, there is usually a need for it to be used; those using the $\pi r^{2,}$ seemed to ignore the data given about 100 atoms thick and 0.50 mm long. Those that were successful in this question were usually seen to draw a small diagram next to their working to help with the formulation of the cross sectional area from the given data.

A rare but correct response scoring all 4 marks.

(b) Graphite used in pencils consists of many layers of carbon. It can be assumed that a pencil deposits approximately 100 layers of carbon atoms when drawn across a piece of paper.

A student carried out an experiment to determine the resistivity of the graphite in a pencil.

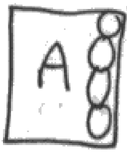
A line of length 0.200 m and width 0.50 mm was drawn on a piece of paper. An ohmmeter was then used to measure the resistance of the graphite line.



Calculate the resistivity of graphite.

resistance = $1.029 \times 10^6\ \Omega$
diameter of carbon atom = 1.4×10^{-10} m

0.5×10^{-3} M



$100 \times (1.4 \times 10^{-10})$

(4)

$\rho = \frac{RA}{L}$

$A = (0.5 \times 10^{-3}) \times (100 \times 1.4 \times 10^{-10})$

$\rho = \frac{(1.029 \times 10^6) \times (7 \times 10^{-12})}{0.200}$

$A = 7 \times 10^{-12}\ M^2$

$\rho = 3.60 \times 10^{-5}\ \Omega M$

Resistivity of graphite = $3.60 \times 10^{-5}\ \Omega M$

ResultsPlus
Examiner Comments

A small diagram helped the candidate to use all of the given data appropriately, as mentioned above. The area was clearly calculated in a separate stage and then correctly substituted into the formula for the resistivity.

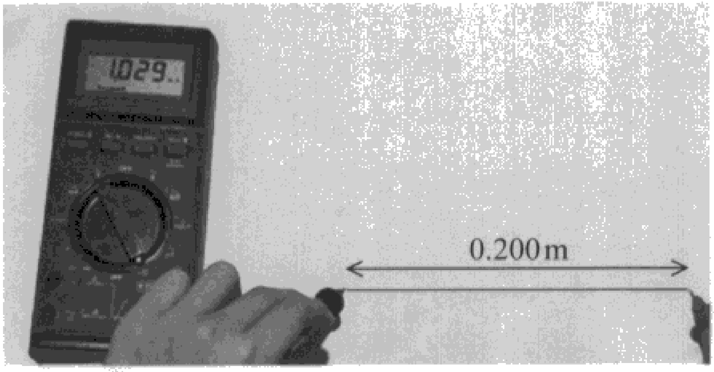
Units were not always included when the answer was correct which prevented the final mark from being awarded.

This response scored 1 mark and was typical of the majority seen.

(b) Graphite used in pencils consists of many layers of carbon. It can be assumed that a pencil deposits approximately 100 layers of carbon atoms when drawn across a piece of paper.

A student carried out an experiment to determine the resistivity of the graphite in a pencil.

A line of length 0.200 m and width 0.50 mm was drawn on a piece of paper. An ohmmeter was then used to measure the resistance of the graphite line.



Calculate the resistivity of graphite.

resistance = $1.029 \times 10^{6}\ \Omega$
diameter of carbon atom = 1.4×10^{-10} m

(4)

$R = \frac{\rho l}{A}$ $\rho = \frac{RA}{L}$

$\rho = \frac{(1.029 \times 10^{6}) \times (\pi \times (7 \times 10^{-10})^{2})}{0.2}$

$\rho = \frac{(1.029 \times 10^{6}) \times (1.54 \times 10^{-18})}{0.2}$

$\rho = \frac{1.58 \times 10^{-12}}{0.2}$ $\rho = 7.9 \times 10^{-12}$

Resistivity of graphite = 7.9×10^{-12}

ResultsPlus

Examiner Comments

The diameter of an atom was halved and incorrectly used in the equation πr^2 as the cross sectional area of the sample. Only MP3 for use of $\rho = RA/l$ could be credited.Just to note here, as was also common with may responses, that no units were given.

Question 16 (c)

This was the last part of the last question on the paper, however some responses, not always from the most able candidates, demonstrated a good understanding of the physics involved as well as the context of the question. Many missed the subtlety of the question in that it was a comparison where the information had been supplied about the graphene and they had to provide the physics of standard photocells from their knowledge.

A significant amount of information regarding the photoelectric properties of graphene had to be included in the stem of the question in order for candidates to be able to draw on their knowledge of the properties of standard photocells and make a comparison between the two types. It was often quite a fine line between repeating information given in the stem and applying it to the comparison. Therefore many responses repeated the information given in the question without adding anything to it to apply the context and answer the question and it is worth pointing out to candidates as obviously no credit would be given for repeating information stated on the paper.

