Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/03 Summer 2024 series

Version 1

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. The paper is designed for candidates taking the Higher tier. Questions 16 and 17 were overlap questions with the Foundation tier and were thus targeted at grades 4 and 5.

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 answer. Candidates should also carefully consider the units of their data.

On this paper, there was one question, 19, 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.

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 answers. Candidates should also make sure that they use appropriate physics terms correctly in their answers.

There were also a number of questions relating to graphs. Candidates should be able to plot data points accurately to less than half a small square and draw lines of best fit both for linear and curved trends, and they should be able to draw a tangent to a curved line. It is also expected that candidates should be able to interpret graphs both qualitatively and quantitatively. In particular, candidates should be able to determine the gradient and *y*-intercept. Candidates should also be able to identify what the gradient and *y*-intercept represent.

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 • read all the options and then eliminated incorrect responses from the multiple-choice questions • in numerical questions, stated the equation used, rearranged the equation, and substituted the data before writing the answer, for example, Question 20 (b) (ii) • structured answers logically, for example, Question 19	• did not use technical terms correctly, for example, Question 5 • gave vague answers rather than relating their explanations to the question set • were not able to interpret key features of the graph such as the gradient and the area under the line, for example, Question 23 (b) and 23 (c).

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• related explanations to the question set • underlined key terms and data in the stem of each question.	

Section A overview

Section A of the paper has fifteen multiple-choice questions, each worth one 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 answer.

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

Question 1

1 A molecule is made up of 10 atoms in a row.

Which measurement is a typical size for this **molecule**?

A 1×10^{-15} m

B 1×10^{-13} m

C 1×10^{-11} m

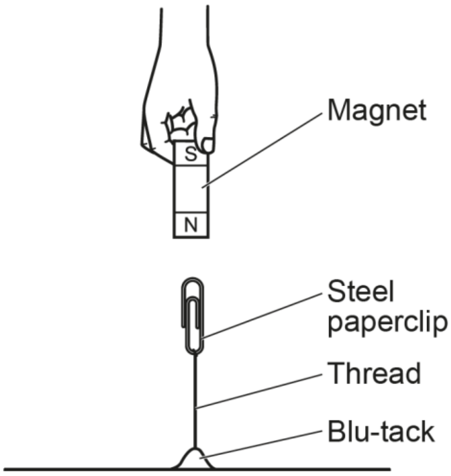
D 1×10^{-9} m

Your answer ☐ **[1]**

This question was well answered by the majority of candidates. A few candidates gave options A or B, perhaps confusing molecule with nucleus. Other candidates gave option C, perhaps not realising the question was asking about the typical size of a molecule.

Question 2

2 A student holds a bar magnet above a paperclip. The paperclip is attracted to the bar magnet.



Which row of the table correctly describes the bar magnet and paperclip?

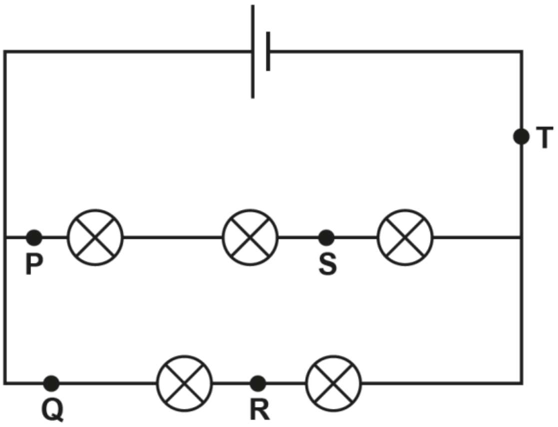
	Bar magnet	Paperclip
A	induced magnet	induced magnet
B	induced magnet	permanent magnet
C	permanent magnet	induced magnet
D	permanent magnet	permanent magnet

Your answer ☐ **[1]**

This question was very well answered, with candidates clearly understanding the difference between an induced magnet and a permanent magnet.

Question 3

3 A student makes a circuit using five identical lamps.



A current of 5A is measured at point **P**.

At which other point in the circuit is the current 5A?

