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OCR
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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/01 Summer 2023 series

Version 1

ocr.org.uk/science

Contents

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. A selection of candidate answers is also provided. 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 and the mark scheme can be downloaded from OCR.

Paper 1 series overview

The number of candidates taking this component in 2023 had returned to the same as it was in 2019. The accessibility principles described in the resource, 'Exploring our exam papers' continue to be applied. The final two questions in the component (Question 22 and Question 23) are overlap questions with the Higher tier component J249/03. Although these questions targeted higher achieving candidates, most candidates were given some marks including for attempting Question 23 (a) and the graph question, Question 23 (b).

The standard of legibility was good, with few scripts being very difficult to read. There were several examples of candidates who were offered a scribe choosing to answer all the questions themselves.

There were many examples of numerical questions where no working out was shown. Some of these candidates would have gained marks if they had shown their working out.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• attempted all the questions • showed their working in calculation questions • read the multiple-choice questions carefully before choosing a response.	• did not respond to some questions • did not show working in calculation questions • answered hastily, without fully understanding what the question was asking.

OCR support

OCR produces a resource that explains accessibility approaches in assessments.

Exploring Exam Papers

Section A overview

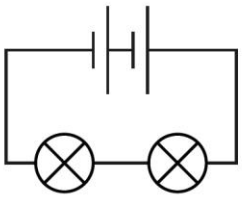
Very few of these multiple-choice questions were left blank. Comments follow on six of the fifteen questions where there are points, which could be useful to centres.

Question 4

4 A student connects four circuits using identical cells and identical lamps.

Which circuit has the **brightest** lamps?

A



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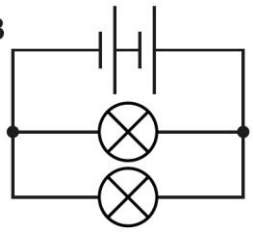
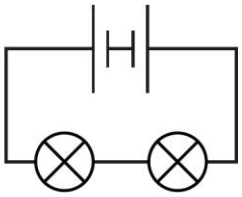
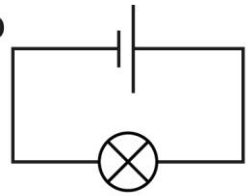


C



D



Your answer ☐ **[1]**

The correct response for this question was Option B. Option A was commonly chosen, suggesting a misunderstanding of the circuit rules.

Question 6

6 The time taken for four students to run a race is recorded.

Student	Time taken (s)
1	21.5
2	21.6
3	21.0
4	21.5

What is the mean time taken by the students?

A 16.0 s

B 21.4 s

C 21.5 s

D 85.6 s

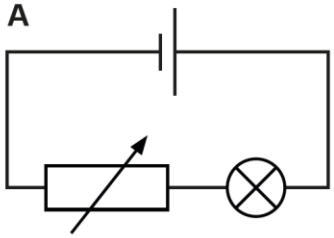
Your answer ☐ **[1]**

Many successful candidates used the space to calculate the mean.

Question 7

7 Which circuit diagram shows how the brightness of a lamp is changed using a variable resistor?

A



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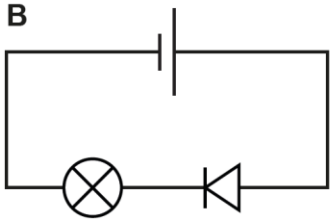
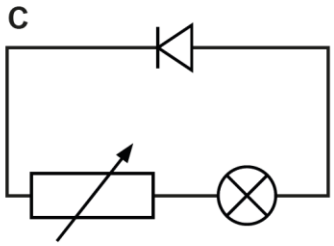
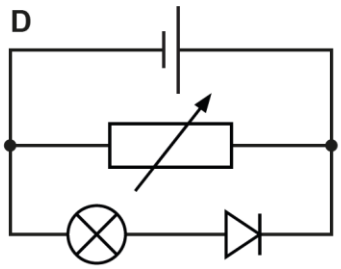


C



D



Your answer

[1]

The correct response for this question was Option A. Option B was commonly chosen suggesting that candidates did not recognise the variable resistor symbol.

Question 12

12 Which pair of resistors has the greatest total resistance?

A 10 kΩ — 1 kΩ

B 10 kΩ — 500 Ω

C 1000 Ω — 500 Ω

D 1000 Ω — 1000 Ω

Your answer

[1]

The correct response for this question was Option A. Option D was commonly chosen, suggesting that candidates did not notice that the values were in kΩ rather than Ω,or did not realise what this meant.

Question 13

13 A student investigates the gears on their bicycle.

The larger cog has 60 teeth and the smaller cog has 20 teeth.

If the larger cog rotates once, how many times does the smaller cog rotate?

A 1

B 3

C 40

D 80

Your answer ☐ **[1]**

More successful candidates often had evidence of working shown in the empty space to the right of this question.

