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Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2016

J250/11 Summer 2019 series

Version 1

Contents

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

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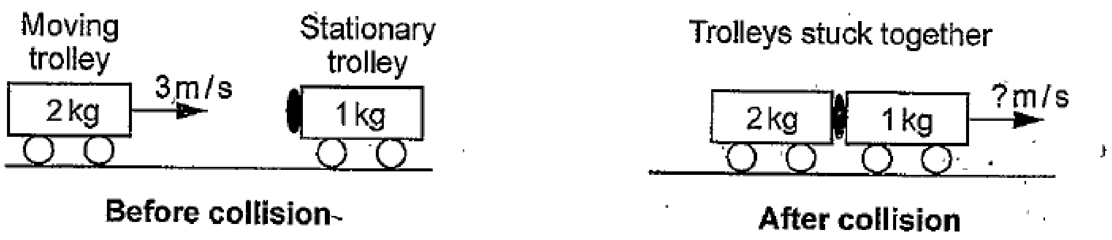
Paper 11 series overview

J250/11 is one of six Papers for the GCSE (9-1) Gateway Science Combined Science A Higher Tier Qualification. It is the first of the two physics papers covering Topics P1 Matter, P2 Forces, P3 Electricity and magnetism and CS7 Practical skills.

This is the second examination series for J250.

Candidates who used the data sheet and clearly showed calculations on questions where it was needed performed well. For example, in Question 10 where it was evident that some candidates had used the equation momentum = mass x velocity. This can be seen in Exemplar 1.

Exemplar 1



Calculate the combined speed of the trolleys **after** the collision.

Use the information in the diagram and the equation: momentum = mass × velocity

A 1 m/s

B 2 m/s

C 6 m/s

D 9 m/s

2x3=6kgm/s

6kgm/s ÷ 3kg = 2m/s.

Your answer B **[1]**

Section A overview

This section consists of 10 multiple choice questions testing AO1 and AO2.

Questions answered well by candidates	***Questions answered less well by candidates***
• Question 2 about melting • Question 5 about gravitational field strength • Question 8 about energy transferred to an electron • Question 9 about charge flowing	• Question 3 about gravitational fields • Question 4 about current in a series circuit • Question 6 about Newton's third law • Question 10 about momentum

Question 1

1 Some quantities are vectors and some are scalars.

Which row of the table is correct?

	Vector	Scalar
A	Speed	Displacement
B	Speed	Distance
C	Velocity	Displacement
D	Velocity	Distance

Your answer ☐ **[1]**

Many candidates were unable to distinguish between the quantities velocity and speed. Most candidates were able to identify distance as a scalar quantity and so the most common error was to select answer B rather than answer D.

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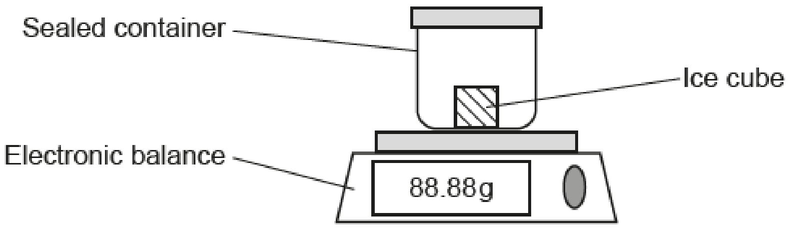
Question 2

2 An ice cube and container are placed on an electronic balance on a hot day. The container is sealed.



Which row of the table correctly describes what happens?

	Reading on balance	Type of change	Name of change
A	Decreases	Chemical	Evaporating
B	Decreases	Physical	Evaporating
C	Stays the same	Chemical	Melting
D	Stays the same	Physical	Melting

Your answer ☐ **[1]**

The majority of candidates selected answer D as they understood that melting was a physical change and that there was no change to the reading on the electronic balance.

Question 3

3 Which statement about gravitational fields is correct?

A A spacecraft has a gravitational field that causes attraction.

B Gravitational fields are attractive and repulsive.

C Gravitational field strength is measured in newtons.

D The larger the mass the smaller the gravitational field.

Your answer ☐ **[1]**

This question was challenging with the majority of candidates selecting answer C or D., rather than the correct answer A.

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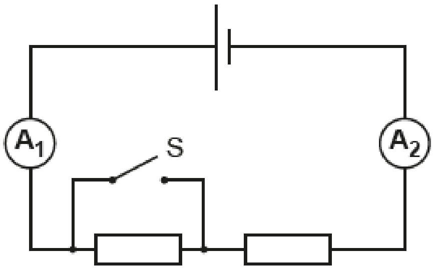
Question 4

4 A student connects this electrical circuit. The resistors are identical.



Ammeter $\mathbf{A_1}$ reads 1.6A when the switch S is open.

