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OCR
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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/03 Summer 2023 series

Version 1

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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 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 encouraged to practise interpreting data both qualitatively and quantitatively from different sources. Candidates need to 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 be encouraged to 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 response. Candidates should also carefully consider the units of their data.

On this paper, Question, 21 (b) gave candidates had the opportunity to demonstrate their knowledge and understanding of physics by constructing their own response. 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 be encouraged to use the number of answer lines and the marks for the sub-part as a guide to the length of their responses. Candidates should also make sure that they use appropriate physics terms correctly in their responses.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used the white space in multiple choice questions for working and eliminated incorrect responses • in numerical questions stated the equation used, rearranged the equation and substituted the data before writing the calculated value • used technical terms correctly • structured responses logically • related explanations to the question.	• did not use the white space in multiple choice questions for rough work • in numerical questions, often just wrote down a final value, omitting both a relevant rearranged equation and the substitution of numbers • gave vague responses rather relating their explanations to the question set.

Section A overview

Section A of the paper has fifteen multiple choice questions, each worth 1 mark. Candidates should be given the opportunity to practise these types of questions under timed conditions. In particular, candidates should be encouraged not to spend too long on any question, but also to read the whole question, including all the possible options.

In numerical questions, candidates should be encouraged to use the "white" space around the question equations and working. This should help them to answer the question and assist them with checking their response.

In other questions, as candidates read through the question, a useful technique is to use small crosses to eliminate incorrect options.

Question 1

1 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]**

Although the majority of candidates gained credit, a significant number of candidates did not realise that 1 J = 1 N m. A common incorrect response was 0.15 N m.

Question 2

2 What is the correct order of the three states of matter in **increasing** density?

A Gas → liquid → solid

B Liquid → gas → solid

C Liquid → solid → gas

D Solid → liquid → gas

Your answer ☐ **[1]**

This question was very well answered. The common incorrect response was D where perhaps candidates had not understood 'increasing' density.

Question 3

3 Four athletes run a race in different times.

Athlete	Time taken (s)
1	21.5
2	21.6
3	
4	21.5
Mean	21.4

What is the time taken by athlete 3?

A 21.0 s

B 21.1 s

C 21.4 s

D 21.5 s

Your answer ☐ **[1]**

This question was well answered. Good candidates used the white space around the question for their working.

Question 4

4 Which sentence is correct when a lever is used as a force multiplier?

A The effort force and load force are both situated at the pivot.

B The effort force is closer to the pivot than the load.

C The load force and the effort force are the same distance from the pivot.

D The load is closer to the pivot than the effort force.

Your answer ☐ **[1]**

The majority of candidates gained credit although a significant number of candidates chose B or C.

Question 5

5 One mile is equal to 1609 metres.

How many miles are there in 5000 metres?

A 0.3218 miles

B 0.6782 miles

C 2.108 miles

D 3.108 miles

Your answer ☐ **[1]**

This question was very well answered.

Question 6

6 A scientist wants to publish a new theory.

Which step should the scientist take before publishing the theory?

A Check the new theory with a friend.

B Have the new theory peer reviewed.

C Keep the new theory secret to avoid others copying.

D Publish the new theory in a local magazine.

Your answer ☐ **[1]**

The majority of candidates correctly realised that a new theory should be peer reviewed.

Question 7

7 Which row describes properties of electric fields and gravitational fields?

	Electric fields	Gravitational fields
A	attractive only	attractive only
B	attractive only	attractive and repulsive
C	attractive and repulsive	attractive only
D	attractive and repulsive	attractive and repulsive

Your answer ☐ **[1]**

The majority of candidates gained credit. Common incorrect responses were B and D.

Question 8

8 Which sentence correctly describes an object when it is moving in a circle at a constant speed?

A The object is accelerating as its velocity is changing.

B The object is accelerating as its velocity is constant.

C The object is not accelerating as acceleration is a scalar quantity.

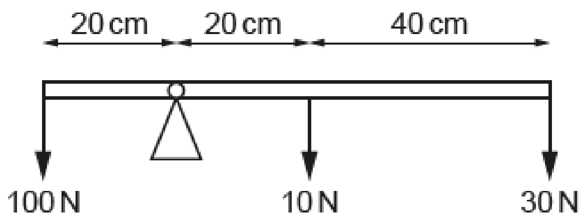
D The object is not accelerating as its speed is constant.

Your answer ☐ **[1]**

While the majority of the candidates gained a mark, a large number of candidates incorrectly thought that since the object is travelling at constant speed, it was not accelerating (Option D).

Question 9

9 A student investigates moments using a beam placed on a pivot as shown in the diagram. The student holds the beam.



What happens to the beam when the student releases it?

A It rotates anti-clockwise with a net moment of 60 N cm.

B It rotates anti-clockwise with a net moment of 600 N cm.

C It rotates clockwise with a net moment of 2000 N cm.

D It stays in equilibrium.

Your answer ☐ **[1]**

Many candidates found this question challenging.

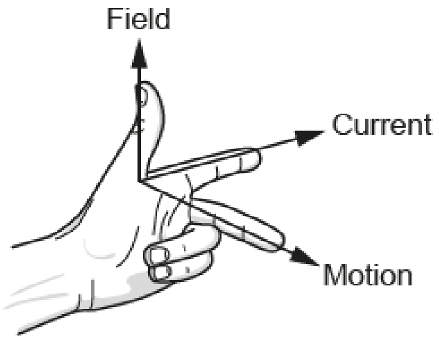
A good technique observed by some candidates was adding distances from the pivot for the 30 N force. Some candidates used the white space surrounding the question effectively, writing down the anticlockwise moment and the total of the clockwise moments.

