Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/03 Summer 2022 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 are 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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 3 series overview

The paper is designed to assess content from Topics P1 to P4 and P9. The practical skills specified in section P9 of the specification is the basis of 15% of the marks on the paper.

There was no evidence to suggest that candidates were short of time in answering the paper. Most candidates answered all the multiple-choice questions. In section B, all the questions were attempted.

Several questions required candidates to analyse information and ideas. Candidates should be familiar with interpreting data both qualitatively and quantitatively from different sources. Candidates should understand how to test for linear, directly proportional and inversely proportional relationships.

There were a number of questions where candidates needed to carry out a numerical calculation. Where an equation needs to be recalled, candidates should write the equation down as a first step. In other numerical questions, candidates should identify the data to use and substitute the data into the equation, before calculating the answer. Candidates should also carefully consider the units of their data.

On this paper, there was one Question, 18, where candidates had the opportunity to demonstrate their knowledge and understanding of physics by constructing their own answer. It is important that candidates answer the question set in a logical way with clear explanations. Candidates should also make sure that they answer the question set.

There are a number of questions where an explanation is required. Candidates should use the number of answer lines and the marks for the sub-part as a guide to the length of their answers. Candidates should also use appropriate physics terms correctly in their answers.

The comments that follow relate to the opportunities that were missed by the candidates.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• Used the white space in multiple-choice questions for working • In numerical questions stated the equation used, rearranged the equation and substituted the data before writing the answer • Used technical terms correctly • Structured answers logically • Answered the question set	• Gave little or no working in numerical questions • Did not answer the question set • Gave general responses rather than specific responses to the question set • Did not use technical terms

Section A overview

Section A of the paper has fifteen multiple-choice questions, each worth 1 mark. Candidates should read the whole question including all the possible options. Other helpful tips include using the "white" space around the question to write done working and/or equations (to assist with answering the question and to help to check the answer at the end of the examination) and eliminate incorrect options.

Question 1

1 A current of 2 A flows in a circuit.

How much charge is transferred in 3 minutes?
Use the Data Sheet.

A 1.5 C

B 6.0 C

C 120 C

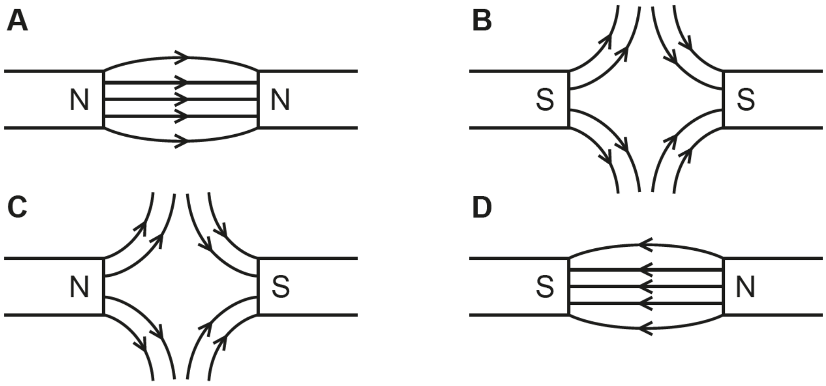
D 360 C

Your answer ☐ **[1]**

Most candidates answered this question well. A significant minority of candidates answered B indicating that they had not changed the minutes to seconds.

Question 2

2 A student draws the magnetic field lines between the poles of two magnets.



Which magnetic field line diagram is correct?

Your answer ☐ **[1]**

This question was answered well. Candidates needed to know that the direction of the field lines is from north to south.

Question 3

3 A student of mass 65 kg climbs a flight of 50 steps. Each step is 0.30 m high.

What is the gravitational potential energy gained by the student?

Use the equation: potential energy = mass × height × gravitational field strength

Gravitational field strength = 10 N/kg.

A 195 J

B 9750 J

C 19 500 J

D 975 000 J

Your answer ☐ **[1]**

In this question a small minority of candidates calculated the potential energy for one step. Candidates who scored a mark on this question often underlined the data used in the question.

Question 4

4 A student holds a balloon near a narrow stream of water from a tap. The water is attracted to the balloon.

Why does this happen?

A The water and the balloon are both negatively charged.

B The water and the balloon are both positively charged.

C The water and the balloon are not charged.

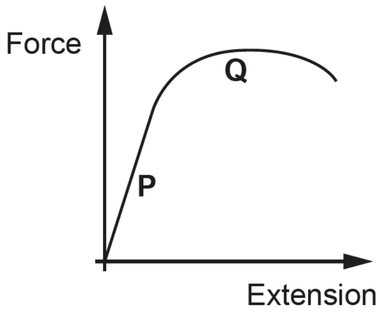
D The water is positively charged and the balloon is negatively charged.

Your answer ☐ **[1]**

This question was very well answered by all candidates. The good approach to answer this type of question is for candidates to read each statement and eliminate the statements by placing a small cross by each distractor.

Question 5

5 The graph shows how a copper wire behaves when it is stretched.



Which row in the table describes part **P** and part **Q** on the graph?

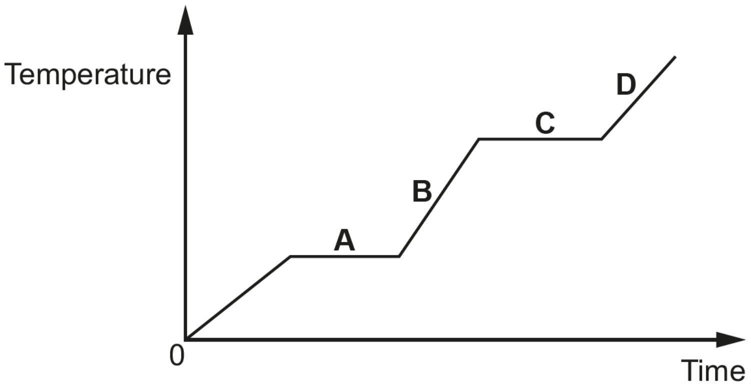
	Part P	Part Q
A	linear	elastic
B	linear	plastic
C	non-linear	elastic
D	non-linear	plastic

Your answer ☐ **[1]**

Most candidates realised that P was linear, but a small minority of these candidates then incorrectly thought that Q was elastic.