Question 15

15 What is 15 J converted into newton-metres?

A 0.15 N m

B 1.5 N m

C 15 N m

D 150 N m

Your answer ☐ **[1]**

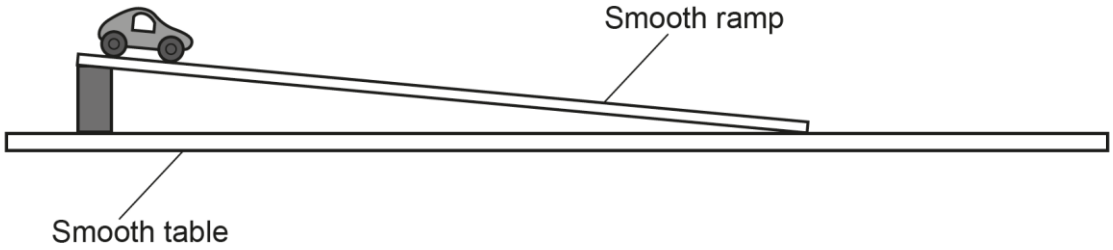
Very few candidates chose the correct option (C). There was no pattern in the incorrect responses.

Section B overview

The calculation questions in this section were well answered by candidates who had practised selecting the correct equation from the equation sheet and substituting in to it before the examination. Even if subsequent calculations went astray, examiners were able to give some marks to those who wrote out their working.

Question 16 (a) (i), (ii), (b) (i) and (ii)

16 The diagram shows a toy car rolling down a smooth ramp onto a smooth table where it travels at a constant velocity.



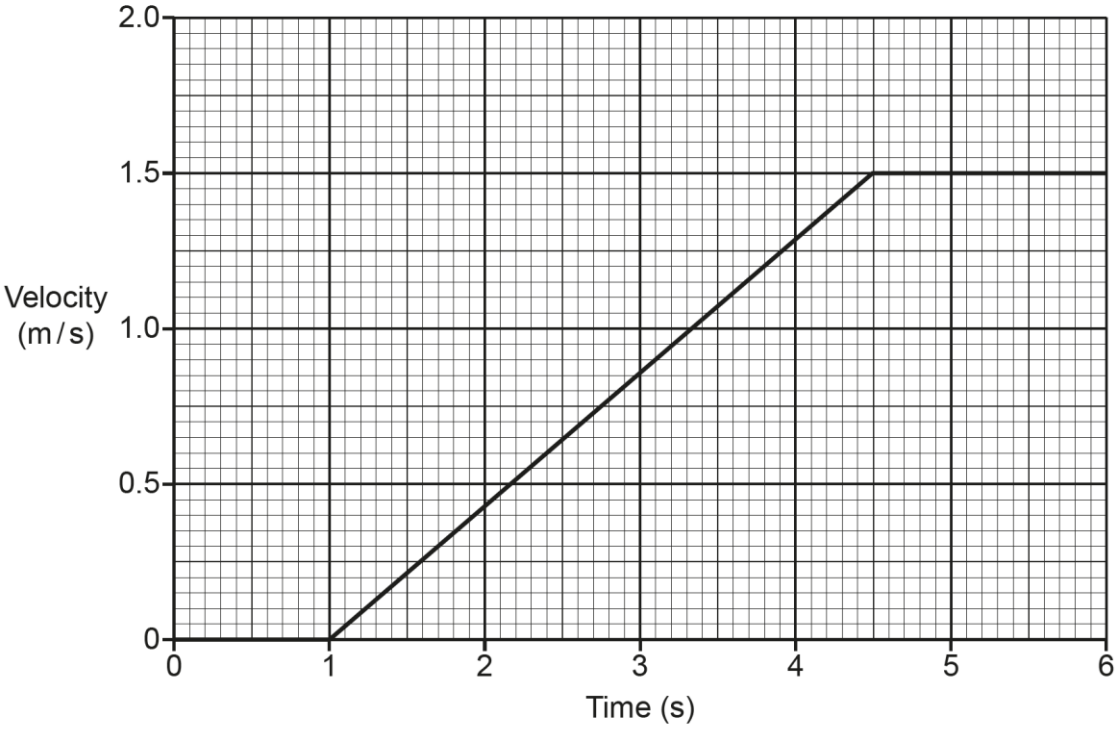
(a) (i) Suggest the equipment the student uses to measure the **distance travelled** by the car on the ramp.

..... **[1]**

(ii) Suggest the equipment the student uses to measure the **time** it takes the car to roll down the ramp.

..... **[1]**

(b) This is the velocity–time graph for the car.



(i) State the time the car starts to move.

..... **[1]**

(ii) State the time the car reaches the bottom of the ramp.

..... **[1]**

The first parts of this question offered a gentle introduction to Section B and many candidates were given full marks.

Question 16 (b) (iii)

(iii) Describe how the acceleration of the car will change if the ramp is made steeper.

..... **[1]**

Responses to this section often referred to speed rather than acceleration. A change in a factor such as acceleration can only be an increase or a decrease, or possibly stay the same. Higher performing candidates realised this and simply wrote 'increases' and were given the mark.

Question 16 (b) (iv)

(iv) Draw a line on the graph to show the acceleration of the car if the ramp is made steeper.

[1]

This was generally well answered by all candidates, and use of a ruler was widespread.

Question 16 (c)

(c) Velocity and speed are different quantities.