A common incorrect response was B, where candidates had used 40 cm rather than 60 cm as the perpendicular distance.

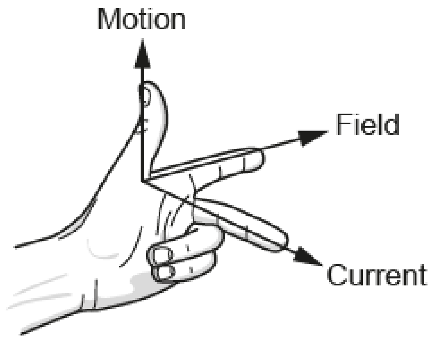
Question 10

10 Which diagram shows the correct thumb and finger labels when using Fleming's left-hand rule?

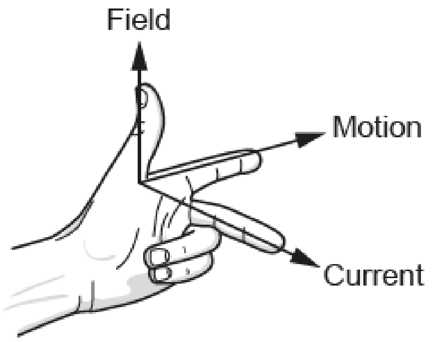
A



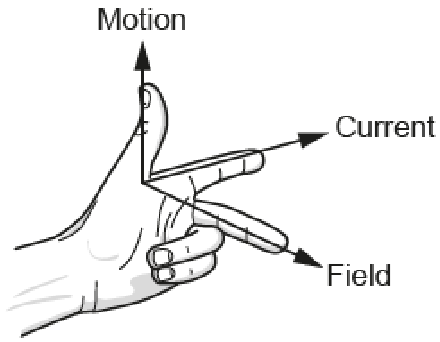
B



C



D



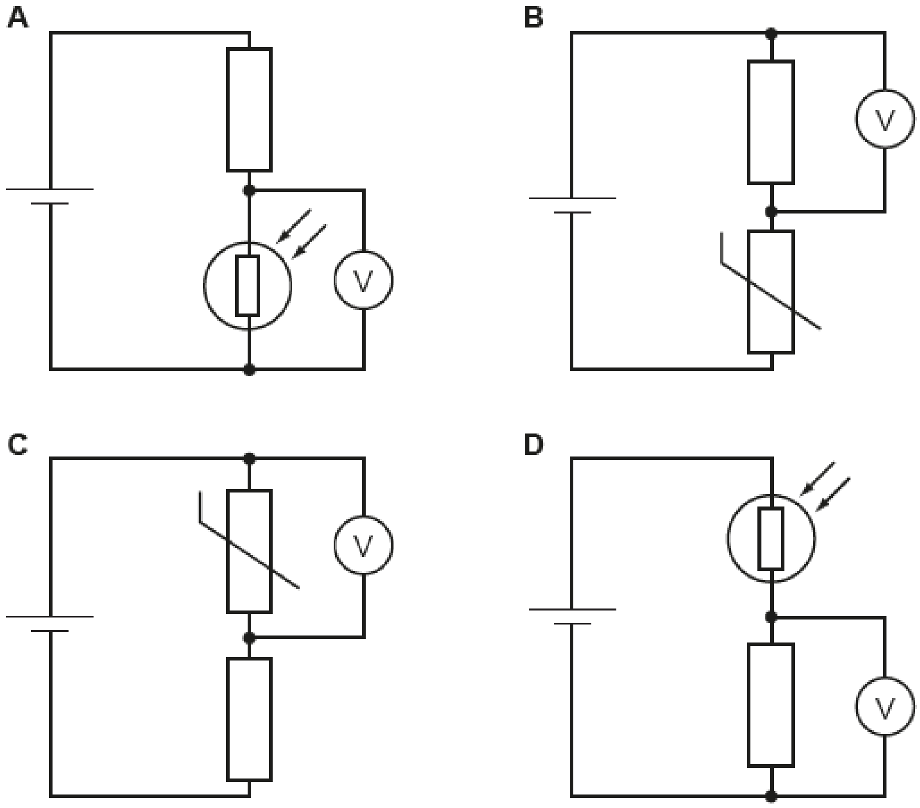
Your answer ☐ **[1]**

This question tested the basic understanding of Fleming's left hand rule. A range of responses was seen from the small minority of candidates who did not choose B.

Question 11

11 An engineer uses a sensing circuit which produces a high output voltage when it gets dark.

Which circuit does the engineer use?



Your answer ☐ **[1]**

Many candidates correctly answered this question. A common error was D where candidates had selected a circuit where the high output voltage would occur when it was light.

Question 12

12 A submarine in an ocean dives from a depth of 50 m to a depth of 60 m.

What is the change in pressure due to the water acting on the submarine?

Use the Equation Sheet.