Question 6

6 A student heats a substance steadily from a solid to a gas. The temperature change is recorded on the graph.



Which section of the graph is where the specific latent heat of vaporisation is used to calculate the energy needed for this change of state?

Your answer ☐ **[1]**

A minority of candidates selected B or D.

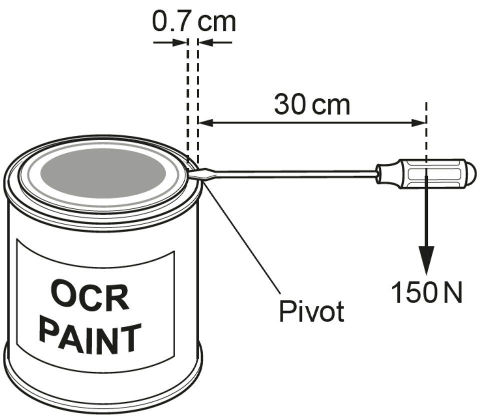
Assessment for learning

Understand the difference between latent heat and specific heat capacity.

This question could be used without the labels for candidates to identify the processes that occur in each section of the graph.

Question 7

7 A decorator uses a screwdriver as a lever to open a tin of paint. The edge of the tin acts as a pivot.



What is the clockwise moment of the screwdriver about the pivot?
Use the Data Sheet.

A 5.0 Nm

B 45 Nm

C 46 Nm

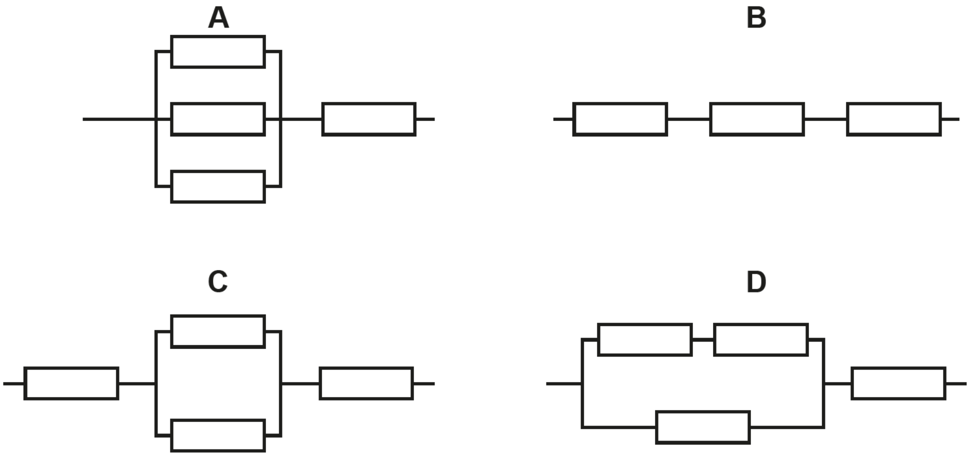
D 500 Nm

Your answer ☐ **[1]**

A small number of candidates multiplied the force of 150 N by 30.7 cm rather than 30.0 cm.

Question 8

8 A student sets up four arrangements, **A**, **B**, **C** and **D**, using identical fixed resistors.



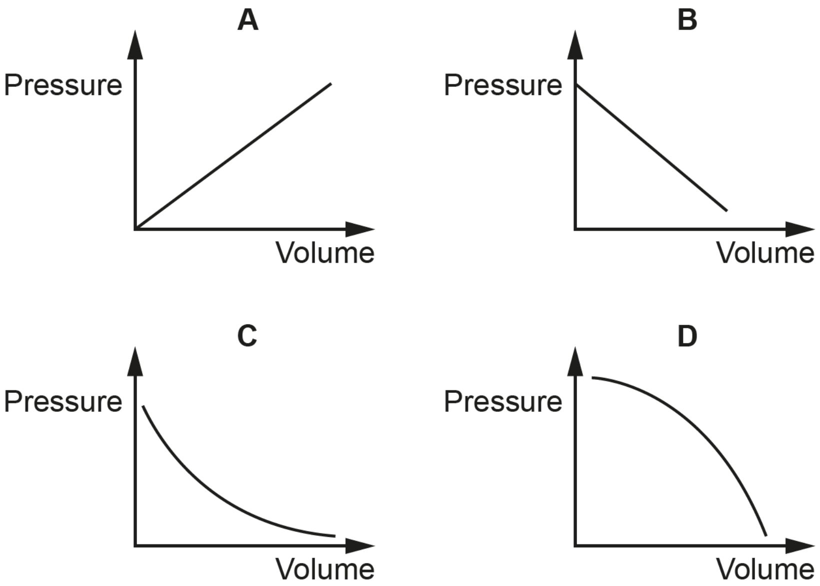
Which arrangement has the lowest resistance?

Your answer ☐ **[1]**

For this type of question candidates need to eliminate incorrect responses. High scoring candidates often worked out the values for each combination before making their choice. Most candidates realised that B could not be the correct answer.

Question 9

9 A teacher measures the pressure and volume of a fixed gas at a constant temperature.



Which graph shows the correct relationship between pressure and volume for the gas?

Your answer **[1]**

Erratum notice

Turn to **page 6** of the **question paper** and look at **question 9.**

In the first line, add the words 'mass of' after the word 'fixed'.

The sentence should now read:

A teacher measures the pressure and volume of a fixed mass of gas at a constant temperature.

In the final print of the question paper "mass of" was omitted – an erratum notice was issued, and it was clear that candidates had written in the two words.

This question was not well answered with many candidates not understanding that the pressure in a fixed mass of gas is inversely proportional to the volume and therefore C was the correct answer.

Many candidates selected B and D so realised that the pressure decreased with an increase in volume. A number of candidates also selected A.