As with 16(a) candidates are expected to apply their knowledge and answer in terms of the physics and not answer in general terms. In this case quite a few candidates were rather vague when discussing the effect of more electrons being emitted stating that more electricity would be generated rather than a greater current. However, answers in terms of a greater efficiency were probably awarded the most frequently and it was pleasing to see some of the middle ability candidates picking up marks for this question as well as the most able.

The most commonly seen misconception about the working of photocells is probably worth mentioning in that some candidates seemed to think that the graphene, as silicon, emit photons rather than absorb them in this process.

This response scores 1 mark.

(c) Photocells traditionally use silicon to generate electricity using visible light. Research demonstrates that unlike silicon, graphene is able to respond at all wavelengths and releases multiple electrons as it absorbs one photon.

Deduce why it would be an advantage to use graphene in photocells to generate electricity.

(3)

As graphene is able to ~~recieve~~ respond to all wavelengths of light, the electrons ~~more~~ ~~to~~ that are released increased, as less ~~to~~ wavelengths are high wavelength could be used to emit electrons. This would increase the number of electrons emitted, making the photocell more efficient as more electricity is being produced from the ~~increase~~ increase of electrons.

(Total for Question 16 = 9 marks)

ResultsPlus
Examiner Comments

1 mark awarded for greater efficiency. As mentioned above and was commonly seen, 'more electricity' was mentioned.

The candidate also started off well and it looked as though they were going to score a mark for a comparison of the range of wavelengths. However, no comparison was made and the candidate had really only repeated information given in the stem of the question without adding anything further to it.

ResultsPlus
Examiner Tip

Check through your work to makre sure you are not just re-writing information stated above at the beginning of the question.

If a question mentions two objects or devices and then asks for you to describe the advantages of one then it would be sensible to make a comparison between the two in order to point out the advantages of the object you have been asked about.

This response scores 2 marks.

(c) Photocells traditionally use silicon to generate electricity using visible light. Research demonstrates that unlike silicon, graphene is able to respond at all wavelengths and releases multiple electrons as it absorbs one photon.

Deduce why it would be an advantage to use graphene in photocells to generate electricity.

(3)

- The advantage would be that the efficiency of the photocell will increase as ~~not an~~ multiple electrons will be released for one photon absorbed which increases current.
- Moreover, it responds to all wavelength of light hence not only visible light but ~~the sun or any~~ ~~any wavelength of~~ ~~vis~~ light of any wavelength will allow the photocell to work.
-

ResultsPlus
Examiner Comments

The candidate correctly identified that a graphene photocell would respond to more wavelengths of light rather than just visible light, i.e. a comparison of the range of wavelengths that both photocells would use (the first bullet point on the mark scheme). They also identified that a graphene photocell would be more efficient.

Finally, it was worth including a response that scores all 3 marks.

(c) Photocells traditionally use silicon to generate electricity using visible light. Research demonstrates that unlike silicon, graphene is able to respond at all wavelengths and releases multiple electrons as it absorbs one photon.

Deduce why it would be an advantage to use graphene in photocells to generate electricity.

(3)

Graphene releases ~~Due to the~~ multiple electrons from absorption of one photon whereas silicon only releases one so this means a greater current can be generated from graphene and silicon is only able to respond to certain wavelengths whereas graphene can respond to all so it will have a greater efficiency at converting incident light into electricity.

ResultsPlus

Examiner Comments

Although this answer is a little concise compared to others, as the candidate made straightforward comparisons between the two cells with each of their points. Their response contains three clear and correct marking points.

A mark was awarded for a comparison of the number of photoelectrons released (one compared to many for the graphene), just to note a statement such as 'graphene releases more electrons' than silicon would not be specific enough as candidates are taught that, for standard photocells, one photon releases one electron. A second mark was awarded for the increased range of wavelengths for graphene and a final mark was awarded for identifying the graphene would have a greater efficiency.

Paper Summary

This paper provided candidates with a wide range of contexts from which their knowledge and understanding of the physics within this unit could be tested.

A sound knowledge of the subject was evident for many, but the responses seen did not reflect this as the language lacked precision and its ambiguity prevented some marks from being awarded.

Based on their performance on this paper, candidates are offered the following advice:

- Slow down during the multiple choice items so that key words in the command sentences are not missed.
- Remember to check responses if there is time at the end of the paper in case careless mistakes have been made, especially powers of 10 or missing units.
- Learn accurate definitions of all terms given in italics in the specification.
- Practice multiple step calculations, especially those requiring trigonometry, to make sure that you have resolved correctly and are using the appropriate component.
- Practice calculations using potential divider circuits and make sure that the correct potential difference is selected when using Ohm's law or other methods to calculate unknown quantities.
- When describing an effect make sure your answers are precise and not in general terms or discussing the wrong object or component that has also been given as part of the question.
- Read the question and answer exactly what is being asked and do not repeat information given to you in the question.

Grade Boundaries

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

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