What does ammeter $\mathbf{A_2}$ read when switch S is closed?

A 0.0A

B 0.8A

C 1.6A

D 3.2A

Your answer [ ] **[1]**

The correct answer is D, but the majority of candidates selected answer C. The candidates had not considered that when the switch was closed it provided a path that did not include one of the resistors. By Ohms law as the voltage was constant and the resistance had halved then the current must double.

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Question 5

5 On the Moon, a 10 kg mass has a weight of 16 N.

What is the gravitational field strength on the Moon?

A 1.6 N/kg

B 6.0 N/kg

C 26 N/kg

D 160 N/kg

Your answer ☐ **[1]**

The majority of candidates recognised that A was the correct answer. The most common incorrect answer was D.

Question 6

6 Which statement describes Newton's **third** law?

A Action and reaction are equal, opposite and act on the same object.

B Action and reaction are equal, opposite and act on separate objects.

C The rate of change of momentum is equal and opposite to resultant force.

D The rate of change of momentum is proportional to resultant force.

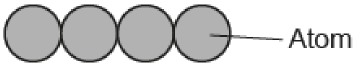
Your answer ☐ **[1]**

Candidates found this question challenging with the most common answer being A.

?	**Misconception**	Many candidates find Newton's third law difficult to visualise. The most common issue is that they do not appreciate that the action and the reaction forces act on separate objects. For example, when A pushes B, the reaction is B pushing back against A.

Question 7

7 A student thinks about atoms placed side by side in a row.



Approximately, how many atoms would fit in a length of 1 m?

A 1×10^{8}

B 1×10^{10}

C 1×10^{12}

D 1×10^{14}

Your answer **[1]**

Half the candidates gave the correct answer B (1×10^{10}). The most common incorrect response was answer (1×10^{8}).

Question 8

8 An electron is accelerated through a potential difference of 12 000 V. The charge on an electron is 1.60×10^{-19} C.

Calculate the energy transferred to the electron.

Use the equation: energy transferred = charge × potential difference

A 1.33×10^{-23} J

B 1.92×10^{-15} J

C 1.20×10^{4} J

D 7.50×10^{22} J

Your answer **[1]**

This question was answered well by most candidates with the few incorrect responses being equally distributed between A, C and D.

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Question 9

9 A current of 2.5A flows for 1 minute through a circuit.

Calculate the charge flowing.

Use the equation: charge flow = current × time

A 0.04 C

B 2.5 C

C 24 C

D 150 C

Your answer ☐ **[1]**

This question was answered well by the majority of candidates (option D, 2.5 A x 60 s = 150 C). The most common incorrect answer was B, where candidates had forgotten to convert minutes to seconds.

Question 10

10 The diagrams show a collision between two trolleys.

Before collision **After collision**

Calculate the combined speed of the trolleys **after** the collision.

Use the information in the diagram and the equation: momentum = mass × velocity

A 1 m/s

B 2 m/s

C 6 m/s

D 9 m/s

Your answer ☐ **[1]**

Only a fifth of candidates applied their understanding of the conservation of momentum correctly and selected option B. The majority of candidates selected option C or option D.

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Section B overview

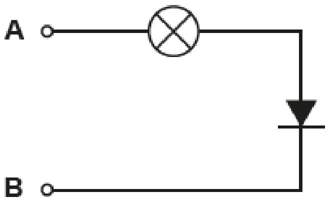
This section consists of six questions testing AO1, AO2 and AO3.

The most successful candidates	*The least successful candidates*
• were able to manipulate equations and apply them to different situations • Question 13 – had experience of solenoids (electromagnets) and understood the experimental procedures, recording of results and interpretation of these results • Question 15 – had experienced the use of a demonstration using light gates and explained the observations using the correct terminology and use of relevant equations	• had difficulty interpreting the scales on graphs • appeared to be unfamiliar with practical science activities and How Science Works • were unable to give answers to questions about incorrect results • were unable to give answers to questions about improvements to procedures • Question 15 – were unable to understand what was being demonstrated and may not have experienced the use light gates

Question 11 (a)

11 A student makes a 'component tester'. He connects a diode to a small filament lamp.

This is a diagram of the component tester.



(a) Describe how the student could use the component tester to find the positive (+) terminal of a cell.

....

....

....

....

....

.... **[3]**

A fifth of candidates gained some credit for this question, although most of those only got one mark. Many candidates did not appreciate that a cell needed to be added to the circuit and that the cell must be positioned with the correct polarity so that the lamp will light when the positive terminal of the cell is connected to A. Some candidates suggested using a metre to measure the speed at which electrons passed around the circuit from A and also from B because these candidates believed that the diode needed the electrons to move faster in order to work.

