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Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2016

J250/05 Summer 2019 series

Version 1

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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.

Paper 5 series overview

J250/05 is one of the two Foundation Physics papers for the GCSE (9–1) Gateway Science Combined Science A. It covers the topics:

- P1 Matter
- P2 Forces
- P3 Electricity and Matter
- CS7 Practical Skills

To do well on this paper, candidates needed to able to recall and manipulate equations and be comfortable applying their knowledge and understanding to both familiar and unfamiliar contexts and practical science activities.

Candidate performance overview

Candidates who did well on this paper generally did the following.

- Recalled and applied or manipulated equations.
- Demonstrated knowledge of scientific procedures (egg finding density and making an electromagnet).
- Labelled forces and identified them as contact or non-contact.
- Analysed and interpreted graphs to draw conclusions and carry out calculations.

Candidates who did less well on this paper generally did the following.

- Found it difficult to recall and apply or manipulate equations.
- Struggled to interpret graphs and produced responses that lacked depth and detail.
- Lacked the necessary knowledge to respond to questions about density and series and parallel circuit.

The majority of candidates completed all questions in the examination within the allotted time.

Section A overview

Section A consists of 10 Multiple Choice Questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

Almost all candidates attempted all of the questions.

Most successful questions	***Least successful questions***
• Magnetic force Question 1 • Heating a gas Question 3 • Calculating charge flow Question 4 • Calculating power Question 6	• Converting units Question 1 • Calculating acceleration Question 7 • Identifying scalars and vectors Question 9

	AfL	Candidates who did well on this section generally did the following. • Underlined keywords. • Wrote equations and / or calculations next to the relevant questions. • Worked through the distractors methodically, e.g. by crossing out obviously incorrect answers.

Question 1

1 This question is about magnetic forces.

Which of the following would cause repulsion?

A	N S	S N
B	N S	N S
C	S N	copper
D	S N	iron

Your answer ☐ **[1]**

Most candidates successfully applied their knowledge of magnetic forces to identify option A as the pair that would cause repulsion.

Question 2

2 How many amperes are there in 1 microampere (1 μA)?

A 1×10^{-6}

B 0.001

C 1000

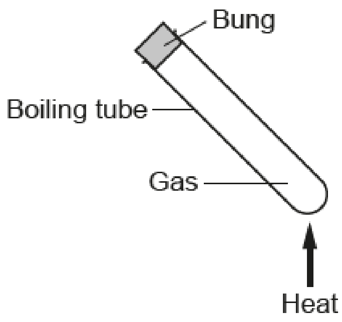
D 1×10^{6}

Your answer [1]

This question assessed candidates' knowledge of SI unit prefixes. Most candidates did not know that micro represented 10^{-6} and the most common incorrect answer was distractor B.

Question 3

3 A sealed boiling tube contains gas.



The boiling tube is heated.

What happens?

A The particles in the gas evaporate.

B The particles in the gas expand.

C The particles in the gas move faster.

D The particles in the gas move slower.

Your answer [1]

Most candidates were able to describe that the particles in the gas move faster when it is heated (option C).

Question 4

4 Which row of the table is correct?

Use the equation: charge flow = current × time

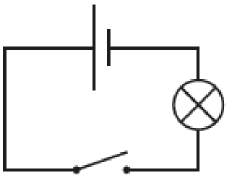
	Current (A)	**Time (s)**	**Charge flow (C)**
A	1.0	2.0	0.5
B	1.0	2.0	2.0
C	3.0	1.5	2.0
D	3.0	2.0	0.6

Your answer ☐ **[1]**

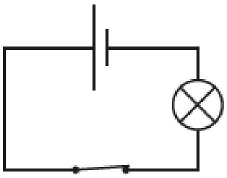
The majority of candidates were able to substitute the values from the table into the equation given to calculate the charge flow correctly as 2.0 C (option B).

Question 5

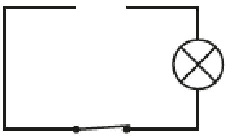
5 Which circuit gives a flow of charge?



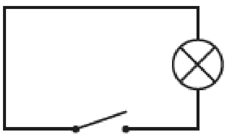
A



B



C



D

Your answer ☐ **[1]**

The majority of candidates successfully applied their knowledge of series circuits to identify that option B was the only complete circuit that would allow charge to flow.

Question 6

6 Which row of the table gives a power of 300 W?

Use the equation: power = work done ÷ time

	Work done (J)	Time taken (s)
A	600	1.5
B	900	3.0
C	1000	5.0
D	1500	300

Your answer ☐ **[1]**

Almost all candidates were able to substitute the values from the table correctly into the equation provided to work out that row B has a power of 300 W.