Density of seawater = 1010 kg / m^3

Use g = 10 N / kg

A 10.1 Pa

B 1010 Pa

C 101 000 Pa

D 606 000 Pa

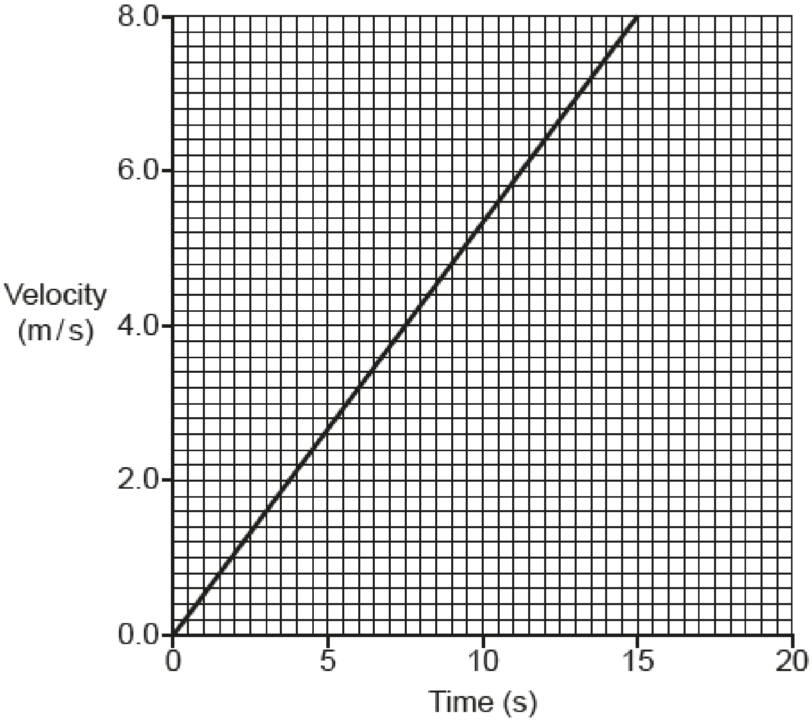
Your answer ☐ **[1]**

Most candidates were able to multiply the numbers together. High scoring candidates often used the white space for their working.

Question 13

13 A scientist draws a velocity–time graph for an object.

What is the distance travelled by the object in 15 s?



A 0.53 m

B 1.9 m

C 60 m

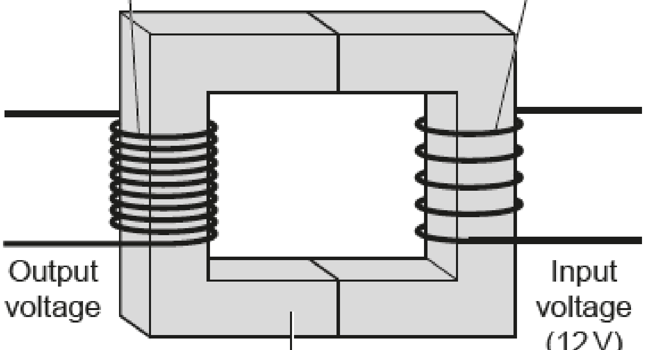
D 120 m

Your answer [ ] **[1]**

The majority of candidates realised that the area under the graph was equal to the distance travelled by the object. Most candidates who did not gain credit incorrectly gave D as the response; this was obtained by just multiplying the two numbers together.

Question 14

14 A teacher makes a model transformer as shown in the diagram.



Which row gives the correct type of transformer and its output voltage?

	Type of transformer	Output voltage (V)
A	step-down	6.0
B	step-down	24
C	step-up	6.0
D	step-up	24

Your answer ☐ **[1]**

The majority of the candidates realised that the type of transformer was step-up. A large minority of candidates perhaps misread the question and assumed that the primary coil was on the left.

Question 15

15 A 0.50 kg ball moving at 3.0 m/s to the right collides with a stationary 0.60 kg ball and stops.

What is the velocity of the 0.60 kg ball immediately after the collision?

Use the Equation Sheet.

A 0.90 m/s to the left

B 0.90 m/s to the right

C 2.5 m/s to the left

D 2.5 m/s to the right

Your answer ☐ **[1]**

The majority of the candidates chose the correct response.

Section B overview

As candidates read a question, they should be encouraged to underline key information and data.

When answering explanation type questions, candidates' responses should relate to the question.

In numerical questions, candidates should be encouraged to write down the equation they are using, substitute the numbers into the equation and then evaluate the response, e.g.:

- equation
- rearrange the equation
- substitute the data
- consider the units (and any prefixes)
- evaluate
- consider whether the response looks right.

Question 16 (a)

16 (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.

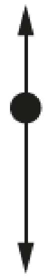
Use the equation: distance travelled = average speed × time

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

This question was well answered. Candidates should be encouraged to show their working.

Question 16 (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 question was well answered. A few low scoring candidates incorrectly labelled the upwards force as 'upthrust'.

Question 16 (b) (ii)

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

....

....

.... **[2]**

The majority of candidates gained at least 1 mark. The question related to the free body diagram; candidates were expected to compare forces due to air resistance and weight.

Question 16 (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]**

The majority of candidates gained full marks for this question. Candidates should be encouraged to show their working. High scoring candidates wrote the equation from the Equation sheet, then substituted in the numbers from the question, before calculating the response.

Question 17 (a)

17 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.

....

....