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AfL	Candidates need to answer the question about how to use the component tester to find the positive terminal of the cell. The majority of candidates described how a diode works. Many wrote in detail about the diode only allowing current to flow in one direction, but did not describe how to use the 'component tester.'

Misconception	There were several common misconceptions these included: • a greater current was provided by the positive terminal • an ammeter is needed to measure current in the circuit before the position of the positive terminal can be determined • that electrons flow in both directions around the circuit and the diode works like a valve to make the electrons flow in only one direction.

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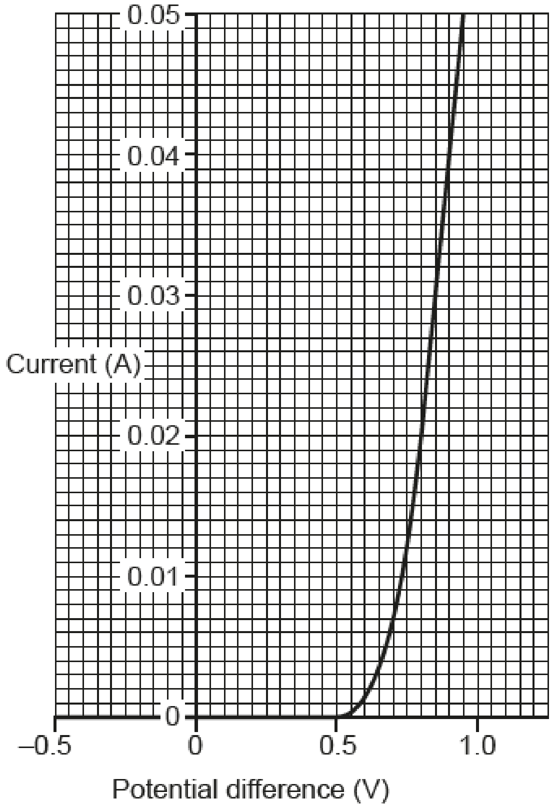
Question 11 (b) (i)

(b) Here is a graph of current against potential difference for a diode.



(i) The diode is **not** a fixed resistor.

Describe **two** ways the graph shows this.

1 ....

....

2 ....

.... **[2]**

This was generally answered well with the majority of candidates gaining one mark for describing that the graph was not a straight line. Many candidates did not describe how the graph showed that the diode was not a fixed resistor but gave answers in terms of the current or potential difference increasing without referring to the graph. Lower ability candidates described the graph as having a constant gradient, as the current decreases the potential difference increases differently and the steepness of the line is different.

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Question 11 (b) (ii)

(ii) Calculate the resistance of the diode at +0.8 V.

Use the graph **and** the equation: potential difference = current × resistance

Resistance = ... Ω **[4]**

The majority of candidates were able to calculate the resistance of the diode at +0.8V. Lower ability candidates often misread the graph with common answers being 0.029 or 0.19 instead of 0.019. Other incorrect responses were from using incorrect formulae so 0.8 x 0.02 and 0.02/0.8 were seen.

Question 11 (c)

(c) The manufacturer of the diode gives the following warning:

The supply voltage must not exceed 1 V.

Use the graph in **11(b)** to explain why.

....

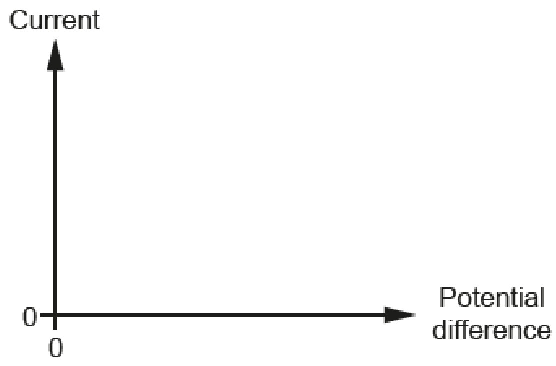
....

.... **[2]**

The majority of candidates were able to explain that the current increased after 1 V but then did not comment on the resistance or the effect of this increased current on the diode. Lower ability candidates gave vague answers in terms of the diode not functioning correctly, the diode not working or that over 1 V it would be dangerous.

Question 11 (d)

(d) Sketch a graph of current against potential difference for a filament lamp.
Use the axes below.



[1]

The majority of candidates were unfamiliar with the I–V characteristics of common circuit components (P3.2g and P3.2h), and only a fifth of candidates were given the mark. Most candidates either drawing a straight positive gradient line which then sharply levelled off or they drew the initial part of the graph with an inverse curve.

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Question 12 (a) (i)

12 **(a)** A student has two metal cubes, **A** and **B**, as shown in **Fig. 12.1**.