Assessment for learning

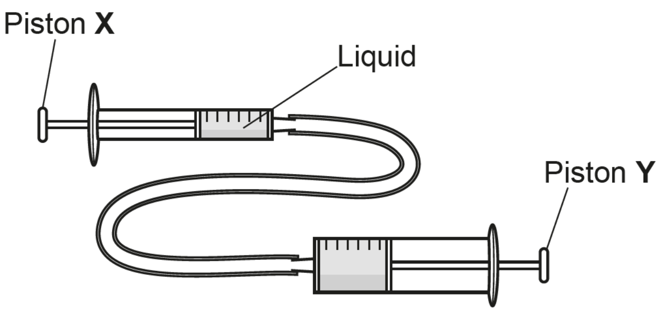
Understand the types of graphs produced for directly proportional, inversely proportional and linear relationships.

Candidates should understand the significance of straight line graphs and how the relationships may be tested.

Question 10

10 The diagram shows when a hydraulic machine uses a liquid to transmit a force.
When piston **X** is pressed, the force is transmitted and piston **Y** moves.

The area of piston **X** is 4.0 cm^2 and the area of piston **Y** is 20 cm^2.



Piston **X** is pressed with a force of 10 N.
What is the force produced at piston **Y**?

Use the equation: $\text{pressure} = \dfrac{\text{force normal to a surface}}{\text{area of that surface}}$

A 2.0 N

B 40 N

C 50 N

D 200 N

Your answer ☐ **[1]**

Candidates should be encouraged to use the white space around the question to demonstrate their working. The sensible method in this question is to use the equation to work out the pressure in the liquid then use the equation a second time to work out the force. A number of candidates incorrectly gave the answer as A.

Question 11

11 There are 1609 m in a mile.
Which of these is approximately the same speed as 56 miles per hour?

A 25 m / s

B 29 m / s

C 52 m / s

D 90 m / s

Your answer ☐ **[1]**

Some candidates incorrectly answered this question often selecting B.

Candidates should be able to convert miles per hour to km / h and then to m /s.

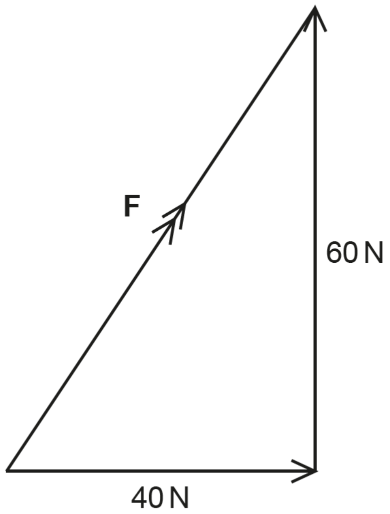
In this question the number of metres in a mile was given, so candidates needed to do the conversion of hours to seconds (1 hour = 3600 s).

High scoring candidates often wrote in the white space $\frac{56\times1609}{60\times60} = 25.028$.

Question 12

12 Two forces, of magnitude 40 N and 60 N, act on an object.

A student draws a scale-diagram to determine the net force **F** acting on the object.



Scale 1 cm = 10 N

What is the net force **F** acting on the object?

A 7.2 N

B 20 N

C 72 N

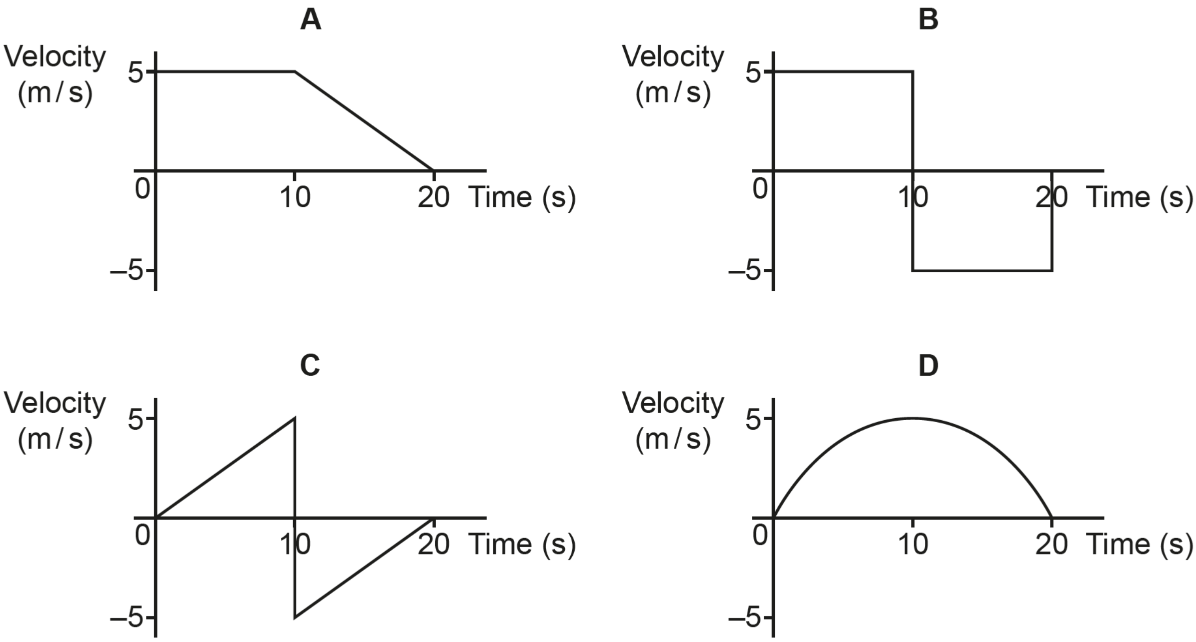
D 100 N

Your answer [1]

This was well answered by most candidates with many candidates choosing to use Pythagoras' theorem. A small minority of candidates did just add 40 and 60 to make 100 N.

Question 13

13 Velocity–time graphs are drawn for four different objects.



Which object has the largest displacement?