Complete the sentence about velocity. Use words from the list.

acceleration	**direction**	**energy**	**force**	**magnitude**

Velocity is a vector quantity because it has ..... and ..... .

[2]

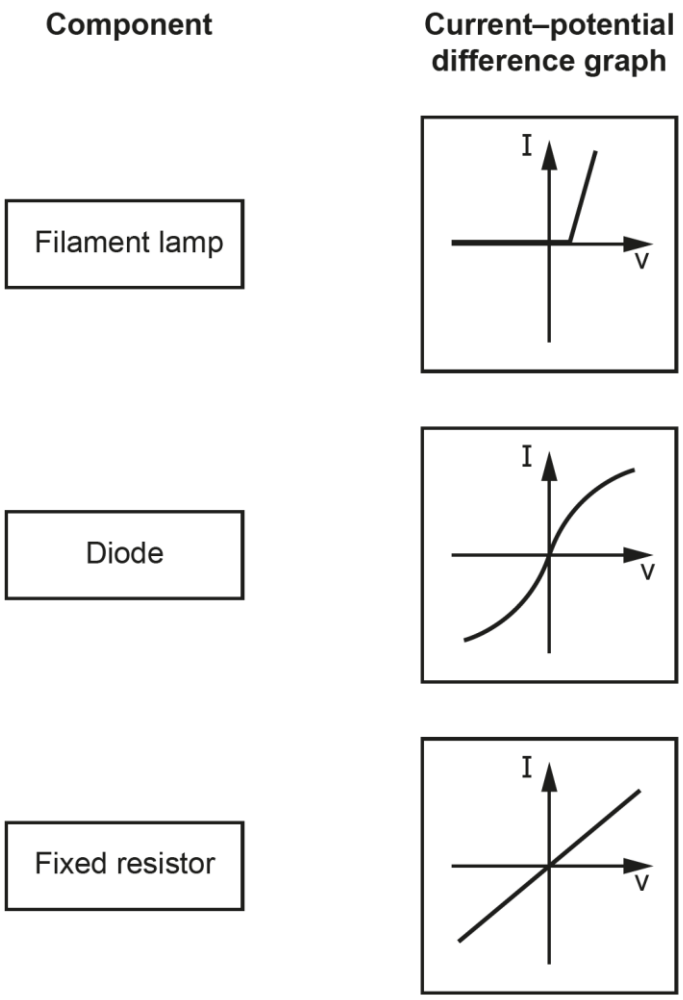
This section was well answered by more successful candidates. A common error was that acceleration was one of the components, rather than magnitude.

Question 17 (a)

17 (a) A student draws current–potential difference (I-V) graphs for three different components. These are shown in **Fig. 17.1**.

Draw one line from each **component** to its correct **current–potential difference graph**.

Fig. 17.1



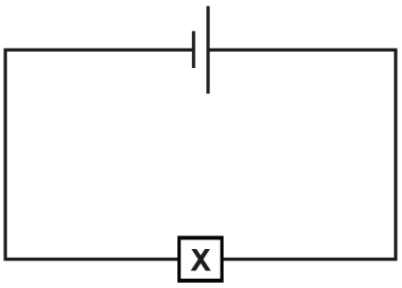
[2]

This was generally well answered by all but the lowest performing candidates, suggesting good revision, as it was a straight recall question.

Question 17 (b) (i) and (ii)

(b) The student uses the circuit in **Fig. 17.2** to investigate the current in component **X** and the potential difference across it.

Fig. 17.2



(i) State the name of the measuring instrument the student uses to measure the current in the circuit.

..... **[1]**

(ii) Draw the circuit symbol for the measuring instrument in **(b)(i)** in a correct position in **Fig. 17.2**.

[2]

Many candidates correctly identified ammeter as the correct response for part (i) and were able to draw the correct symbol in series.

Question 17 (b) (iii), (iv)

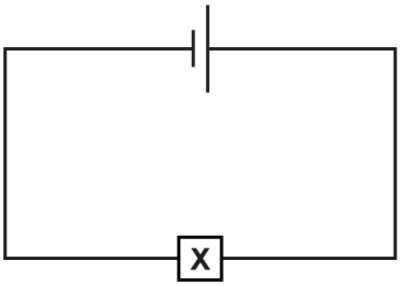
(iii) State the name of the measuring instrument the student uses to measure the potential difference across component **X**.

..... **[1]**

(iv) Draw the circuit symbol for the measuring instrument in **(b)(iii)** in a correct position in **Fig. 17.3**.

[2]

Fig. 17.3



Less successful candidates were unable to identify a voltmeter as the correct instrument for measuring potential difference and only the most successful candidates drew the correct symbol in parallel to component X.

Question 17 (c)

(c) Component **X** has a resistance of 6.0 Ω.

A current of 4.0 A flows through component **X**.

Calculate the potential difference across component **X**.

Use the Equation Sheet.

Potential difference = ... V **[3]**

The equation for potential difference = current × resistance was given on the equation sheet and it did not need rearrangement. Most candidates were given all 3 marks here.

Question 18 (a) (i)

18 A student investigates how the number of turns of wire on an electromagnet affects the strength of the magnetic field produced.

The student passes a current through a wire wrapped around an iron nail and uses this to pick up paperclips.