Question 7

7 A car changes velocity from 5 m/s to 15 m/s in 10 s.

What is the acceleration of the car?

Use the equation: acceleration = change in velocity ÷ time

A $0.5 m/s^2$

B $1.0 m/s^2$

C $1.5 m/s^2$

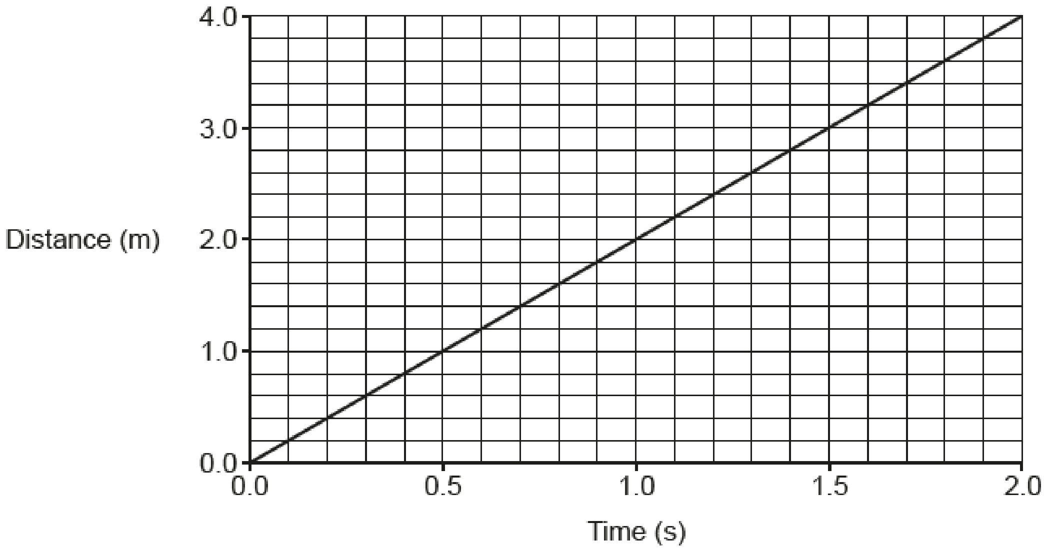
D $2.0 m/s^2$

Your answer ☐ **[1]**

This question required candidates to work out the change in the velocity of the car and then substitute that number and the time given into the equation provided to calculate the acceleration. Although most candidates were able to do this correctly, many candidates appeared to struggle with the extra step of having to work out the change in velocity first. Common errors observed included using just one of the velocity values or added the two velocities together.

Question 8

8 Look at the graph of distance against time for an object.



What is the speed of the object?

A 0.5 m/s

B 2.0 m/s

C 4.0 m/s

D 8.0 m/s

Your answer [ ] **[1]**

Most candidates were able to interpret the distance-time graph to calculate the speed of the object. Many successful candidates wrote down their workings to calculate the gradient or wrote down the equation speed = distance / time.

Exemplar 1

What is the speed of the object?

A 0.5 m/s

B 2.0 m/s

C 4.0 m/s

D 8.0 m/s

$\frac{\Delta y}{\Delta x}$ $\frac{2}{1} \approx 2$

Your answer [B] **[1]**

Exemplar 1 shows how the candidate has worked out the gradient of the distance-time graph in order to find the speed of the object.

Question 9

9 Some quantities are vectors and some are scalars.

Which row of the table is correct?

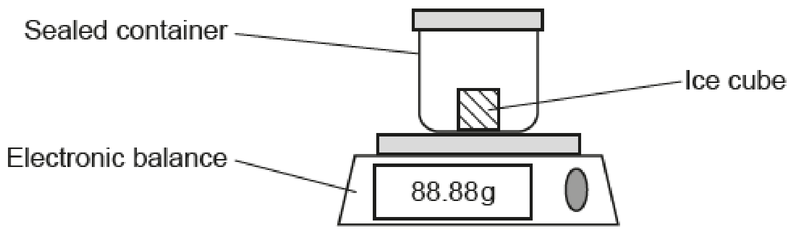
	Vector	Scalar
A	Speed	Displacement
B	Speed	Distance
C	Velocity	Displacement
D	Velocity	Distance

Your answer ☐ **[1]**

Around a third of candidates were unable to correctly identify a scalar and a vector quantity from the table.