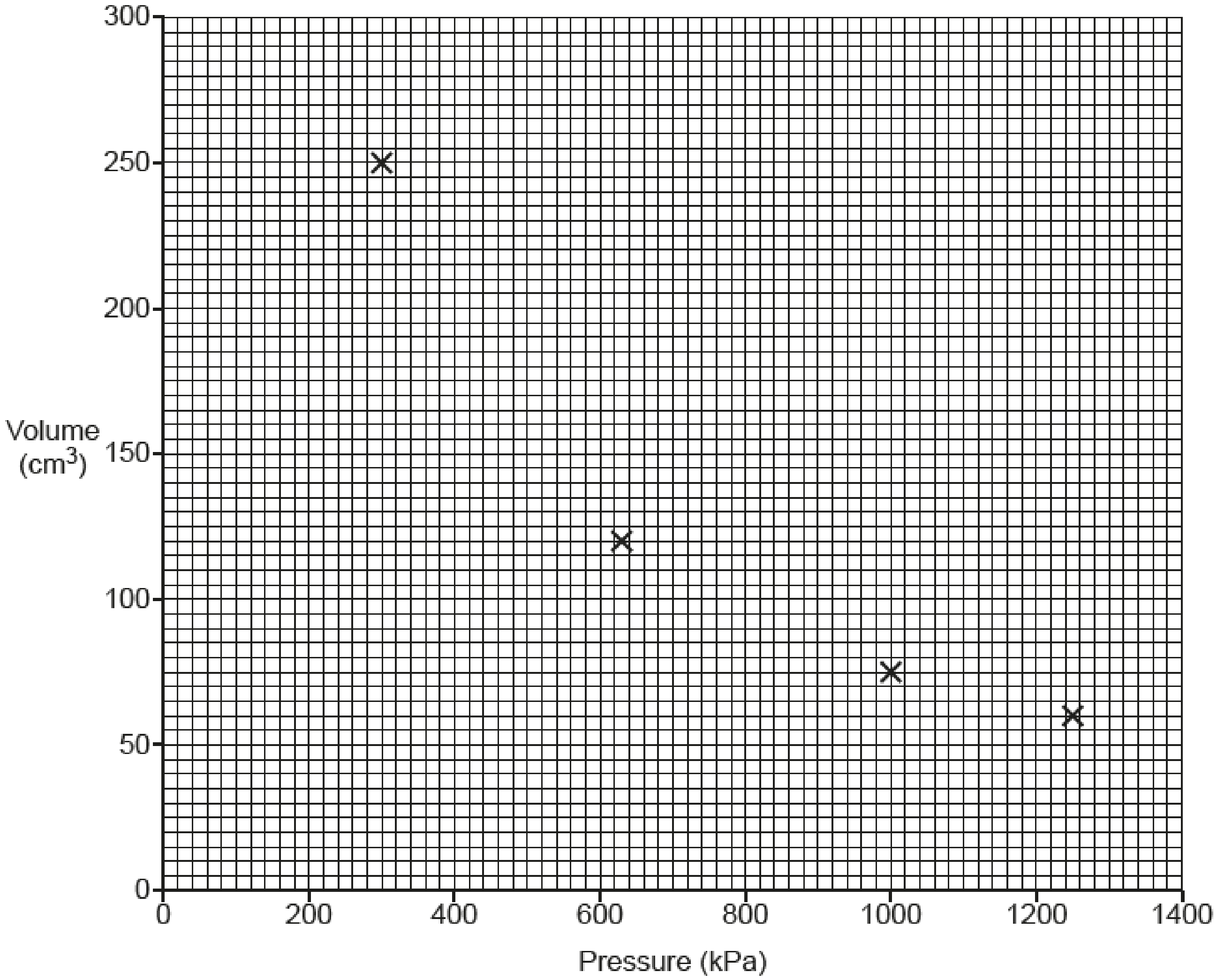
....

.... **[3]**

The majority of the candidates scored 3 marks. Some candidates wrote values of pV beside the table. A few candidates calculated the constant pV, but did not then explain that the results were all the same.

Question 17 (b) (i)

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



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

The majority of candidates correctly plotted the missing plot. High scoring candidates used a small cross using a fine pencil. Candidates should plot their data points to within half a small square.

Question 17 (b) (ii)

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

The majority of the candidates drew a curved line of best fit. Some low scoring candidates incorrectly drew a straight line. Other candidates incorrectly drew several lines or did not have a balance of points about the line.

Question 17 (b) (iii)

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

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

Most candidates correctly read off the value. High scoring candidates drew lines onto the graph clearly indicating the 900 kPa and the relevant value on the volume axis.

Question 17 (c)

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

....

....

....

.... **[2]**

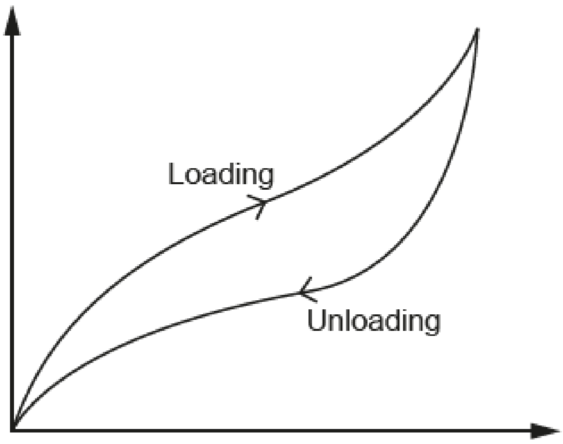
High scoring candidates scored both marks. Many candidates realised that the pressure decreased with an increase in height. Many candidates discussed change in density, without mentioning that there would be less air or atmosphere or fewer particles. Some candidates discussed temperature changes rather than pressure changes.