(a) (i) Name **two** variables the student controls in the experiment.

1 .....

2 .....

[2]

Only the higher performing candidates correctly identified control variables. Common errors were to put 'the number of turns' or the 'number of clips' having not realised that the question was asking for control variables or not understanding what a suitable control variable would be in this experiment.

Assessment for learning

It is not clear whether candidates who wrote 'the number of turns' or the 'number of clips' for example were unaware of what a control variable in an investigation is or that they did not read the question carefully and assumed it was asking about independent or dependent variables. Giving candidates the opportunity to learn how to read questions and instructions accurately is an important part of preparing for GCSE examinations.

Question 18 (a) (ii)

(ii) The table shows the student's results.

Number of turns	Number of paperclips picked up
4	5
8	10
12	15
16	20
20	25

Describe the pattern shown by the student's results.

.....

..... **[2]**

This was generally well answered by all candidates, with the higher performing candidates scoring 2 marks.

Question 18 (a) (iii)

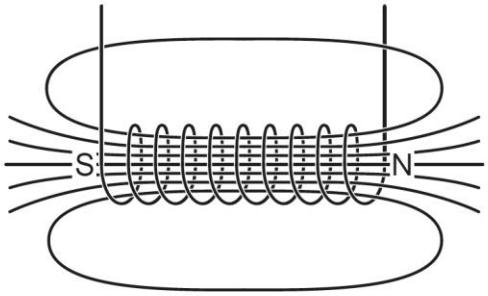
(iii) Predict how many paperclips the electromagnet will pick up if it has 28 turns.

..... **[1]**

This was also very well answered by all candidates.

Question 18 (b) (i), (ii) and (iii)

(b) The diagram shows a sketch of the magnetic field around the electromagnet.



(i) Add arrows to the magnetic field lines to show the direction of the magnetic field. **[1]**

(ii) Write the letter **X** to show a position where the magnetic field is stronger. **[1]**

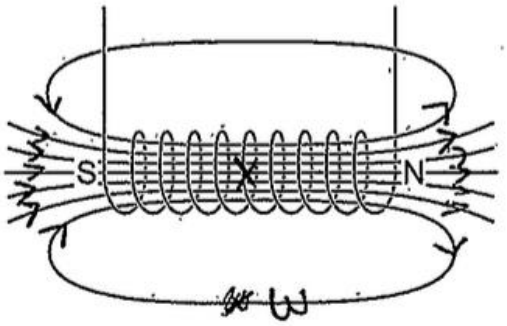
(iii) Write the letter **W** to show a position where the magnetic field is weaker. **[1]**

This question was generally poorly answered. Only the higher performing candidates realised that the diagram was of a solenoid and that the strongest magnetic field would be inside the coils. A common misconception was that the field was stronger at the N end and weaker at the S end.

More successful candidates were able to correctly label the direction of the magnetic field as coming from the N end and going to the S end. A common mistake was to draw arrows in both directions.

Exemplar 1

(b) The diagram shows a sketch of the magnetic field around the electromagnet.



away from N
towards south

(i) Add arrows to the magnetic field lines to show the direction of the magnetic field. **[1]**

(ii) Write the letter **X** to show a position where the magnetic field is stronger. **[1]**

(iii) Write the letter **W** to show a position where the magnetic field is weaker. **[1]**

In Exemplar 1, the candidate has been given all 3 marks as they have drawn arrows on the magnetic field lines going from N to S, drawn an 'X' correctly inside the coil and drawn a 'W' outside the region where the field lines are close together.

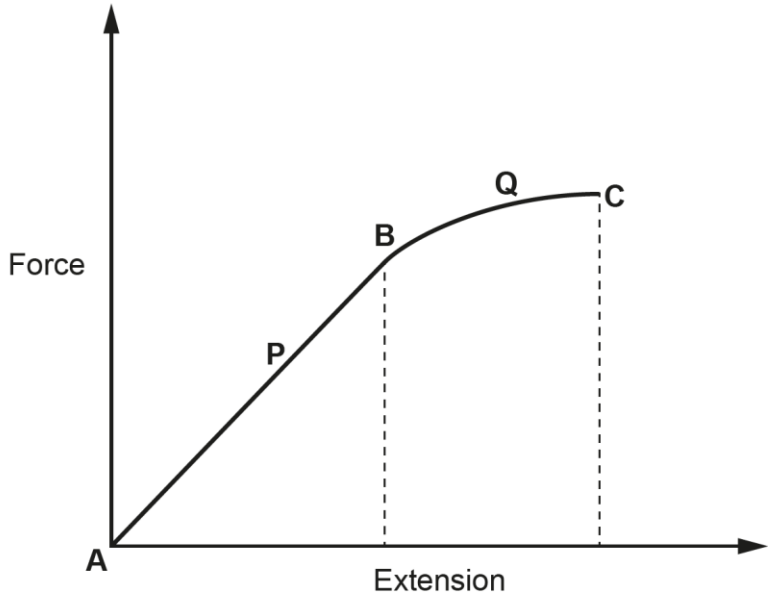
Question 19 (a) (i), (ii), (iii) and (iv)

19 A student applies different forces to a spring and measures the extension of the spring each time. The force–extension graph shows their results.