Question 10

10 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]**

This question required candidates to apply their scientific knowledge about change of state and physical and chemical changes. Most candidates were able to do this successfully and chose option D.

Section B overview

Section B consisted of short, 1 mark, questions as well as questions requiring longer answers and a Level of Response question. It covered all of the assessment objectives and many questions needed candidates to use mathematical skills.

Most successful questions	*Least successful questions*
• Calculating density Question 11aii • Naming apparatus to measure mass Question 11bi • Interpreting a table of results to describe a relationship Question 12cii • Calculating the force on a spring Q13a	• Defining weight Question 15ai • Interpreting the relationship shown on a graph Question 15d • Describing how to use a component tester 16a • Sketching a graph for a filament lamp Question 16d

Candidate performance overview

Candidates who did well on this section generally did the following.

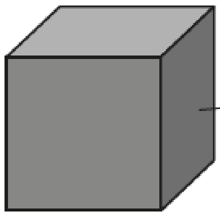
- Underlined key words.
- Recalled equations and wrote down all of their calculations.
- Labelled forces correctly and identified them as contact or non-contact.
- Worked methodically in order to describe and explain the differences between the series and parallel circuits, using ideas about current and resistance, in the Level of Response question.
- Applied their knowledge to interpret and identify relationships from tables of results and graphs.

Candidates who did less well on this section generally did the following.

- Struggled with the mathematical skills required.
- Only wrote the answers to questions involving equations, no calculations were shown.
- Gave answers that lacked depth and showed poor quality of communication.
- Struggled to interpret graphs and the relationships shown.

Question 11 (a) (i)

11 (a) A student is given a **solid** metal cube.



(i) Explain how the student can use a ruler to calculate the volume of the metal cube.

....

....

.... **[2]**

This AO1 question required candidates to recall how to calculate the volume of a regular object, using a ruler. Most candidates gained at least 1 mark for stating that the ruler would be used to measure the side of a cube. However, only the higher ability candidates could explain how this measurement would be used to calculate the volume.

?	**Misconception**	A common misconception was that volume can be calculated by multiplying 'all of the sides' of the cubes together.

Question 11 (a) (ii)

(ii) The metal cube has a volume of 125 cm^3 and a mass of 850 g.

Calculate the density of the metal cube.

Use the equation: density = mass ÷ volume

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

Most candidates correctly substituted the values for mass and volume into the equation and calculated the density to gain full credit. Some candidates struggled to use the equation, even though it was provided. Common errors included dividing volume by mass, mass x volume or using 125^3 as the volume.

Question 11 (b) (i) and (ii)

(b) The student wants to calculate the density of a stone. The stone has an irregular shape.

(i) Suggest **one** piece of apparatus that she can use to measure the **mass** of the stone.

.... **[1]**

(ii) Suggest **one** piece of apparatus that she can use to **measure** the **volume** of the stone.

.... **[1]**

Although most candidates could recall that a balance was required to measure the mass of a stone, only the more able candidates could identify that a measuring cylinder or displacement can was needed to measure the volume. Candidates did not distinguish between measuring the volume of a regular-shaped object and the volume of an irregular-shaped object, as the most common incorrect answer was a ruler.

	AfL	All candidates will have experienced this practical activity in one of the Practical Activity Groups, candidates could benefit from short activities, e.g. where they have to match pieces of equipment with what needs to be measured.

Question 12 (a) (i) and (ii)

12 A teacher shows her class some magnets.

(a) **Fig. 12.1** shows the magnetic field around a bar magnet.