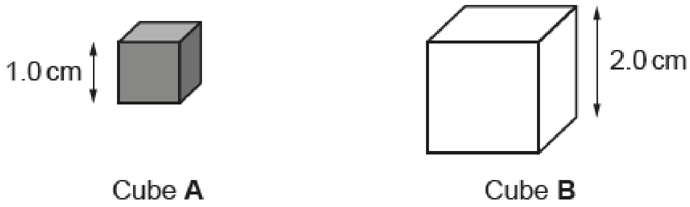

Fig. 12.1

Each side of metal cube **A** is 1.0 cm. Each side of metal cube **B** is 2.0 cm.

Both metal cubes have the same mass. The density of metal cube **A** is 16 g / cm^3.

(i) Calculate the density of metal cube **B**.

Use the equation: density = mass ÷ volume

Density = ... g / cm^3 **[3]**

The majority of candidates were able to calculate the density of metal cube B. Most candidates wrote down clear and ordered workings before giving the correct answer on the answer line. Lower ability candidates rearranged the equation incorrectly that many of them calculated the mass as 16 ÷ 1 instead of 16 x 1. Other candidates rearranged the density equation in a number of different ways and versions that gave the mass as 16 x 8 = 128, 16 ÷ 2 = 8 and 2 x 16 = 32 were all seen.

Exemplar 2

$1 \times 1 \times 1 = 1.0 cm^3$

$16 = \frac{mass}{1.0}$

mass = 16g

$2 \times 2 \times 2 = 8.0 cm^3$

density = $\frac{16}{8}$ = 2 g/cm^3

Density = ...2.... g / cm^3 **[3]**

This candidate response shows an example of clearly set out workings with a logical structure that was easy to follow and was awarded all three marks.

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Question 12 (a) (ii)

(ii) Metal cube **A** sinks when placed in water.

Explain why.

....

.... **[1]**

This was generally answered correctly by two thirds of candidates. The most common misconception was where candidates compared the density of cube A with cube B rather than comparing the density of cube A with water. Many lower ability candidates thought that cube A was heavier, or more solid, than water. Several candidates stated that the volume / surface area of cube A was greater than the volume / surface area of water.

Question 12 (b) (i)

(b) The student hangs cube **A** from the end of a vertical spring and waits for the spring to become stationary, as shown in **Fig. 12.2**.

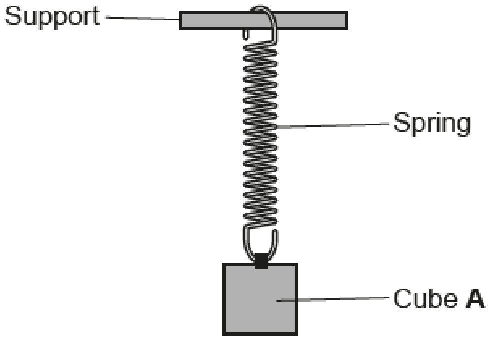

Fig. 12.2

(i) Draw a labelled free body force diagram **for the spring**.

The spring is attached to the support at the top and has cube **A** attached at the bottom.

[2]

This was a very challenging question and very few candidates gaining any marks. The expected answer was for candidates to show the pull of the support (upward force on spring) and the gravity force of the spring+weight (as the downward force on the spring). Many candidates gave weight / gravity as the downwards force and air resistance / drag as the upward force. Other candidates did not attempt to draw a free body diagram and instead just added the support to the top of the spring and the cube to the bottom of the spring without indicating the forces involved.

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Question 12 (b) (ii)

(ii) The resultant force on the spring is zero.

Explain why.

Use your answer to **12(b)(i)** to help you.

....

.... **[1]**

The majority of candidates were able to describe the forces involved as being equal and opposite.

Question 12 (b) (iii)

(iii) More than one force is required to stretch the spring.

Describe what happens if only one force is applied.

....

.... **[1]**

This question was challenging with the majority of candidates failing to appreciate that the spring would accelerate. Many candidates thought that the spring would extend and go beyond its elastic limit, the spring would become plastic, the spring would deform or the spring would stretch.

Question 12 (b) (iv)

(iv) The student removes cube **A** and places another cube, cube **C**, on the spring.

The extension of the spring due to cube **C** is 0.04 m.

The spring constant of the spring is 30 N/m.

Calculate the weight of cube **C**.

Weight = ... N **[3]**

Candidates either gained full marks or got no marks for this question. Higher ability candidates were able to quote the equation F = kx and then show clear working to obtain the correct answer of 30 x 0.04 = 1.2 N. Lower ability candidates were unable to use the equation correctly and the most common misconception was 30 ÷ 0.04 = 750 N. Some candidates used the equation $F = 1/2kx^2$ with the calculation being $F = 0.5 \times 30 \times 0.04^2$.