A, **B** and **C** are points on the graph.

P is the region on the graph between points **A** and **B**.

Q is the region on the graph between points **B** and **C** where the spring is permanently deformed.



(a) Use the letters **A, B, C, P** and **Q** to answer the following questions about the graph.

(i) Which letter represents where the spring has elastic deformation?

..... **[1]**

(ii) Which letter represents where the spring obeys Hooke's Law?

..... **[1]**

(iii) Which letter represents the elastic limit of the spring?

..... **[1]**

(iv) Which letter represents where the graph is non-linear?

..... **[1]**

Question 19a was generally poorly answered by all but the highest performing candidates. Many who did not get part (i) correct were able to answer part (ii) correctly.

Question 19 (b)

(b) State the **minimum** number of forces that need to be applied to the spring in order to stretch it.

..... **[1]**

Higher performing candidates answered this correctly, but a common misunderstanding of the question was to miss the word 'number' and answer in terms of a force, for example '1N'

Question 19 (c) (i) and (ii)

(c) The spring constant of the spring is 28 N / m.

(i) Calculate the force exerted by the spring when it is extended by 0.15 m.

Use the equation: force exerted by a spring = spring constant × extension

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

(ii) Calculate the energy transferred when the spring is extended by 0.15 m.

Use the Equation Sheet.

Energy transferred when stretching = ... J **[2]**

Question 19 (c) was two simple calculations where all candidates had to do was substitute in to equations from the equation sheet and most middle and higher performing candidates managed full marks on both parts. Many lower performing candidates were also given full marks on part (i). On part (ii) less successful candidates substituted in to the elastic potential energy equation but did not square the extension, so those who had written the numbers into the equation as working were given 1 mark that was missed by candidates who had just written the incorrect answer.

Question 20 (a)*

20 (a)* A student investigates the resistance of a thermistor at different temperatures.

The student uses a Bunsen burner to heat the water in a beaker to three different temperatures. The student uses an ohmmeter to measure the resistance of the thermistor at each temperature.

Fig. 20.1 shows how the student sets up their experiment and **Fig. 20.2** shows a graph of their results.

Fig. 20.1

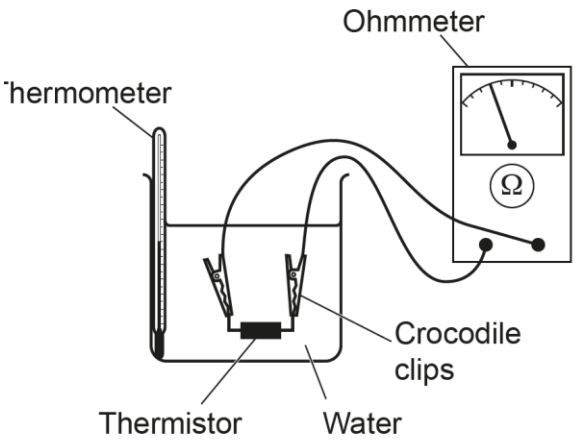
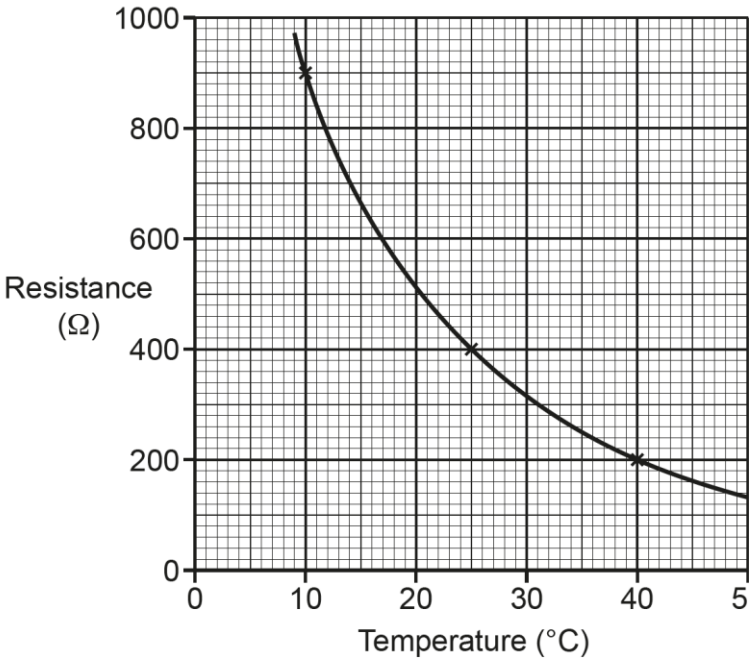


Fig. 20.2



Describe the trend shown by the graph.

Suggest how the student's method could be improved. Include ideas about accuracy and precision.

.....

.....

.....

.....

.....

..... **[6]**

This was a relatively straightforward level of response question for most Foundation candidates. Many were able to describe the trend in simple terms. More successful candidates described the curving nature of the relationship or read the graph and gave examples.