Question 18 (a) (i)

18 A teacher stretches an elastic band by increasing the force applied and measures the extension during loading.
The teacher then reduces the force applied and measures the extension during unloading.

Fig. 18.1 shows the force–extension graph of their results.

Fig. 18.1



(a) The teacher writes some facts about the experiment.

State if each fact is **correct** or **incorrect**. Put a (ring) around the correct option.
Explain your answers.

(i) The elastic band obeys Hooke's Law.

correct **incorrect**

Reason ....

.... **[1]**

A large minority of candidates gained credit in this question. Some candidates thought that the statement was correct because the elastic band returned to its original shape. Candidates who gained the credit either stated that the forces was not proportional to the extension or that the lines were not straight.

Question 18 (a) (ii)

(ii) The elastic band undergoes plastic deformation.

correct **incorrect**

Reason ....

.... **[1]**

More candidates gained credit in this question. Some candidates gave vague responses, although it was expected that candidates would refer to the original length or shape of the elastic band.

Question 18 (a) (iii)

(iii) There is a linear relationship between force and extension for the elastic band.

correct **incorrect**

Reason ....

.... **[1]**

The majority of candidates gained credit. Some low scoring candidates effectively repeated the 'incorrect' by stating as their reason that the graph was non-linear.

Question 18 (b)

(b) A spring has a spring constant of 28 N / m.

Calculate the work done stretching this spring by 0.20 m.

Use the Equation Sheet.

Work done = ... J **[2]**

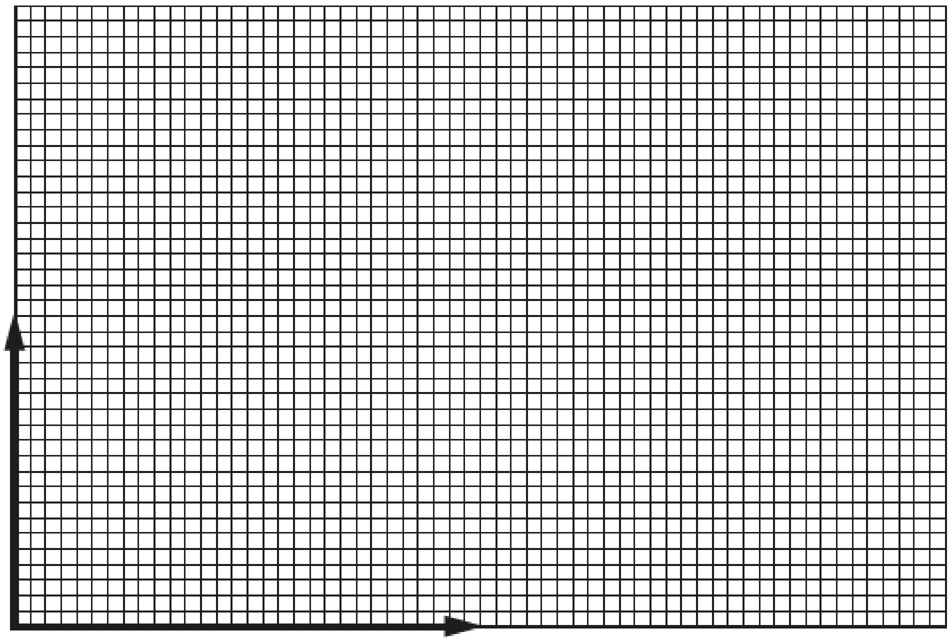
Candidates found this question challenging, with many choosing the incorrect equation of F = kx giving an answer of 5.6 J. It is good practice to select the correct equation and substitute the numbers from the question, before evaluating the response.

Question 18 (c)

(c) The teacher pulls another object with two separate forces of 2.0 N and 3.0 N. The forces act at right angles to each other.

Fig. 18.2 shows the two forces.

Fig. 18.2



Scale: 1 N = 2 cm

On **Fig. 18.2** draw the resultant force on the object.

Determine the magnitude of the resultant force.

Resultant force = ... N **[3]**

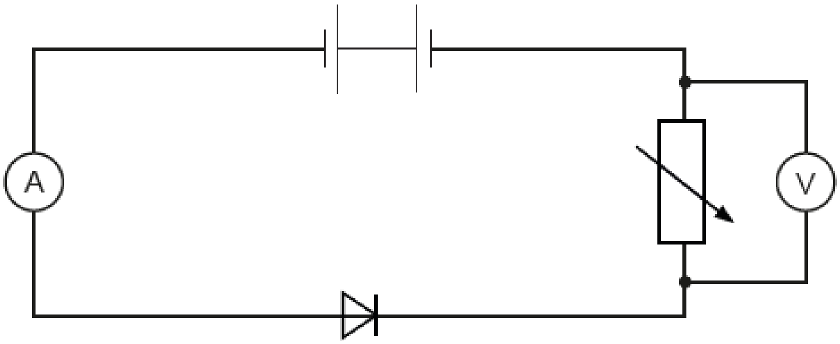
Many candidates scored 2 marks for this question with many candidates drawing the incorrect resultant force. A common approach was to use Pythagoras theorem to determine the resultant; this gained credit. Other candidates correctly measured the resultant length and converted this to 3.6 N.