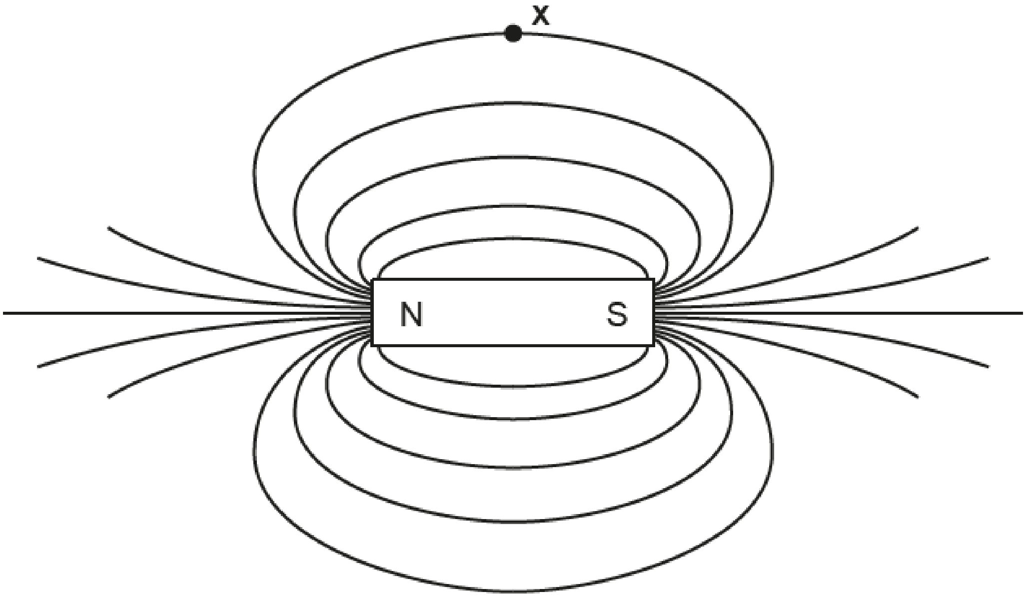


Fig. 12.1

(i) What is the direction of the magnetic field at **X**?

Draw an arrow **on the diagram** in **Fig. 12.1** to show your answer. **[1]**

(ii) Where is the magnetic field **strongest** around the bar magnet?

.... **[1]**

Around one third of candidates were familiar with concepts of magnetism and magnetic fields and did knew the correct direction of the magnetic field at position X. Most other candidates drew arrows pointing in a variety of different directions. In part (a)(ii) half of the candidates knew that the field was strongest close to the poles of the magnet, but most other responses were too vague, e.g. 'nearest to the magnet.'

?	**Misconception**	Answers for 12 (a)(ii) were often too vague, e.g. 'nearest to the magnet' or candidates had the common misconception that the magnetic field around the magnet was strongest 'in the middle.'

Question 12 (b)

(b) A compass points towards 'magnetic north'.

What does this tell us about the Earth?

....

.... **[1]**

Many candidates misinterpreted or misread the question and gave responses referring to gravity. Poor quality of communication prevented some less able candidates from gaining credit as they did not express their answers clearly enough for a creditable marking point to be identified.

Question 12 (c) (i)

(c) The teacher wraps a coil of insulated wire around a soft iron core as shown in **Fig. 12.2**.

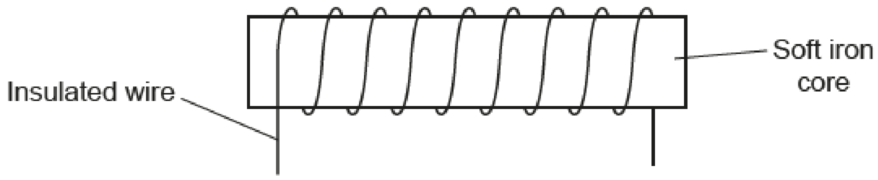


Fig. 12.2

(i) Describe what the student needs to do to create a magnetic field.

....

.... **[1]**

The majority of candidates found this question very challenging with only some of the more able candidates gaining credit. Many responses included vague statements adding a bar magnet and candidates seemed unfamiliar with how a solenoid (electromagnet) is made (P3.3g).

Question 12 (c) (ii)

(ii) The student changes the number of turns in the coil. He records the number of steel pins that the magnetic field can pick up.

Number of turns in coil	Number of steel pins picked up
5	0
10	1
15	2
20	2

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

Explain if his conclusion is true. Use the results in the table in your answer.

....

....

.... **[2]**

This question assessed AO3 and required candidates to interpret and analyse information from the table. Most gained 1 mark for concluding that the number of pins picked up did not increase between 15 and 20 turns. Good responses also identified that the more turns in the coil, the more pins were picked up.

A common misconception was to repeat the stem of the question (the more turns, the stronger the magnetic field). Candidates need to be careful to answer the question asked (explain using data) not to just repeat the question in their answer.

Question 13 (a)

13 A student hangs a mass from the end of a spring as shown in **Fig. 13.1**.

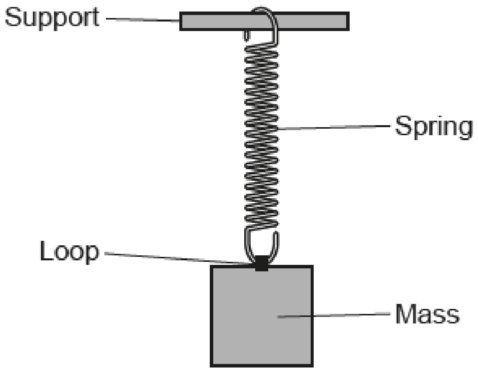


Fig. 13.1

(a) The spring in **Fig. 13.1** extends by 0.06 m. The spring constant is 25 N/m.