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Question 13 (a) (i)

13 (a) A student wraps a coil of insulated wire around a soft iron rod to make an electromagnet. He places some steel pins on a wooden mat under the iron rod. **Fig. 13.1** shows the set-up of the apparatus.

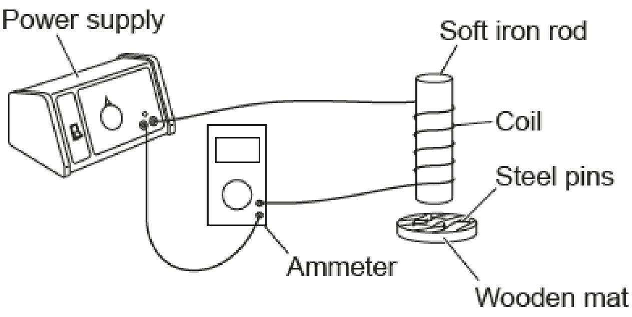

Fig. 13.1

He changes the number of turns in the coil. He records how many pins are picked up by the iron rod. The table shows his results.

Number of turns in coil	Current (A)	Number of pins
10	0.50	1
20	0.50	2
30	0.25	2
40	0.25	2
50	0.50	4

(i) The student concludes 'The more turns, the stronger the magnetic field'.

Do the results in the table support his conclusion?

Explain your answer.

....

.... **[1]**

This question was answered well with good answers including the use of two sets of linked information from the table. Most candidates explained that as the number of turns increased from 1 to 10 the number of pins picked up increased from 1 to 5. A common misconception by lower ability candidates was to link the number of turns to the size of the current.

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Question 13 (a) (ii)

(ii) The electromagnets with 20 and 40 turns pick up the same number of pins.

Suggest why the electromagnet with 40 turns is more useful.

....

.... **[1]**

Two thirds of candidates answered this question correctly and less current was the most common answer given.

Question 13 (b) (i)

(b) **Fig. 13.2** shows the inside of a simple d.c. motor. The direction of the current in the coil is shown.

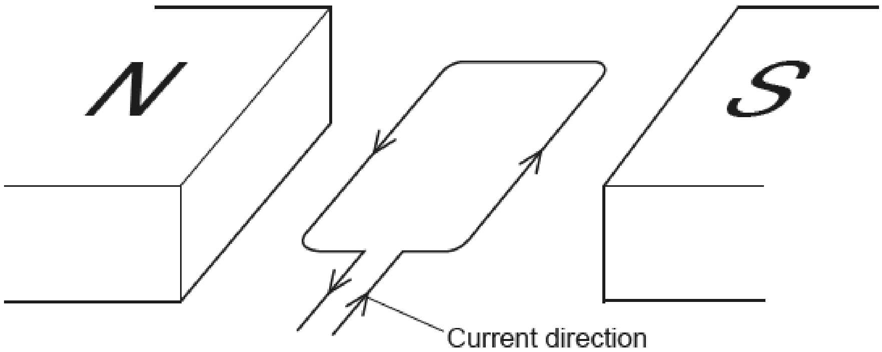

Fig. 13.2

(i) Which direction will the coil rotate in **Fig. 13.2**?

State the name of the rule you used to work out your answer.

Direction ....

Name of rule .... **[1]**

Only the highest ability candidates were able to answer this question correctly. While a large number of candidates gave the name of the rule as Fleming's left-hand rule, they were unable to describe the direction in which the coil would rotate.

?	**Misconception**	The coil/rotor in the diagram will rotate in a clockwise direction (from the point of view of the observer). A significant number of candidates gave this direction as: • to the right • upwards • to the left • north or south None of these descriptions gives the direction of a rotation

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Question 13 (b) (ii)

(ii) **Fig. 13.3** shows the simple d.c. motor from above.

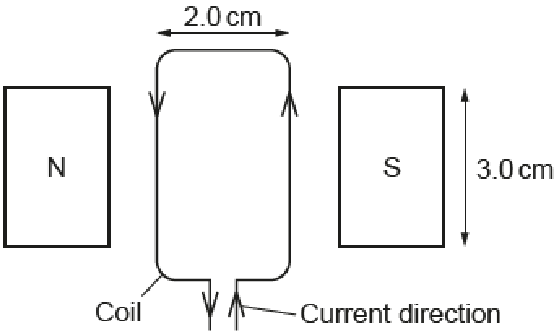


Fig. 13.3

In **Fig. 13.3** the magnetic field between the poles is uniform. The magnetic flux density between the poles is 0.08 T. The current in the coil is 0.50 A.

Calculate the maximum magnetic force on **one** side of the coil.