Your answer [ ] **[1]**

Candidates found this question challenging with the common incorrect answer being B where candidates added together the two areas to work out the distance the object travelled rather than the displacement.

Question 14

14 An object floating in water experiences an upwards force.

What causes this upwards force on the object?

A Pressure at the top of the object is greater than at the bottom of the object.

B Pressure at the top of the object is less than at the bottom of the object.

C The density of the object is greater than the density of the water.

D The weight of the water displaced is less than the weight of the object.

Your answer [ ] **[1]**

High scoring candidates worked through each of the distractors eliminating the incorrect answers.

Question 15

15 A submarine travels to the bottom of an ocean. The ocean is 2.5 km deep and the density of the sea water is 1020 kg / m^3.

What is the water pressure on the submarine at the bottom of the ocean?

Use the Data Sheet.

Gravitational field strength = 10 N / kg.

A 2.55 kPa

B 25.5 kPa

C 2.55 MPa

D 25.5 MPa

Your answer [ ] **[1]**

The common incorrect answer was B where candidates did not allow correctly for the km. Candidates should underline data including the units to avoid such errors.

Section B overview

Candidates should read the question carefully underlining key information and data to answer the question set.

When answering explanation type questions, candidates' answers should relate to the question rather than general ideas.

Question 16 (a)

16 Two students decide to determine the mean speed of cars passing outside their school.

(a) Describe how the students will take the measurements they need to be able to calculate the mean speed of a car.

....

....

....

....

....

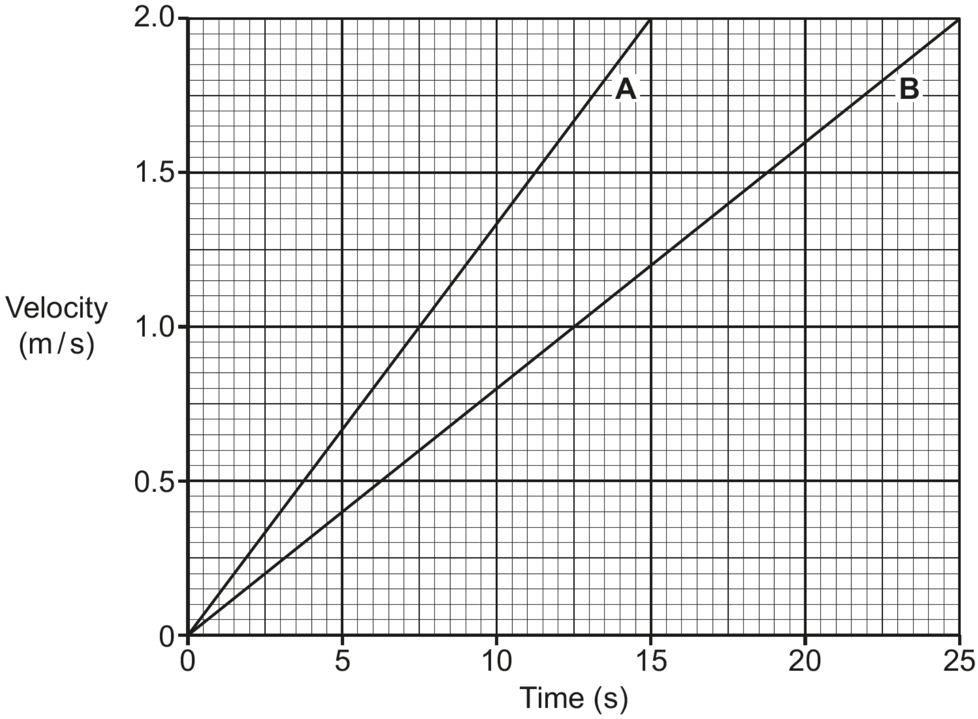
.... **[4]**

The emphasis of this question was on the measurements that the students were to make outside a school. To do this experiment successfully as students, it would be necessary to choose an appropriate set distance, to measure the distance and then time cars passing through the set distance. Candidates needed to suggest appropriate measuring instruments. For distance, the cars would have needed to have travelled many metres and thus ideally measuring tape or a trundle wheel should have been used. A ruler was inappropriate and did not gain marks.

Candidates were not given marks for the use of speed guns or cameras since students were unlikely to have access to this equipment in a school science laboratory. References to the use of mobile phones did not score.

Question 16 (b) (i)

(b) The students also investigate the motion of two battery-powered toy cars, **A** and **B**.
The velocity–time graph shows their results.



(i) Which toy car, **A** or **B**, has the greater acceleration? Explain your answer.

Car ....

Reason ....
[1]

Most candidates scored the mark in this question. Candidates should relate the gradient of the velocity time graph to the acceleration and make a comment in terms of the steepest gradient.

Question 16 (b) (ii)

(ii) Use the graph to calculate the acceleration of car **B**.

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

Candidates should show their working. In this case it was expected to see appropriate read-offs from the graph to determine the gradient.

Assessment for learning

Understand how to calculate the gradient of a straight line.

Candidates should practise using

$gradient = \frac{y_2 - y_1}{x_2 - x_1}$.

Question 16 (b) (iii)

(iii) Both cars have the same mass.

Suggest why it takes different amounts of time for them to reach their top speeds.

.... **[1]**

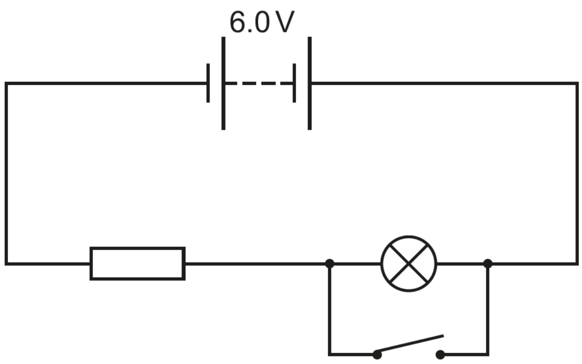
Some vague answers were seen in this question. Ideally candidates would reference that car A had a greater power or a larger driving force. Many candidates correctly stated that the friction forces on car B may have been greater. Answers such as different battery (which could mean a blue battery rather than a red battery) and bigger battery did not gain marks.