Calculate the force on the spring.

Use the equation: force = extension × spring constant

Force = ... N **[2]**

The majority of candidates gained full credit for this question. Very few other candidates gained 1 mark as they did not write down any of their calculations and so could not be credited with compensatory mark.

Question 13 (b) (i)

(b) **Fig. 13.2** shows the forces acting **on the mass**.

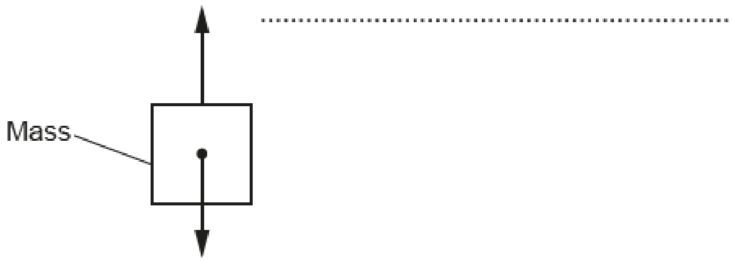


Fig. 13.2

(i) Label the forces **on the diagram** in **Fig. 13.2**. **[2]**

The question required candidates to apply their knowledge of forces to label a free-body diagram for the mass. Most candidates correctly identified the downward force as weight but were unable to identify the upwards force as the pull of the spring.

	**Misconception**	Most common misconceptions for the upwards force included air resistance and upthrust. Upthrust is the buoyancy force acting on a submerged or partially submerged object.

Question 13 (b) (ii)

(ii) The loop at the end of the spring breaks and the mass falls.

Explain why the mass falls and describe its motion as it falls.

....

....

.... **[2]**

The majority of candidates found this question very challenging and did not any gain credit. Responses were very vague and included ideas about the mass falling due to gravity. Candidates needed to link this to a resultant force or unbalanced forces causing the mass to accelerate towards the Earth.

Question 13 (c)

(c) The mass is placed on a bench, as shown in **Fig. 13.3**.

This is a diagram showing the force of the bench on the mass.

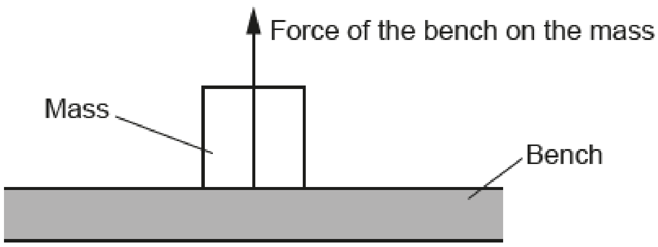


Fig. 13.3

Newton's third law is about how forces come in pairs.

Complete the table to describe the other force in this pair.

	Force in diagram	**Other force in this pair**
Name	Force of the bench on the mass	....
Type of force	Contact force	....

[2]

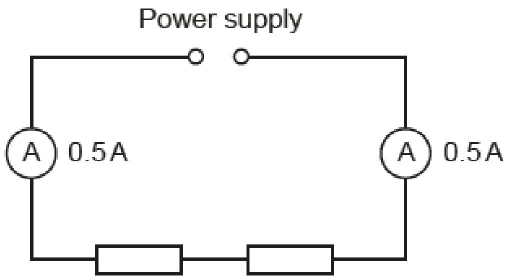
This AO2 question required candidates to apply their knowledge and understanding of Newton's Third Law in the familiar context of an object on a bench. Very few candidates appeared familiar with naming the missing force in an interaction pair, or with distinguishing between contact and non-contact forces.

?	**Misconception**	The most common misconceptions involved ideas about gravity as candidates confused forces acting in interaction pairs with forces on a free-body diagram.

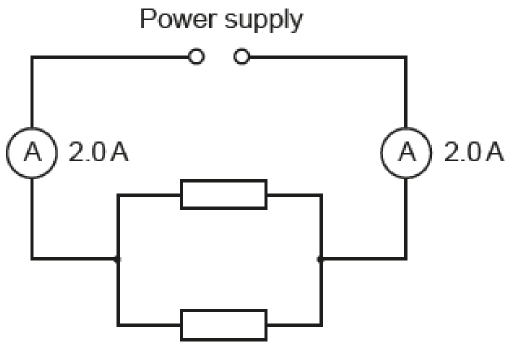
Question 14

14* A student has a fixed voltage power supply and two identical resistors.