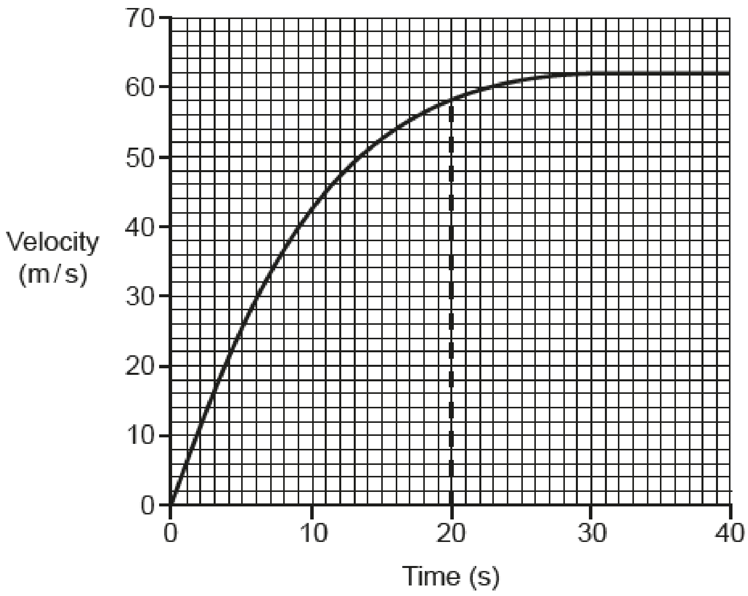
Use the values in the diagram to help you.

Maximum magnetic force = ... N **[4]**

Half of the candidates got some credit for this question although most candidate responses were credited with either one mark or 3 marks. The candidates who gained 3 marks did not convert 3 cm into 0.03 m and calculated the maximum magnetic force as 0.12N. Lower ability candidates were able to select the correct equation from the data sheet as force on a conductor = magnetic flux density x current x length (F = BIL) but then used an incorrect value for the length of coil in the magnetic field.

Question 14 (a)

14 A car accelerates from rest. This is a graph of the motion of the car on a straight road.



(a) In the first 20 seconds, the car travels 750 m.

Show that the **total** distance travelled in 40 seconds is approximately 2000 m.

Use the graph to help you.

[2]

This question proved challenging for many candidates, who did not read data correctly from the graph or did not realise that they had been given the value for the area of the first part on the graph (750 m) in the question. A common misconception was to use 62 x 40 to calculate the area rather than 62 x 20. Some candidates tried to calculate the whole area under the graph by breaking it down into several smaller parts. This method usually resulted in an answer that was outside the acceptable range (1200–1240 m).

Question 14 (b)

(b) Calculate the **average speed** for the total journey shown in the graph.

Average speed = ... m/s **[3]**

This question was answered well by the majority of candidates. Most candidates either used their answer from part (a) instead of the 2000 or used 2000/40 to calculate the average speed. Many lower ability candidates were credited with one mark for quoting the speed = distance travelled ÷ time equation.

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Question 15 (a)

15 Student **A** does an experiment to find out if force is related to acceleration.

Fig. 15.1 is a diagram of her experiment.

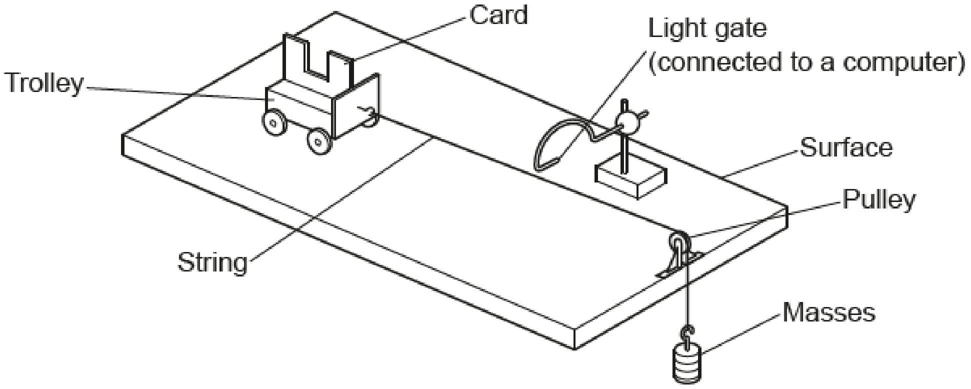

Fig. 15.1

(a) She hangs a 400 g mass over the pulley.

How can she work out the accelerating force on the trolley?

Use an equation to help explain your answer.

....

....

....

.... **[2]**

Most candidates only addressed the first part of the question in their answers with less than half of candidates gaining any credit. These candidates were credited with a mark for giving the equation F = ma as part of their answer but very few candidates explained how this equation could be used to work out the accelerating force. A common misconception was to confuse acceleration with the accelerating force and then use the equation a = v/t to calculate the acceleration.