Question 19 (a)

19 A student investigates the current–potential difference characteristics of a diode.

Fig. 19.1 shows the circuit diagram the student sets up to measure the current in the diode and the potential difference across the diode.

Fig. 19.1



(a) The student has made **two** mistakes when setting up the circuit.

Identify the two mistakes and explain how to correct them.

Mistake 1 ....

Correction 1 ....

Mistake 2 ....

Correction 2 ....
[4]

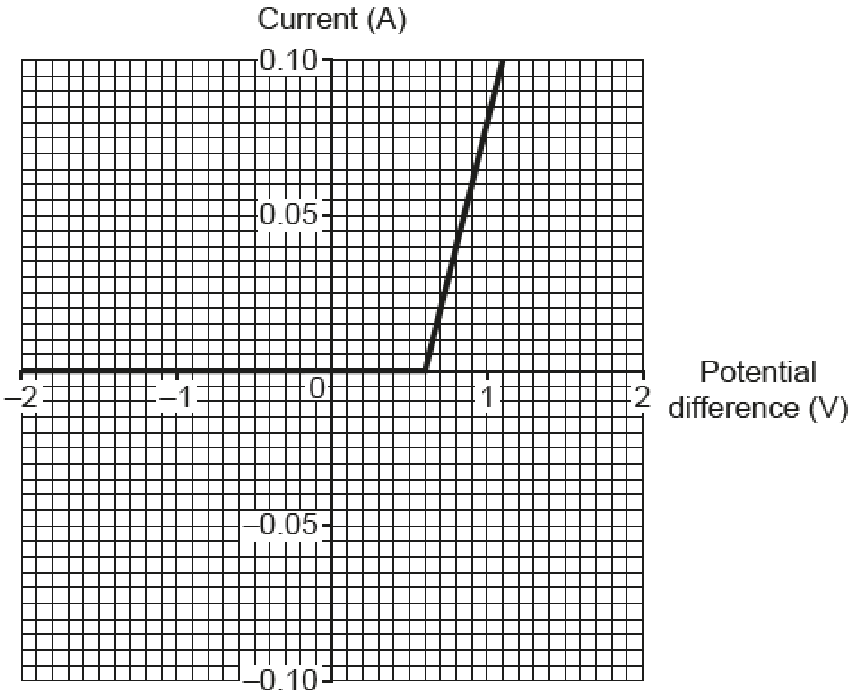
There were many vague responses to this question, for example the diode should have a circle around it. Other incorrect responses included 'the diode is pointing the wrong way' and the ammeter is in the wrong position.

High scoring candidates often stated that the cells in the battery were facing each other and that the left hand cell needed to be reversed. Other candidates discussed the position of the voltmeter.

Question 19 (b) (i)

(b) The student corrects the circuit and records the current for different values of the potential difference. **Fig. 19.2** shows a graph of their results.

Fig. 19.2



(i) State the potential difference when the diode starts to conduct.

.... **[1]**

The majority of the candidates read the graph correctly as 0.6 V.

Question 19 (b) (ii)

(ii) Use the gradient of the graph to calculate a value for the resistance of the diode when it is conducting.

Resistance = ... Ω **[4]**

Many candidates correctly determined the gradient but then did not invert their value to determine the (dynamic) resistance of the diode. Other candidates used the ratio of V / I to determine the (static) resistance of the diode. Either method required candidates to accurately interpret the graph. When reading values from the graph, it is good practice to read off values at gridlines rather than estimating values between gridlines.

Question 20 (a)

20 (a) Explain **two** similarities and **two** differences between the operation of a loudspeaker and the operation of a microphone.

Similarities ....

....

....

Differences ....

....

....

[4]

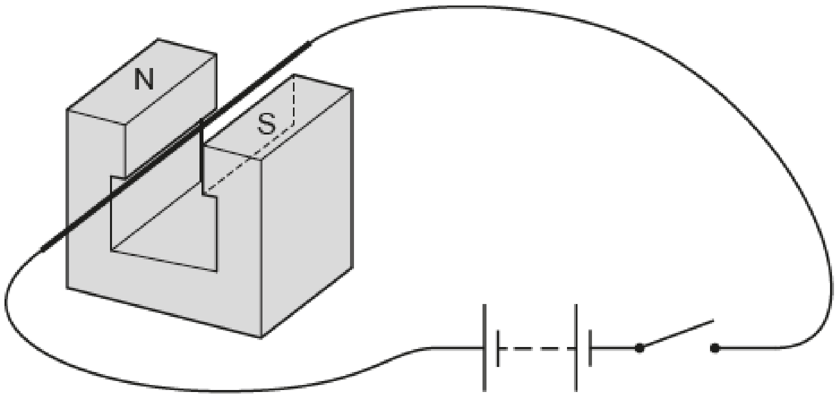
A large number of candidates correctly stated that both a microphone and a loudspeaker use coils and/or magnets. Some candidates' responses were vague with a similarity being that a microphone and a loudspeaker both have a current rather than being more specific and discussing a changing or alternating current.

In describing differences, high scoring candidates discussed the transfer of sound waves to an electrical signal for a microphone and the transfer of an electrical signal to sound waves for a loudspeaker.

A common response that did not gain credit was that the loudspeaker used the motor effect and the microphone used the dynamo effect – a more detailed response was expected.

Question 20 (b)

(b) The diagram shows a current-carrying wire in the magnetic field between the North pole and the South pole of a magnet.