Candidates should be encouraged to state which car in this type of question.

Since the question stated that both cars had the same mass, different masses could not gain marks.

Question 17 (a) (i)

17 A scientist sets up an electrical circuit.



The lamp and the resistor each have a resistance of 5.0 Ω so that the total resistance in the circuit is 10.0 Ω.

(a) **(i)** Calculate the current in the circuit when the switch is open.
Use the Data Sheet.

Current = ... A **[3]**

Most candidates correctly calculated the current. Candidates who gained the incorrect answer but showed their working often scored a mark for stating that current = potential difference / resistance. A common error was incorrectly using 5 Ω for the resistance.

Ideally candidates should state the equation, rearrange the equation, substitute the data and then evaluate the answer.

Misconception

The meaning of open and closed switches.

Question 17 (a) (ii)

(ii) State the potential difference across the resistor when the switch is open.

Potential difference = ... V **[1]**

A minority of candidates gained marks with an answer of 3.0 V. Many candidates stated the potential difference of the battery.

Question 17 (b) (i)

(b) The switch is now **closed**.

(i) Describe how the current through the resistor changes. Explain your answer.

....

....

.... **[2]**

Some candidates stated correctly that the current increased but then the reasoning was vague. Often candidates stated incorrectly that the current would remain the same since the resistance of the resistor has not changed.

Misconception

How current changes with resistance in series and parallel circuits.

The resistance of a short circuit becomes zero.

Question 17 (b) (ii)

(ii) Describe how the potential difference across the resistor changes. Explain your answer.

....

....

.... **[2]**

Many candidates did not link the increase in current to an increase in the potential difference across the resistor. Often candidates stated it remained the same as the battery (6 V)

Misconception

How potential difference changes with resistance in series and parallel circuits.

Question 17 (b) (iii)

(iii) State the potential difference across the lamp when the switch is closed.

Potential difference = ... V **[1]**

Many candidates did not understand that the potential difference across the lamp would now be zero.

Question 18

18* Two students, **P** and **Q**, investigate how the resistance of wire varies with its length. Each student uses different lengths of the **same** wire and the **same** equipment for their experiment.

- **Table 18.1** shows the data that student **P** obtained.
- **Table 18.2** shows the data that student **Q** obtained.

Table 18.1

Student P data

Length of wire (cm)	Resistance Trial 1 (Ω)	Resistance Trial 2 (Ω)	Mean resistance (Ω)	Resistance per unit length (Ω/cm)
10	12	20	16	1.6
15	25	30	28	1.9
19	21	29	25	1.32

Table 18.2

Student Q data

Length of wire (cm)	Resistance Trial 1 (Ω)	Resistance Trial 2 (Ω)	Mean resistance (Ω)	Resistance per unit length (Ω/cm)
10.0	11.0	11.2	11.1	1.10
20.0	19.8	20.2	20.0	1.00
30.0	33.0	33.2	33.1	1.10
40.0	48.0	48.4	48.2	1.20
50.0	55.1	55.5	55.3	1.10

The manufacturer of the wire states that the value for its resistance per unit length is 1.2 Ω/cm.

Compare the data recorded in the two tables. Explain which student's data is the most accurate and precise.

....

....

....

....

.... **[6]**

This question required candidates to compare the data of the two tables and explain which data is more accurate and more precise. This question tested the language of measurement in scientific investigations.

This type of question is deliberately open ended to give candidates the opportunity of structuring their answers.

A useful way for candidates to answer this type of question is to start by explaining the meaning of the word accurate and the word precise.

There were then many comparisons that candidates could make using the data. When answering this type of question candidates should be encouraged to support their answers with evidence. Ideally each comparison should then link with whether this indicated that the data is more / less accurate or more / less precise.

High scoring candidates often calculated the mean values of the resistance per unit length – often by the table of results. Some candidates effectively wrote notes on the two tables of results and based their answers on these notes.

Exemplar 1

Student's Q's data is both the most accurate and precise. Firstly this is because student Q had two more lengths included in the data than Student P, meaning they can see if there is much range in the values of resistance per unit length. Additionally, the lengths increase by a set amount of 10cm rather than it being added randomly like it was done in student P's data.

Student P also made erros in his mean calculations; the values include too much range, they could be counted as anomalies, which are supposed to be ignored. This shows how student Q's results are more accurate as the values are more closer to one another. Finally, [6]

The range in the final resistance per unit length is much greater in student P's data showing how it is not as precise as student Q's data, which is also closest to the manufacturer's value of 1.2Ω/cm.

In this response the candidate makes a general opening comment about Q's data being more accurate and precise – this on its own is vague since it does not address the meaning of accurate and the meaning of precise.

There is then an irrelevant section referring to the lengths increasing by a set amount.

The student then compares the data but lacks detail on why the mean calculations are incorrect. The final paragraph makes it clear that the candidate understands preciseness and then discusses closest to the true value.

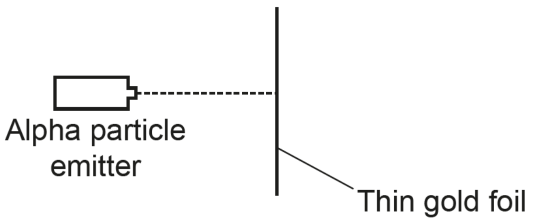
Overall, there is some confusion between accuracy and precision so Level 2. The communication statement is met so 4 marks were given.

Misconception

Candidates are often confused between the terms accurate and precise. To assist candidates there is a useful publication – Language of measurement.

Question 19 (a) (i)

19 (a) Between 1908 and 1913, two scientists did experiments to help understand the structure of atoms.
The diagram shows how the scientists fired alpha particles at a thin piece of gold foil and detected what happened to these particles.



(i) The scientists detected that a very small number of particles reflected directly back, some particles were deflected, and most particles passed straight through the foil.

Describe the model of the atom following these observations.

....

....

....

....