He sets up two different circuits **A** and **B** and measures the currents in each circuit.



Circuit **A**



Circuit **B**

Describe and explain the **similarities** and **differences** between circuit **A** and circuit **B**.

Use ideas about current and resistance in your answer.

....

....

....

....

.... **[6]**

This Level of Response question was designed to give opportunities for higher ability foundation tier candidates. It assessed AO2 and AO3, and required students to analyse information and apply their knowledge of series and parallel circuits.

The question proved challenging to most students, with very few answering both parts of the question by making clear creditworthy statements about current and resistance. Many weaker responses gave basic similarities and differences in the components but gained no credit because did not relate this to the circuits. Others simply stated the ammeter reading in each circuit.

For Level 1, candidates usually identified which circuit was series and which was parallel. The more able candidates were able to also link the larger current in circuit B to the fact that the circuit had different loops or the current splits between the two resistors. A more complete response for Level 3 could have also included a comparison of the resistance of each circuit.

	AfL	Poor quality of communication prevented some candidates from gaining higher marks. Candidates should be aware that ideas about stronger/weaker/faster/slower current or electricity will not gain credit. Many candidates would benefit by underlining key parts of the question to help make sure that they include all parts of the question in their response.

Exemplar 2

- Circuit A is series circuit so the current will be the same ~~of any wer.~~ to each other.
- ~~The resistance from A~~
- Circuit B is ~~series~~ parallel circuit so the current from 2 resistor add up to get the ~~m~~ total current
- The ~~resistance~~ current ~~from~~ of A is smaller than the current of B, This means the resistance of A is bigger than the resistance of B
- Both of circuit have the same of ~~amou~~ power supply (voltage) and amount of resistore(2)

Exemplar 2 illustrates a Level 2 response that was given 4 marks. It clearly states that circuit A is series and circuit B is parallel. There is also a description of the current in each circuit linked to ideas about resistance. To progress to Level 3, the candidates could have given a quantitative comparison of the current or a more detailed description in terms of different loops and the current splitting in the parallel circuit.

Question 15 (a) (i)

15 A student measures the acceleration of a trolley on a horizontal surface.

Fig. 15.1 is a diagram of her experiment.

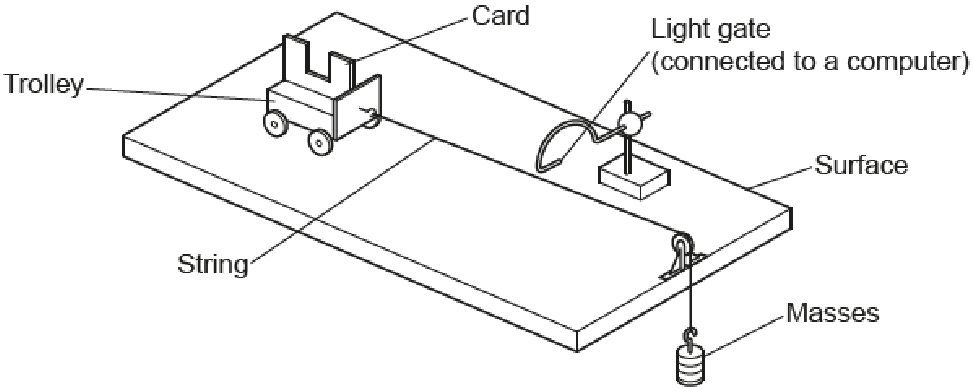


Fig. 15.1

(a) The weight of the masses accelerates the trolley.

(i) Define the term weight.

....

.... **[1]**

The majority of candidates could not recall the basic definition of weight (P2.3h), with most responses referring to mass or how heavy something is rather than the gravitational force or mass x gravitational field strength.

Question 15 (a) (ii)

(ii) Show that the weight of a 100 g mass is 1 N.

[3]

This question required students to convert grams into kilograms and to recall the equation: weight (gravity force) = mass x gravitational field strength. Many students chose not to attempt this question. Most of the ones who did, were not given any marks for it. The more able candidates often gained 1 mark for converting 100 g into kilograms. Most responses involved various incorrect ways of manipulating the value for mass to give an answer of 1 N.

Question 15 (b)

(b) Friction can change the results of this experiment.

Suggest **one** way friction can be reduced.

....

.... **[1]**

This AO3 question assessed candidates' ability to analyse information and ideas in order to improve the experiment. Many responses were too vague, referring to 'changing the surface' or 'decreasing the mass'.