Describe and explain what happens to the wire when the switch is **closed**.

....

....

....

....

.... **[3]**

This question required candidates to logically explain that the wire would move downwards. High scoring candidates stated that the current in the wire has a circular magnetic field around the wire which interacts with the magnetic field due to the poles of the magnet.

Question 20 (c)

(c) A current of 5.0 A passes through a wire with a length of 0.75 m.

The wire is in a field of magnetic flux density 0.30 T.

Calculate the force acting on the wire.

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

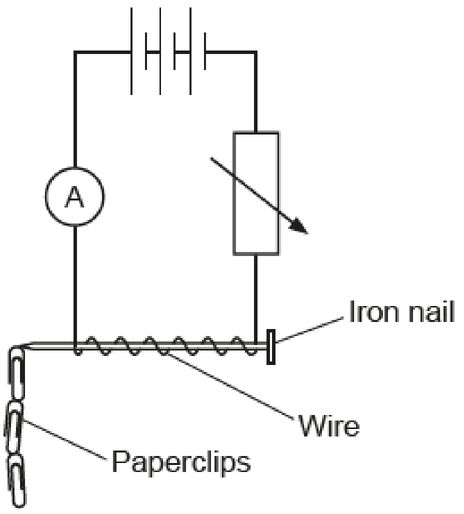
Use the Equation Sheet.

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

This question was well answered. A small minority of candidates did not score the last mark as they rounded their final value to 1.13 (2 decimal places, where they were asked for 2 significant figures).

Question 21 (a)

21 A student makes a solenoid by wrapping wire around an iron nail as shown in the diagram.



The student investigates how the current in the wire affects the magnetic field of the solenoid.

(a) Suggest why the student uses an iron nail in the centre of the solenoid.

.... **[1]**

Many candidates simply stated that iron was magnetic rather than suggesting why this was helpful. High scoring candidates stated that the strength of the magnetic field would be increased.

Question 21 (b)*

Describe the trend shown by these results.

Suggest what the student should have done in their method to obtain accurate and valid results.

....

....

....

....

....

.... **[6]**

The level of response question gives candidates the opportunity of structuring their own response. In this particular question there were two sections that needed to be addressed by the candidate.

Firstly, there needed to be reference to the trend shown by the data in the table. Most candidates were able to describe a simple trend; however, high scoring candidates discussed whether the current and number of paper clips were directly proportional with some reasoning. In this case, candidates could have discussed the regular increase in the number of paperclips

Secondly, candidates needed to describe the method used to gain accurate and valid results. Many candidates discussed the need to repeat measurements, and a significant number gave extra detail about removing anomalies and calculating a mean. Some candidates identified that the current was recorded to the nearest 1 A and that an ammeter recording to the nearest 0.1 A or 0.01 A would improve the method. Other candidates discussed the quantities that needed to be kept constant to make sure that it was a fair test.

A number of candidates discussed using other people to do the experiment (reproducible) which did not answer the question since the question was concerned with the candidate's method.

Exemplar 1

Current (A)	Number of paperclips picked up
1	5
2	11
3	17
4	22
5	28
6	32

→ higher current = more paperclips

→ higher amount of paperclips = high magnetic field strength.

→ average increase with 1A = 6 paperclips
mean = 5.4 paperclips.

could have gone to a higher current = 10A?

could have done the same current multiple times before swapping to a higher current. = more accurate

could have compared to another result.

could have gone into .5A like 1.5A to see the change.

the trends the results show are that as the current increases so does the amount of paperclips picked up. Another trend is that as the number of paperclips increases, it shows that the magnetic field is increasing in strength. Another trend is that by a 1 Amp increase in current, the amount of paperclips usually increase by 6. The student could have gone to a higher current than 6A so more results can be shown making it more accurate. the student could have also repeated each current amount multiple times to make sure it is accurate and valid. The student could have also decreased the amount of current to the next like going into .5 Amps to get more results and making it valid and accurate. The student could have also compared their results to another to make them more valid and accurate. **[6]**

The candidate describes a simple trend and starts to discuss the type of relationship by the increase in the number of paper clips for an increase in current of 1 A. This line of reasoning could have been developed further both by indicating that the increase was not always the same and what type of relationship could have existed.

The candidate has discussed the method of using different currents and repeating the experiment. The reasoning is 'making it valid and accurate'.

Overall the scientific content is Level 2 and the communication statement is met so four marks. To have achieved Level 3, the candidate needed to develop the reasoning relating to the trend, by arguing that the relationship was (or was not) directly proportional with some reasoning, and giving some more detail, perhaps by stating quantities that needed to be kept constant and explaining why repeat readings were being taken.

Assessment for learning

Candidates should understand how to test for a proportional relationship.

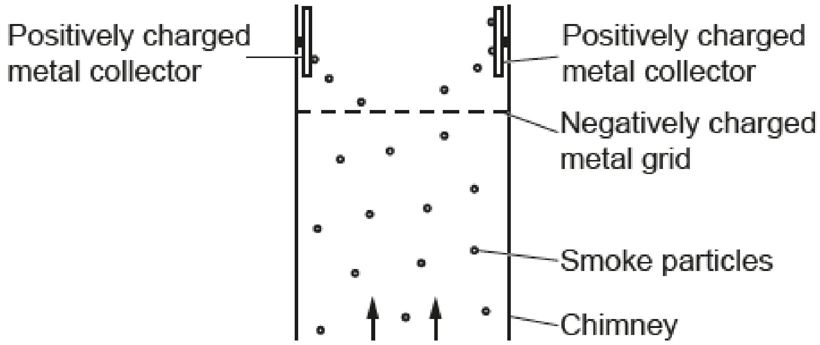
To show that two quantities are directly proportional, candidates should be able to test graphically with a straight line passing through the origin or from a table of results to produce a constant.