Suggestions for improvements were seen from the full range of candidates. A proportion of lower performing candidates described improvements to increase reliability, along the lines of taking repeat measurements. Examiners were able to give some marks to those who added that taking the repeats was either to calculate a mean or to discard anomalies. More successful candidates suggested stirring the water, using digital instruments, putting the thermometer closer to the thermistor, and taking a wider range of measurements. The last two of these were the most common correct responses seen.

This question was accessible to all candidates, and the majority were able to demonstrate some scientific understanding.

Exemplar 2

As temperature increases resistance decreases. The student could improve the accuracy of the experiment By using a digital ohmmeter and thermometer and by running the experiment more times

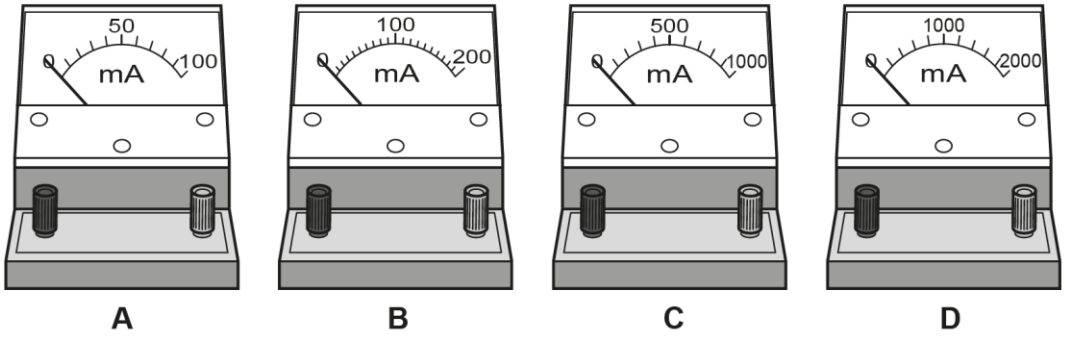
In Exemplar 2, the candidate has described the trend shown by the graph in simple terms. They have also suggested using digital meters to improve the accuracy of the readings. The candidate has mentioned running the experiment several times, which on its own would not be a valid suggestion to improve accuracy as mentioned above. This response is at Level 2 and was given 4 marks.

Question 20 (b)

(b) At one of the temperatures, the current in the thermistor is 300 mA.

Fig. 20.3 shows a choice of ammeters that the student can use to measure this current accurately.

Fig. 20.3



Which ammeter should the student use to measure a current of 300 mA?

Ammeter .....

Explain your answer.

.....

.....

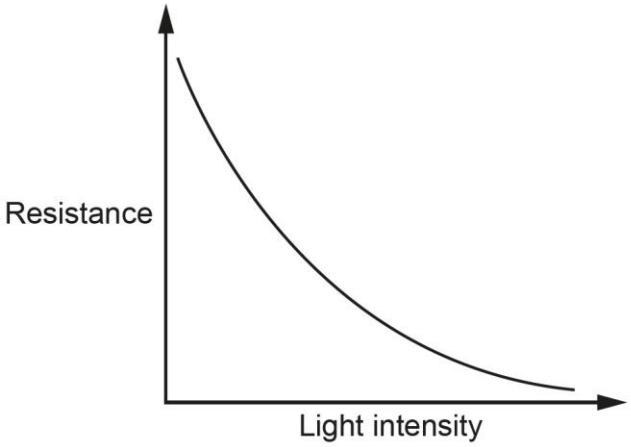
.....

[2]

Many candidates across the range of performance were able to spot that Option C was the best choice. The easiest way to be given the second mark was to say that A and B did not read high enough. Candidates who instead tried to explain that Option D had a higher resolution without using the word 'resolution' often ran into difficulties due to poor communication skills.

Question 20 (c)

(c) The graph shows how the resistance changes for a light dependent resistor (LDR).



State **one** use for a light dependent resistor and describe how it is used.

.....

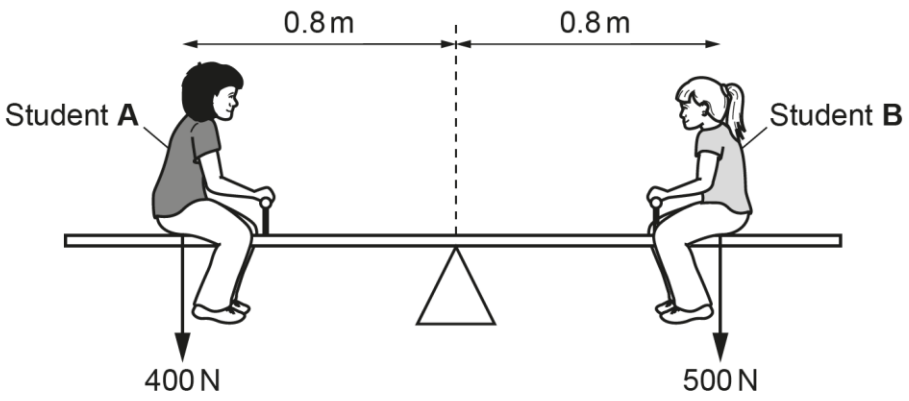
.....