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Question 15 (b)

(b) The tall parts of the card on the trolley labelled **X** and **Y** pass through the light gate, as shown in **Fig. 15.2**.

The light gate can measure:

- the time it takes for **Y** to go through
- the time it takes for **X** to go through
- the time between **Y** and **X** going through.

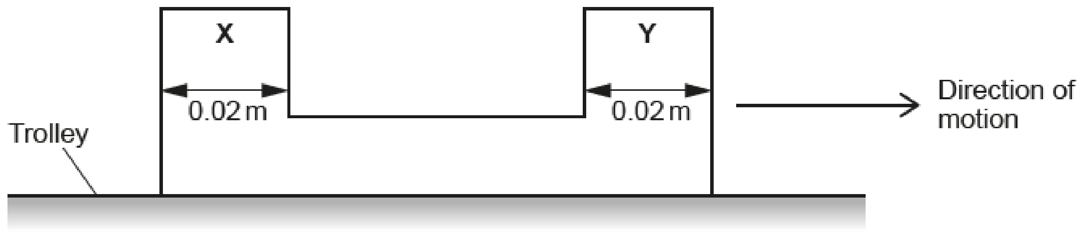

Fig. 15.2

How can student **A** use the **light gate** and **card** to measure the acceleration of the trolley?

Use an equation to help explain your answer.

....

....

....

....

.... **[2]**

The majority of candidates used the equation a = (v-u)/t as part of their answer and gained some credit for their response to the question. Many good answers were seen where seen where candidates used specific detail to link the change in speed (or velocity) of the trolley to the experimental procedure.

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Question 15 (c)

(c) Describe **one** way this experiment could be improved.

....

.... **[1]**

Only a few higher ability candidates successfully answered this question. Most of these candidates wrote answers in terms of using a slope or a smoother surface, although there were several other ways that this experiment could be improved. Many candidates thought that one way the experiment could be improved was to make the surface longer, to use a stopwatch, to use more light gates, and to increase the height of the card.

?	**Misconception**	Many candidates believe that to repeat and take an average on their own will improve the quality of an experiment/a result. Repeats only affect sets of data and will improve the precision of the data set but not the accuracy of the individual measurements.

i	**OCR support**	The Glossary of terms, https://www.ocr.org.uk/Images/467774-glossary-of-terms.doc is written in a student accessible way, and provides definition of the most common terms associated with practical procedures and the designing of experiments.

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Question 15 (d)

(d)* Student **A** records some measurements. She plots the data points and draws a line of best fit on the graph in **Fig. 15.3**.