The testing should be extended to inverse proportional relationships (such as Question 17(a)).

Question 22 (a) (i)

22 An electrostatic dust precipitator uses static electricity to remove smoke particles from gases before the gases are released from a chimney in a factory.

The diagram shows an electrostatic dust precipitator in a chimney.



The smoke particles at the bottom of the chimney initially have a neutral charge. The smoke particles move upwards and pass through a negatively charged metal grid in the chimney.

(a) **(i)** Explain how the precipitator removes the smoke particles when the gases move upwards through the chimney.

Use ideas about charges.

....

....

....

....

.... **[3]**

This question was generally well answered with the majority of candidates understanding that the negatively charged grid transferred electrons to the smoke particles so that the smoke particles became negatively charged and were attracted to the positive collector plates.

Some high scoring candidates correctly stated that the negatively charged smoke particles would also be repelled from the negatively charged grid.

This type of question needs candidates to write a logical explanation using relevant physics terms.

Question 22 (a) (ii)

(ii) Suggest why many scientists think these precipitators should be fitted to all factory chimneys.

....

.... **[1]**

Candidates needed to relate their response to the context of the question. Answers such as to prevent damage to the environment were considered too vague. The key point was that the precipitator would reduce the smoke being released.

Question 22 (b)

(b) The precipitator uses high voltages.

Why are high voltages dangerous?

....

.... **[1]**

Many candidates gave a vague response about harm and death, as opposed to relating their responses to the high voltage. High scoring candidates discussed the possibility of electric shocks and electrocution. Some very detailed responses which also gained full credit discussed the interference with the heart and damage to the nervous system.

Question 22 (c)

(c) The collectors receive 360 C of charge every two minutes.

Calculate the current in the collectors.

Use the equation: charge flow = current × time

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

This question was answered well. Where errors occurred, it was often due to not changing the time to seconds.

Question 23 (a) (i)

23 A medical freezer is used to keep vaccines cool.

(a) **(i)** Calculate the energy required by the freezer to cool 0.50 kg of solid vaccines from –5 °C to –35 °C.

Assume the specific heat capacity of the vaccines is 1900 J / kg °C.

Use the Equation Sheet.

Energy = ... J **[2]**

This question was answered well. The majority of the candidates correctly determined the temperature change.

Question 23 (a) (ii)

(ii) It takes 5 minutes for the freezer to cool the vaccines.

Calculate the power of the freezer.

Use the Equation Sheet.

Power = ... W **[3]**

This question was also answered well. A small minority of candidates did not change the five minutes to 300 seconds.

Candidates should be encouraged to think about their calculated values. A power of 5700 W (not changing the time to seconds) is much larger than that of any domestic electrical appliance.

Question 23 (a) (iii)

(iii) Suggest **two** reasons why the actual power of the freezer will be greater than that calculated in part **(a)(ii)**.

1 ....

....

2 ....

....
[2]

Answers were generally vague and many candidates did not gain credit. Many candidates stated that the freezer was not 100% efficient but did not explain why.

High scoring candidates often discussed that there was a container for each vaccine or that there were other contents in the freezer. Other candidates discussed the transfer of energy to/from the surroundings or heating in the motor.

A common incorrect response was to state the specific heat capacity may be a different value.

Question 23 (b) (i)

(b) (i) When the vaccine is used by doctors, it has to be changed back into a liquid. The temperature of the vaccine is first raised to its melting point but it remains as a solid.

Explain **two** reasons why more energy is needed to change the solid vaccine into a liquid at its melting point.

1 ....

....

2 ....

....
[2]

Many candidates scored 1 of the 2 marks for stating the energy is needed for a change in state.

Question 23 (b) (ii)

(ii) Calculate the number of 5 mg vaccine doses which can be melted using 6800 J of energy.

Assume the specific latent heat of fusion for the vaccines is 340 000 J/kg.

Use the Equation Sheet.

Number of vaccine doses = ... **[6]**

This question enabled candidates to decide on their own approach to a multi-stage calculation.

Clear working should be encouraged.

High scoring candidates rearranged the equation before substituting the numbers from the question.

Many candidates struggled with the conversion between kg.

Some candidates correctly determined the energy needed to melt one dose and then went on to indicate that this worked out to be 4000 doses. This alternative method was correct physics, and thus full credit was given.

Exemplar 2

$E = mL$

$m = \frac{E}{L}$

$m = \frac{6800}{340\,000} = \frac{1}{50}\,kg = 0.02\,kg$

$0.02\,kg = 20\,g$ $\frac{20000}{5} = 4000$

$20\,g = 20000\,mg$

Number of vaccine doses = 4000 **[6]**

The candidate clearly rearranges the equation and substitutes in the correct numbers from the question to determine the mass of vaccine melted (0.02 kg).

The candidate then indicates how the mass of 0.02 kg is changed initially to a mass of 20 g before changing it to a mass 20 000 mg.

The final calculation is then shown giving the answer of 4000 doses.

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