.... **[3]**

It was expected that candidates would state that since most of the alpha particles passed straight through, most of the atom is empty space. Since a very small number of alpha particles were reflected straight back, this gave the idea of a small, positive nucleus where the mass of the atom is concentrated. A number of candidates did not mention "nucleus".

Question 19 (a) (ii)

(ii) Explain why the previous model of the atom needed to change after this experiment.

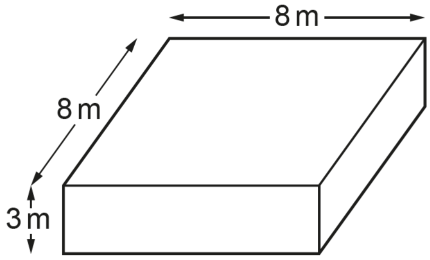
....

.... **[1]**

Many candidates correctly explained that the results from the alpha scattering experiment did not support the plum pudding model. Some candidates enhanced the answers by explaining the differences in terms of positive charge.

Question 19 (b) (i)

(b) A classroom contains air particles. A drawing of the classroom is shown in the diagram.



(i) Calculate the volume of the classroom.

Volume = ... m^3 **[1]**

This question was answered well. High scoring candidates often showed their working.

Question 19 (b) (ii)

(ii) The density of air is 0.012 kg / m^3.
Calculate the mass of air in the classroom.

Use the equation: density = mass / volume

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

This question was answered well. High scoring candidates often showed their working.

Candidates should show the rearrangement of the equation and the data correctly substituted.

Question 20 (a) (i)

20 Two skaters are standing, at rest, opposite each other on an ice rink.

Skater **A** has a mass of 40 kg and skater **B** has a mass of 50 kg.

A
40 kg

B
50 kg

Skater **A** pushes against skater **B** with a force of 30 N.

(a) (i) What does Newton's third law tell us about the force that skater **A** experiences from skater **B**?

....

....

.... **[2]**

Many candidates scored both marks in this question. When only 1 mark was scored it was generally because candidates had not mentioned the direction.

Question 20 (a) (ii)

(ii) Calculate the acceleration of skater **B** when they are pushed with the force of 30 N.

Use the equation: force = mass × acceleration

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

This question was answered well. High scoring candidates often showed their working.

Candidates should show the rearrangement of the equation and the data correctly substituted.

Question 20 (b) (i)

(b) **(i)** State the total momentum of both skaters **before** skater **A** pushes skater **B**.

.... **[1]**

This was well answered - some candidates showed the calculation others stated zero.

Some low scoring candidates stated 90 (the combined mass).

Question 20 (b) (ii)

(ii) After pushing skater **B**, skater **A** has a velocity of 2 m/s.

Calculate the momentum of skater **A**.

Use the equation: momentum = mass × velocity

Momentum = ... kg m/s **[2]**

This was very well answered. It is useful to see the method – the first mark was given for 80 × 2.

Question 20 (b) (iii)

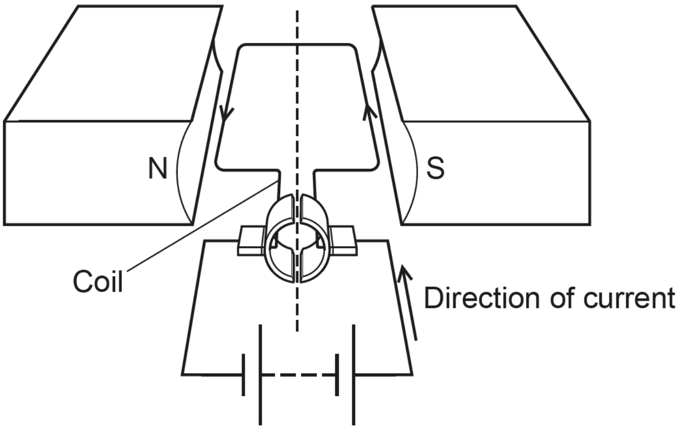
(iii) Calculate the velocity of skater **B** after being pushed by skater **A**.

Velocity = ... m/s **[3]**

This was again very well answered by high scoring candidates. Common errors included the wrong value of mass or using a different value of momentum.

Question 21 (a) (i)

21 A student investigates a simple electric motor as shown in the diagram.



(a) **(i)** Suggest why the coil turns when a current flows.

....

.... **[1]**

Answers to this question were often vague. There was little reference to the magnetic field of the coil interacting with the magnetic field due to the current in the coil causing opposite forces to act on the coil.

Question 21 (a) (ii)

(ii) In which direction will this motor turn?
State the name of the rule you used to work this out.

Direction ....

Name of rule ....

....
[2]

For the direction, it was expected that the candidates would state clockwise. Many candidates gave vague answers such as up, sideways.

It was expected that Fleming's left-hand rule would be quoted.

Question 21 (b)

(b) Suggest **two** ways in which the size of the force on the coil could be increased.

1 ....

2 ....
[2]

Most of the candidates stated two out of increasing the current, increasing the number of coils and increasing the strength of the magnetic field. Examiners did not allow larger magnets since larger magnets does not necessarily mean a stronger magnetic field.

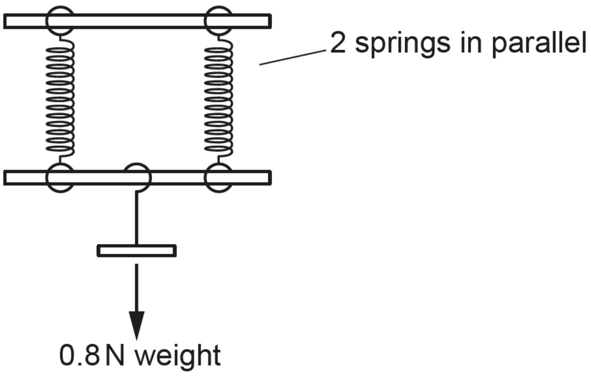
Some candidates stated increasing the potential difference – this was allowed as an alternative to increasing the current.