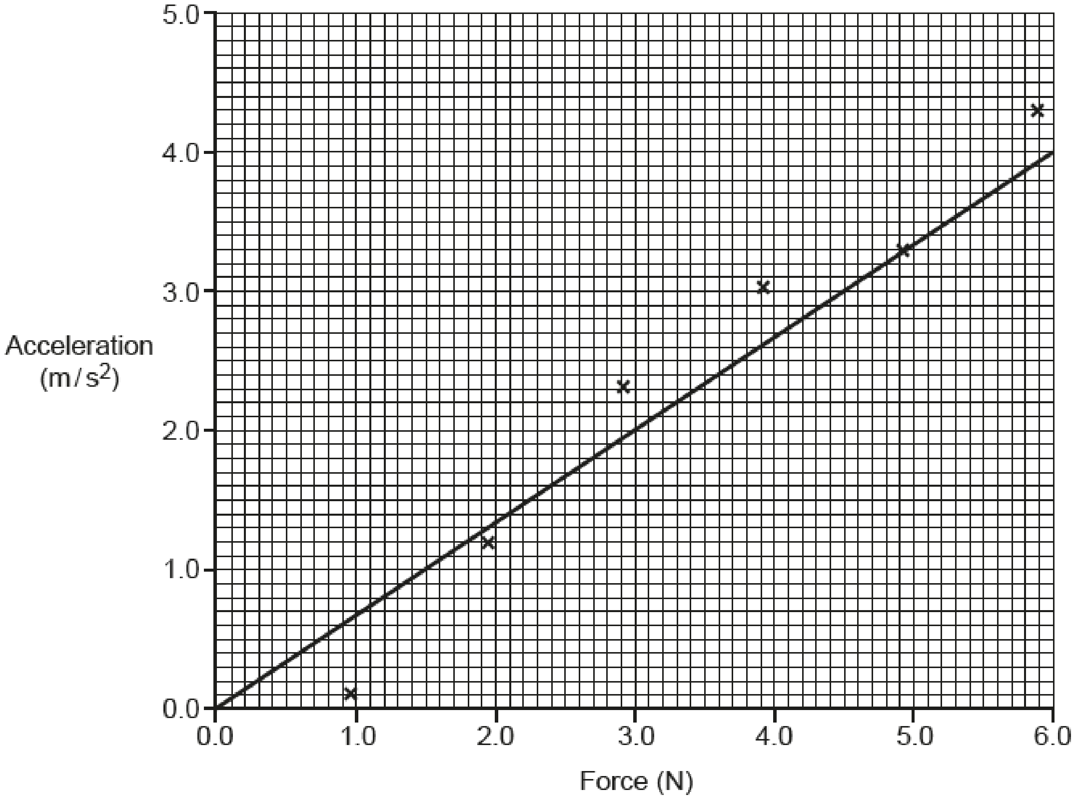

Fig. 15.3

Describe and explain what the results in **Fig. 15.3** show. Comment on the validity of student **A**'s results shown on the graph in **Fig. 15.3**.

You are **not** expected to include a calculation.

....

....

....

....

.... **[6]**

This is the level of response question. This question was attempted by the majority of candidates and the full range of the marks available were given. Many candidates gained credit for AO2for describing the relationship between force and acceleration and AO3 for a limited comment on the validity of the line of best fit. A few candidates evaluated the information on the graph and discussed how the data points were not being close to the line of best fit, the line of best fit may not go through the origin (0,0), that there were not enough data points or no evidence of repeated observations.

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Exemplar 3

Her line of best fit is incorrect, as it does not go through most of the points on the graph. (It only goes through one point) The line needn't start at the origin, as the first point is plotted at 1.0 N. Her results show that a higher force will increase the rate at which the trolley accelerates. This is a positive correlation. Her results, however, seem to be scattered quite randomly, suggesting that she may need to do ~~repe~~ repeat tests to get more accurate results.

In Exemplar 3 the candidate has broken their response down into a series of clear statements that cover all the requirements for AO2 and AO3. This is a good example of a response that meets all the criteria for Level 3 and was credited with 6 marks.

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Question 15 (e) (i)

(e) Student **B** does the same experiment.

Fig. 15.4 is a graph of her results.

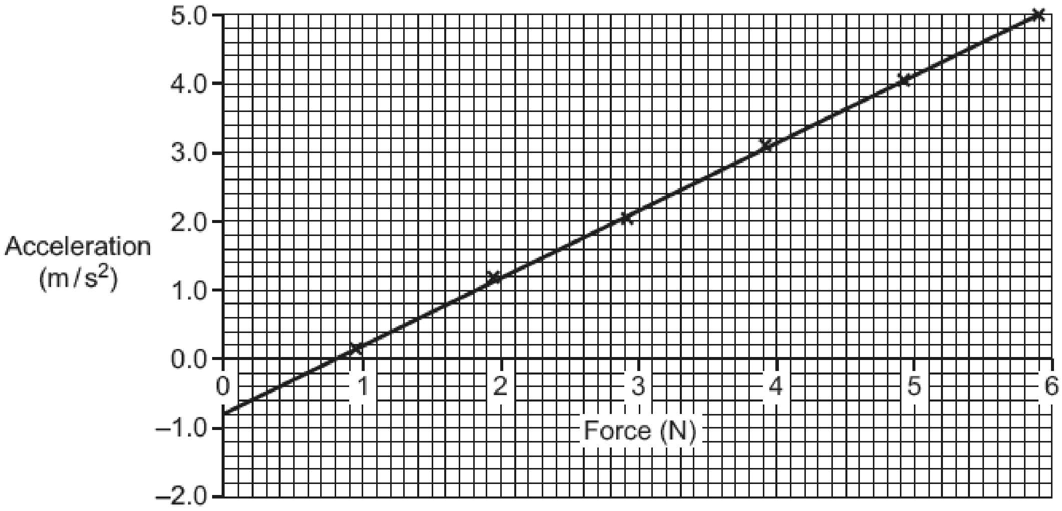

Fig. 15.4

(i) Calculate the gradient of the graph in **Fig. 15.4**.

Gradient = ... per kg **[2]**

Around half of all candidates were able to read the scale on the graph correctly in order to get the data they needed to calculate the gradient.

i	**OCR support**	The Mathematical Skills Handbook provides guidance on the use of graphs www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf Even simple operations using graphs can be challenging to students when there is something unfamiliar with the graph such as the negative values on the y-axis in Fig.15.4.

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Question 15 (e) (ii)

(ii) Student **B**'s graph in **Fig. 15.4** can be described by an equation.

Write this equation in the form: $y = mx + c$

Use your answer to **15(e)(i)** and student **B**'s graph in **Fig. 15.4** to help you.

....

....

....

.... **[2]**

The majority of candidates were able to apply the equation. The most common misconception was to read the intercept value incorrectly as either +0.8 m/s^2 or -0.9 m/s^2.

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