..... **[2]**

Although this was a straightforward recall question, it was generally poorly answered by many candidates. Higher performing candidates were able to recall a suitable use, for example 'streetlights' and give a simple description of how it is used, for example 'turn on when it is dark'.

Question 21 (a) (i)

21 The diagram shows two students sitting on a seesaw.



(a) (i) Explain what happens to the seesaw when both students lift their feet off the ground.

.....

.....

..... **[2]**

Many candidates across the range of performance were able to identify that Student B moved down, but only a handful of higher performing candidates explained that this was due to a higher **turning** force or moment. Many candidates said that Student B had a 'higher force', but this was insufficient to gain the second marking point. The simplicity of the situation in the diagram may have contributed to this. If the distance had been different each side, it would have been more obvious that the response needed to be in terms of a moment, however this would have made the first marking point harder to achieve for lower performing candidates.

Question 21 (a) (ii)

(ii) Calculate the distance from the pivot that student **B** sits to balance the seesaw when student **A** sits 0.6 m from the pivot.

Use the equation: moment of a force = force × distance

Distance = ... m **[3]**

Higher performing candidates were able to use the equation, but many did not first calculate Student A's moment before rearranging and substituting. This was quite a challenge for Foundation tier candidates and only the highest performing candidates were given full marks here.

Question 21 (b) (i)

(b) Student **A** has a weight of 400 N.

(i) Calculate the mass of student **A**.

Use the equation: gravitational force = mass × gravitational field strength

Mass = ... kg **[3]**

More successful candidates remembered that the value of gravitational field strength was ten and were able to rearrange the formula. Candidates who rearranged the formula but could not remember the value were given marks for this, if they wrote it in the working.

Question 21 (b) (ii)

(ii) Student **A** stands on one foot when they leave the seesaw.

The area of their foot in contact with the ground is $2.5 \times 10^{-2}\,m^2$.

Calculate the pressure student **A** exerts on the ground.

Use the Equation Sheet.

Pressure = ... Pa **[3]**

Higher performing candidates were able to select the appropriate equation, rearrange it, substitute in and complete the calculation. Middle performing candidates generally managed to select the appropriate equation and substitute in but were unable to rearrange correctly. A common misconception was that candidates were confused by the 'm²' and squared the area when calculating the final answer. If they had written the stages of the calculation out, examiners were able to give them 2 of the 3 available marks for this question.

Exemplar 3

$400 \div 2.5 \times 10^{-2} m^2 =$

Pressure = ... 6 ..... Pa **[3]**

In Exemplar 3, the candidate has correctly rearranged the equation from the equation sheet and substituted in the correct numbers but has not calculated the answer correctly. This candidate was given 1 mark for rearranging the equation and 1 mark for substituting as per the mark scheme.

Assessment for learning

The importance to candidates of showing their working can never be emphasised enough. There are several calculation questions on this paper and the difference between showing working and not could make a difference of up to 12 marks for a candidate.

Question 22 (a)

22 (a) A teacher drops a ball from a height of 2.1 m. The ball hits the floor after 0.6 s.

Calculate the average speed of the ball as it falls.

Use the equation: distance travelled = average speed × time

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

This was generally well answered by higher performing candidates. If candidates could rearrange the equation, many were able to complete the rest of the question and were given all 3 marks.

Question 22 (b) (i)

(b) The teacher draws a free body force diagram for the ball as it falls.

(i) Label the two forces acting on the ball as it falls. **[2]**

This was answered well by higher performing candidates but a common misconception among less successful candidates was that the upward resistive force was 'upthrust' rather than air resistance.

Misconception

Upthrust was often given as the upwards force, rather than air resistance. If we assume that a ball is denser than the air it is falling through, there will be negligible upthrust. Some candidates were confusing this with an object floating in water or something like a hot air balloon.

Question 22 (b) (ii)

(ii) Explain the motion of the ball as it falls.

.....

.....

..... **[2]**

Very few candidates explained that there was an unbalanced force causing the motion. More successful candidates were given 1 or more of the remaining marking points. Common responses were that the ball speeds up and that air resistance increases.

Question 22 (c)

(c) A lorry has a mass of 30 000 kg.

Calculate the force needed to accelerate the lorry at 3.0 m / s^2.

Use the Equation Sheet.

Force = ... N **[3]**

This was generally well answered by middle and higher performing candidates as it was a simple substitution into an equation from the equation sheet.

Question 23 (a)

23 A scientist investigates how the pressure and volume of a gas are related.

The results from their experiment are shown in the table.

Pressure (kPa)	Volume (cm^3)
300	250
500	150
625	120
1000	75
1250	60

(a) Explain how these results show that pressure × volume = constant.

Use calculations in your answer.