	AfL	Candidate should be aware that the need to be specific in their answers, and link what they say to the context of the question.

Question 15 (c) (i)

(c) (i) The tall parts of the card on the trolley (**U** and **V**) pass through the light gate, as shown in **Fig. 15.2**.

The velocity of **U** is 0.5 m/s.

The velocity of **V** is 1.0 m/s.

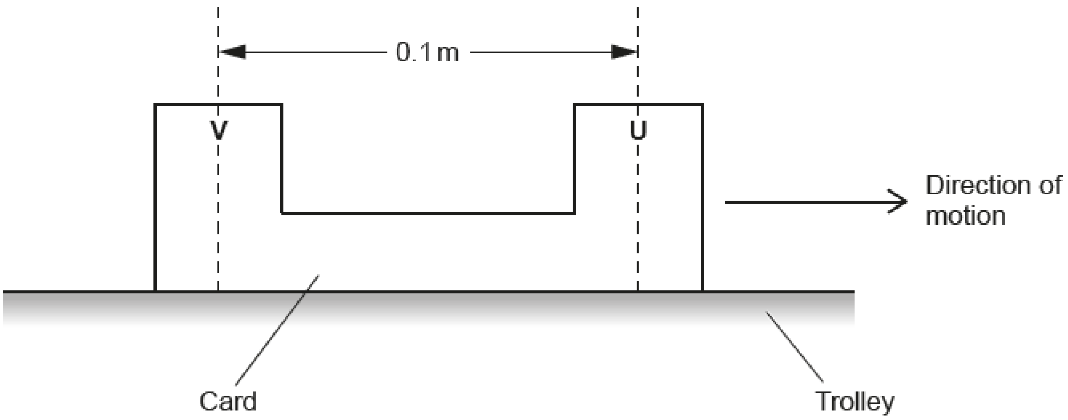


Fig. 15.2

Calculate the acceleration of the trolley.

Use the equation: (final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

Acceleration = ... m/s^2 **[3]**

Candidates struggled with substituting values into the equation and rearranging it to calculate the acceleration of the trolley. Some candidates were able to substitute the values for (final velocity)^2 – (initial velocity)^2 to give 0.75 for 1 mark. Only the most able candidates were then able to progress to gain full credit.

	AfL	Practising applying both the recall and the data sheet equations will help students develop their problem-solving skills. This should include opportunities where they need to rearrange equations.

Question 15 (c) (ii)

(ii) When the trolley reaches the edge of the surface, it is moving at 1.2 m/s.

The mass of the trolley is 1.0 kg.

Calculate the kinetic energy of the trolley.

Kinetic energy = ... J **[3]**

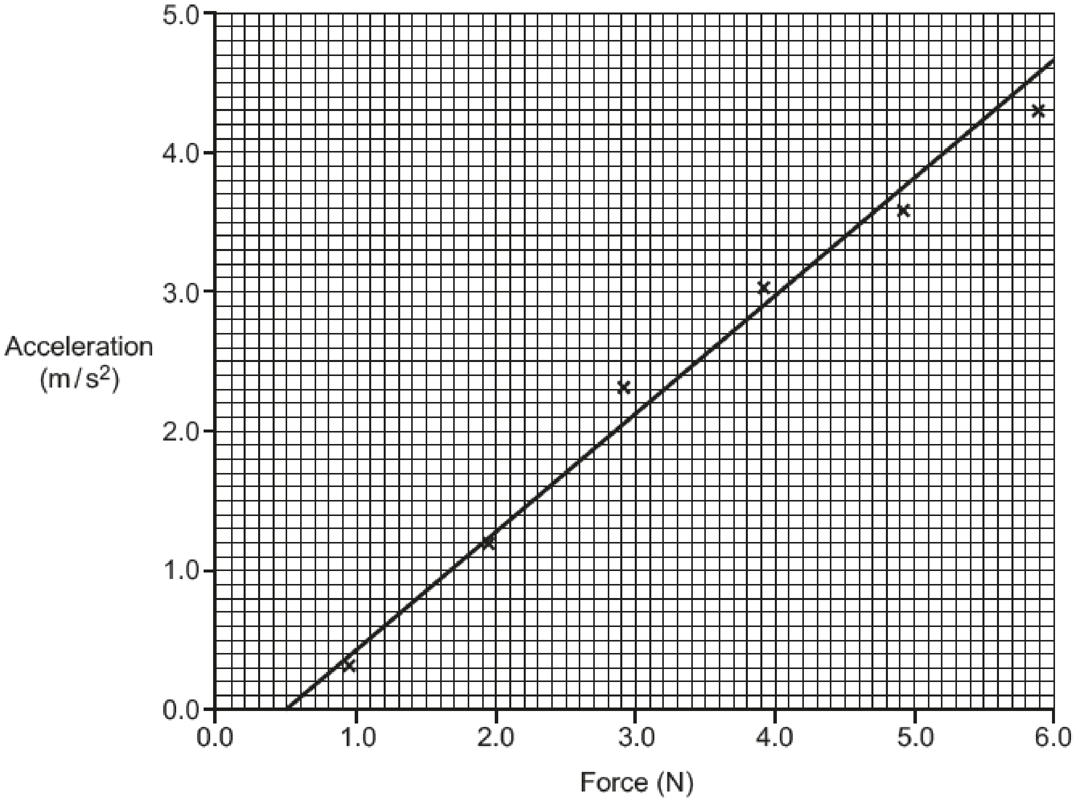
This question required candidates to recall and apply the equation: kinetic energy = 1/2 x mass x speed^2. Nearly all of the candidates attempted the question, but the majority did not gain any credit as they did not recall the equation correctly. Few candidates gained credit, but most of those who did were given all 3 marks. The very few candidates who gained 1 or 2 marks did so because they wrote down their working despite their final answer being incorrect. Most other candidates only wrote their final answer and because they did not write down their method, they could not be given any compensatory marks.