Question 22 (a) (i)

22 A student investigates the extension of springs in parallel.

The student attaches a 0.8 N weight to two, four, six and eight springs in parallel. They then measure the extension using a ruler.

The diagram shows the experiment with two springs in parallel.



The results are shown in the table.

Number of springs in parallel	Extension (cm)
2	1.2
4	0.6
6	0.4
8	0.3

(a) **(i)** Explain why the student found it difficult to measure the extensions shown in the table.

....

.... **[1]**

When answering this type of question candidates need to give answers that are relevant to the experiment and the data given. In this experiment the extensions are very small and close to each other and most importantly close to the smallest division (1 mm) on a ruler.

Question 22 (a) (ii)

(ii) Suggest how the student could change the experiment to produce extensions that are easier to measure.

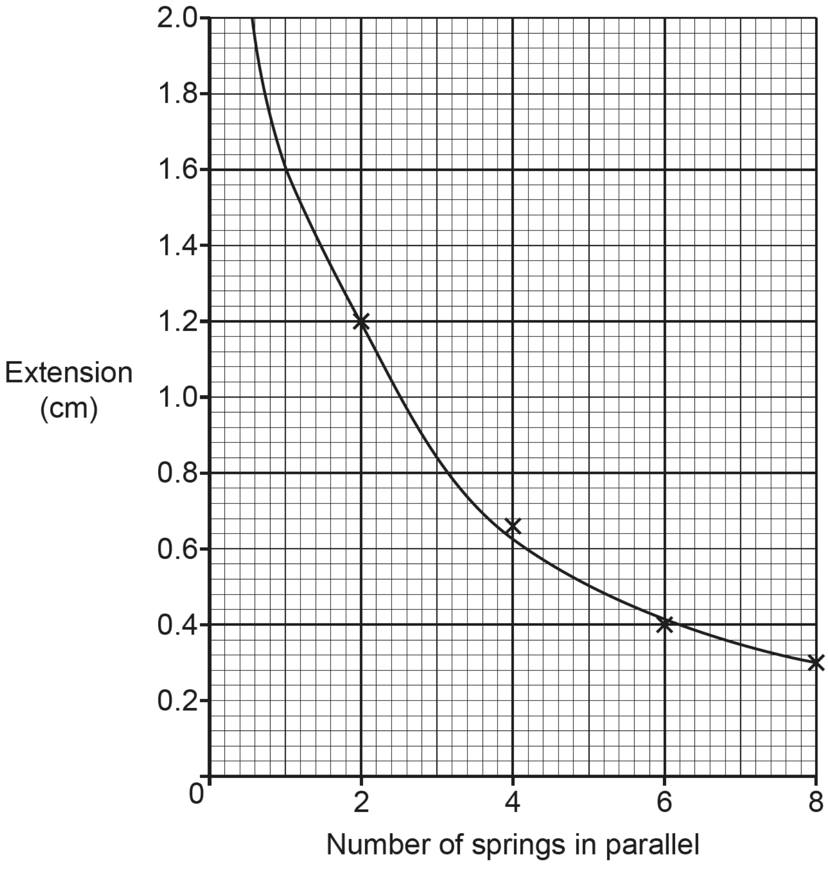
....

.... **[1]**

Candidates needed to explain a method to obtain larger extensions. The majority of candidates correctly suggested the use of a larger weight.

Question 22 (b) (i)

(b) The graph shows these results.



(i) One point has been incorrectly plotted.
Circle the incorrectly plotted point and then plot it in the correct place. **[2]**

This question was answered well with most candidates correctly circling the incorrectly plotted point. Some candidates did not then plot it in the correct position.

Question 22 (b) (ii)

(ii) Describe the relationship between the number of springs in parallel and their extension.

....

....

.... **[2]**

Most candidates correctly stated that as the number of springs in parallel increased, the extension decreases. A small minority of candidates went on to state that the extension is inversely proportional to the number of springs in parallel.

Assessment for learning

Understand how to test inverse proportionality both from tables of data and from graphs

Candidates should be given the opportunity to check whether two quantities are inversely proportional.

For example, when considering the variation of pressure *p* in a fixed mass of gas at constant temperature with the volume *V*

(a) If one quantity is doubled the other quantity is halved, e.g. if the pressure is double the volume is halved.

(b) By multiplying pairs of the two quantities together to see whether a constant is produced, e.g. pV = constant

(c) From a graph taking pairs of quantities and applying (a) or (b)

(d) Plotting a graph of one of the quantities against the inverse of the other quantity, e.g. plot a graph of p against $1/V$ – if a straight line is produced that passed through the origin, then p is inversely proportional to V.

Question 22 (c)

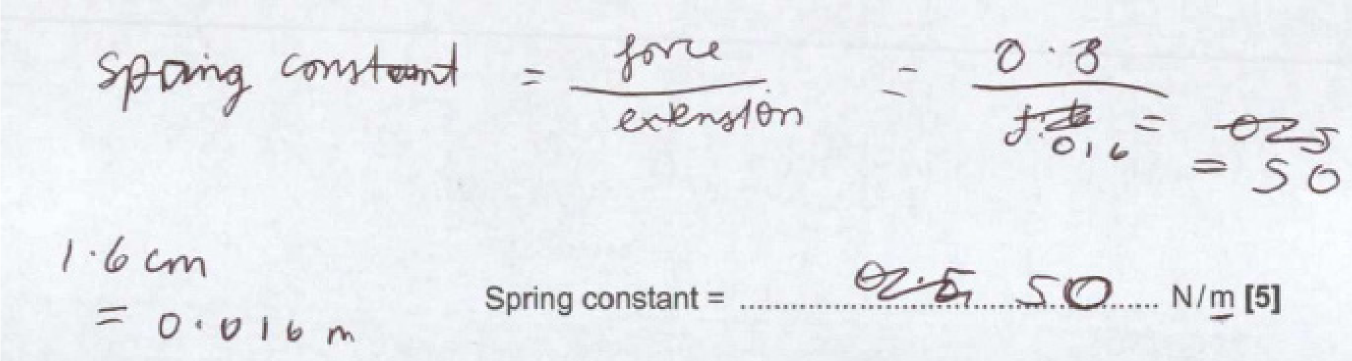
(c) Use the graph to calculate the spring constant for a single spring.