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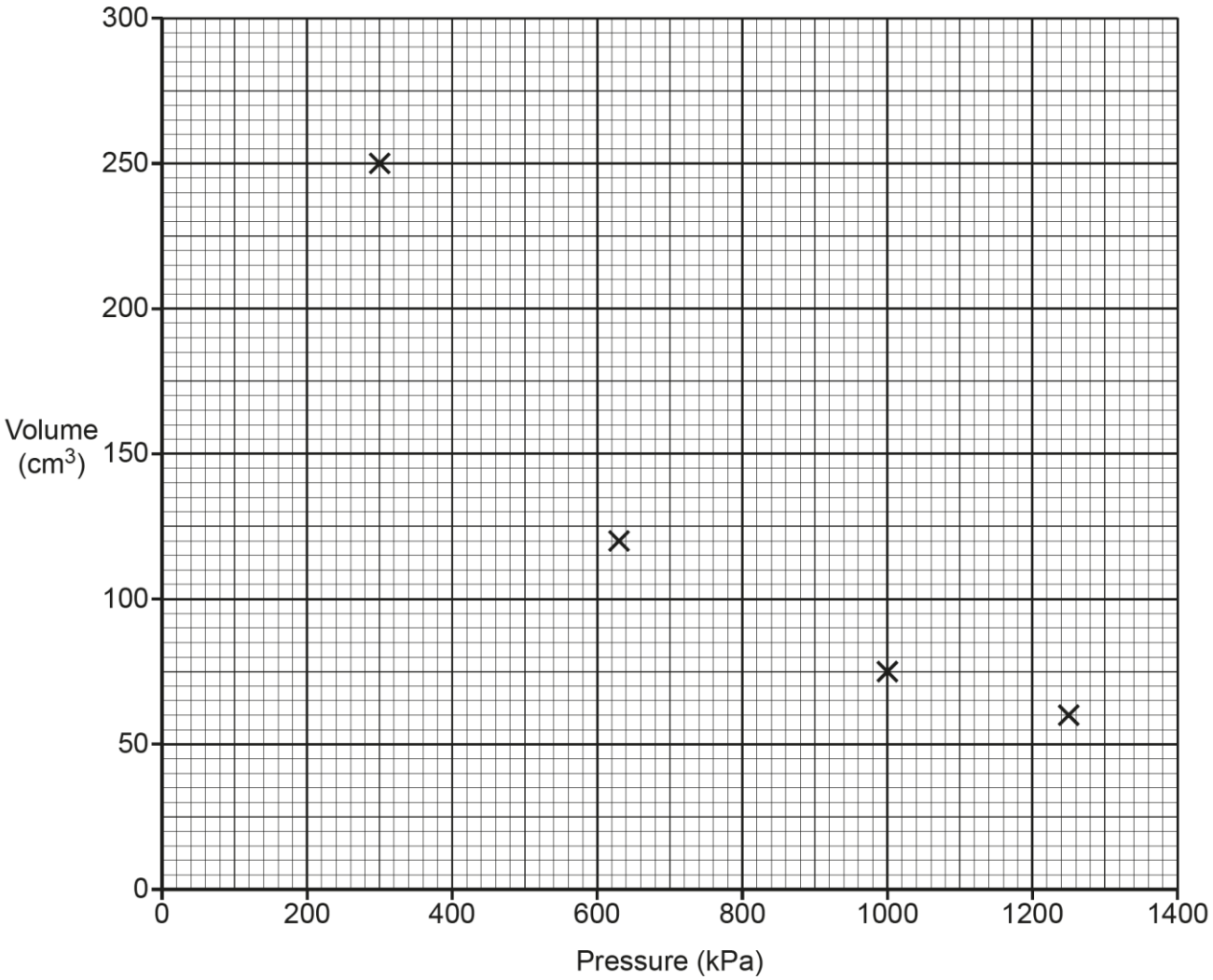
..... **[3]**

This question was generally well answered by candidates who wrote out example calculations to explain their response as instructed in the question.

Question 23 (b) (i)

(b) The graph shows the scientist's results.



(i) Plot the missing point on the graph. **[1]**

Almost all candidates were able to plot the point correctly.

Question 23 (b) (ii)

(ii) Draw a line of best fit on the graph. **[1]**

Higher performing candidates drew a smooth line of best fit through the points, but many lower performing candidates drew a single straight line through the points.

Misconception

While candidates may have been taught in Maths GCSE that lines of best fit are expected to be straight*, they need to be aware that in Science GCSE exams a curved line of best fit may be required.

The Language of Maths in Science (LOMIS) teacher guide - Language of maths in science, ASE highlights (page 31) that in GCSE maths the expected line of best fit is always a straight line.

Question 23 (b) (iii)

(iii) Use the graph to find the volume of gas at 900 kPa.

Volume of gas = ... cm^3 **[1]**

Most successful candidates were able to use their line of best fit to find the volume of gas correctly. Marks were given to candidates who had incorrectly drawn a line of best fit, if they had clearly used the graph to find the answer they put. Drawing lines on the graph was the best way to demonstrate to the examiner that the line of best fit had been used to find the volume. Some higher performing candidates calculated the volume as 83.3 using the constant they had calculated in part (a). They were given the mark as their response fell within the range of acceptable answers.

Question 23 (c)

(c) Explain how and why atmospheric pressure changes with height above the surface of the Earth.

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..... **[2]**

This question was beyond many Foundation tier candidates. The most common misconception was to say pressure increased with height above the Earth. Many said there was less oxygen or less gas higher up, but still said the pressure was greater.

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