	AfL	Candidates could again benefit from writing down the equation and calculations rather than only their final answer so that compensatory marks may be given.

Question 15 (d)

(d) The student repeats the experiment with different masses.

This is a graph showing her results.



The student says, 'The graph shows that the acceleration of the trolley is directly proportional to the force.'

Is the student correct?

Explain your answer.

....

.... **[1]**

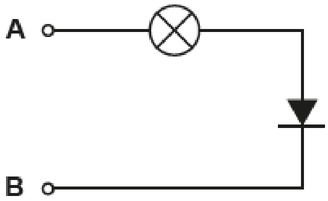
Few candidates appeared to fully understand what a graph showing direct proportionality looks like.

?	**Misconception**	A common misconception was that direct proportionality was related to how close the points were to the line of best fit on the graph.

Question 16 (a)

16 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]**

This question covered AO3 and assessed candidates' ability to develop experimental procedures. It required candidates to use their knowledge of circuits, cells and diodes. Most candidates did not gain any credit. Some responses stated that the cell should be connected to the circuit, for 1 mark, but did not progress to describe how the positive terminal of the cell should be connected to A and the negative terminal to B for the lamp to light up.

Question 16 (b) (i)

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

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

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

1 ....

....

2 ....

....

[2]

The quality of candidates' written communication often prevented them form gaining marks. Many candidates recognised that something happened at 0.5 V but incorrectly stated that the p.d. started at that point on the graph.

The more able candidates recognised that it was not a straight line.

Question 16 (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]**

This question required candidates to read a value off the graph and to rearrange the equation provided to calculate the resistance. The majority of candidates found this very challenging and did not gain any credit. Only a few candidates were able to read the value of the current correctly from the graph for 1 mark.

Of those candidates who could manipulate the equation correctly, almost all gained full credit. Many candidates, however, only wrote down their final answer so could not gain compensatory marks if their answer was incorrect.

	AfL	Candidates could benefit from practising reading values from different graphs

Question 16 (c)

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

The supply voltage must not exceed 1 V.

Use the graph in **16(b)** to explain why.

....

....

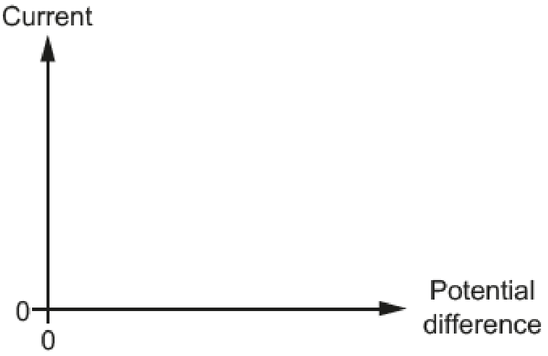
.... **[2]**

This AO3 question required students to analyse the information about a diode in order to draw conclusions. Poor responses included vague ideas about 'too much potential difference' or the circuit not working properly.

The more able candidates referred correctly to the diode becoming damaged and some also recognised that the current would become too large.

Question 16 (d)

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



[1]

Very few candidates were able to recall the correct graph for a filament lamp (P3.2d and P3.2h).

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