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

Spring constant = ... N/m **[5]**

Many candidates did not score well on this question since they did not give full answers.

Exemplar 2


spring constant = force / extension = 0.8 / 0.016 = 50

1.6 cm = 0.016 m

Spring constant = ~~0.25~~ 50 N/m [5]

The candidate has identified the read off from the graph (1.6 cm) and converted it to 0.016 m.

The candidate has correctly rearranged the equation and then substituted the data before evaluating the answer.

Assessment for learning

Candidates should show their working in calculations.

Candidates should:

(a) Write the equation they are to use

(b) Rearrange the equation so that the unknown quantity is the subject of the equation

(c) Substitute the data into the equation

(d) Evaluate the data showing intermediate stages

(e) Give the answer

(f) Consider the number of significant figures

This method will also assist candidates in checking their answers.

Question 22 (d)

(d) A manufacturer has a choice of three different springs to use in a mattress for a bed as shown in the table.

Mattress spring	Spring Constant (N/m)
R	6000
S	9000
T	12000

Explain which mattress spring, **R**, **S**, or **T**, compresses the most when a person lies on it.

Mattress spring ....

Reason ....

.... **[1]**

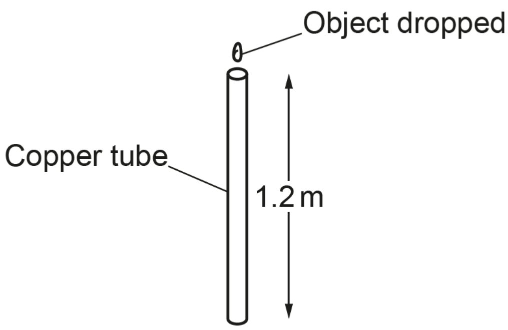
Most candidates gained marks linking the answer of R with the lowest spring constant. Some candidates identified R as the spring but then repeated the question by stating that R compresses the most.

Some lower scoring candidates stated T since it had the largest spring constant.

Question 23 (a) (i)

23 A student drops a piece of metal and a small magnet through a vertical copper tube.
They record the time taken for each object to pass through the tube.

The diagram shows how they set up the experiment.



The student records their results in a table.

	Time taken to fall through the copper tube (s)					
	1	**2**	**3**	**4**	**5**	**Mean**
Magnet	1.13	1.11	1.12	1.11	1.13	
Metal	0.44	0.45	0.46	0.44	0.43	0.4444

(a) (i) Calculate the mean time that the magnet takes to pass through the copper tube.

.... **[1]**

Most candidates correctly calculated the mean to be 1.12.

Question 23 (a) (ii)

(ii) The student has made a mistake when recording their results in the table.

Identify the mistake and suggest a correction.

Mistake: ....

Correction: ....
[2]

Most candidates correctly identified that the mean for the metal, 0.4444, was the mistake and that the correct value of the mean was 0.44 (rounded) or 0.444 (unrounded).

Question 23 (a) (iii)

(iii) The student claims that their data shows that their experiment is reproducible.
Explain if the student is correct.

....

.... **[1]**

Many candidates did not state that the data showed that the experiment was NOT reproducible. Some high scoring candidates explained that for the experiment to be reproducible, the experiment would need to be compared with someone else doing the experiment or different equipment or techniques being used.

Misconception

Candidates are often confused between the terms repeatable and reproducible. To assist candidates there is a useful publication – Language of measurement.

Question 23 (a) (iv)

(iv) Why did the student repeat their experiment 5 times and calculate a mean?

....

.... **[1]**

Many candidates stated that repeating the experiment would be more accurate which did not gain marks. Candidates who gained marks often stated that it would identify anomalies or outliers and increase the precision. Candidates could also have stated that it reduced random errors or check that the experiment was repeatable.

Misconception

Candidates are often confused between the terms accurate and repeatable. To assist candidates there is a useful publication – Language of measurement.

Question 23 (b) (i)

(b) (i) Calculate how many times longer it took the magnet to fall compared to the piece of metal.

Number of times longer: .... **[1]**

Most candidates scored marks for this question. Some candidates inverted the answer.

Question 23 (b) (ii)

(ii) Calculate the mean speed of the metal through the copper tube.

Write your answer to **2** significant figures.

Use the equation: distance travelled = speed × time

Mean speed = ... m/s **[4]**

This question was well answered. Some candidates used the wrong mean. Useful advice is to underline the quantities in the question.

Question 23 (c)

(c) Explain why the magnet took longer to fall than the piece of metal.

Include ideas about electromagnetic induction in your answer.

....

....

....

....

....

.... **[3]**

Many candidates discussed the magnet being attracted to the copper. Some high scoring candidates realised that the falling magnet produced a changing magnetic field which induced a current in the copper tube. To gain further marks, candidates needed to state that the induced current in the copper created a magnetic field that opposed the motion of the magnet.

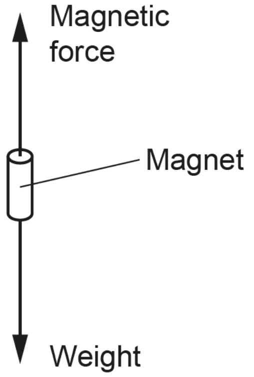
Misconception

Many candidates stated that the magnet was attracted to copper.

Many candidates did not understand electromagnetic induction.

Question 23 (d)

(d) The diagram shows a free-body force diagram for when the magnet is at a point in the middle of the tube.



Explain the motion of the magnet.

....

....

....

.... **[2]**

Several candidates gave vague explanations.

Careful measuring of the arrows indicate that the magnetic force was equal to the weight so that the resultant force on the magnet was zero. Having determined the resultant force acting on the magnet was zero, the magnet was travelling at constant speed downwards or at its terminal velocity.

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