A Point **Q**

B Point **R**

C Point **S**

D Point **T**

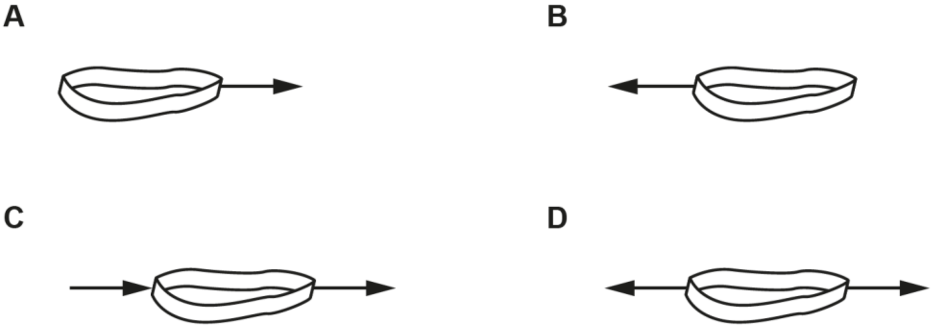
Your answer ☐ **[1]**

The majority of candidates correctly identified that the current would also be 5 A at point S. A significant number of candidates chose either A (not realising that the current would be different with fewer identical lamps in series) or D (not understanding that point T would be the total current in the circuit).

Question 4

4 The arrows on these scale diagrams represent forces acting on an elastic band.

In which diagram will the elastic band stretch?



Your answer ☐ **[1]**

This question was very well answered with almost all the candidates realising that the elastic band would only stretch in D.

Question 5

5 Which sentence about an atom is correct?

A Most of the mass is in the nucleus.

B The nuclear radius is much larger than the rest of the atom.

C The nucleus has a neutral charge.

D The nucleus is surrounded by positively charged electrons.

Your answer ☐ **[1]**

Most candidates answered that most of the mass is in the nucleus. A small minority of candidates gave answer C, perhaps indicating either a misunderstanding between the terms atom and nucleus or a misunderstanding between the terms nucleus and neutron.

Question 6

6 An object moves in a circular path at a constant speed.

Which description is correct?

A All of the forces acting on the object are balanced.

B The object moves with a constant velocity.

C The resultant force acts away from the centre of the circle.

D The resultant force acts towards the centre of the circle.

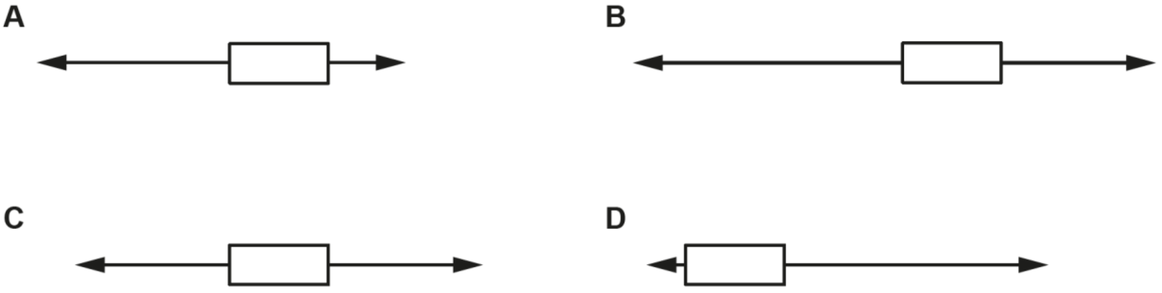
Your answer ☐ **[1]**

Candidates found this question challenging. All four options were commonly selected.

Question 7

7 The arrows on these scale diagrams represent forces.

Which diagram shows the **largest** net force?



Your answer ☐ **[1]**

High-scoring candidates measured the distance of the arrows on the diagram, recording the values next to each arrow to assist them in determining the largest net force.

The majority of the candidates correctly identified option D. The common distractor was B.

Question 8

8 Ice at 0 °C is heated until it turns into water at 25 °C. The mass of the ice is known.

Which extra information is needed to calculate the energy required for this change?

Use the Equation Sheet.

A Specific heat capacity of water and specific latent heat of fusion of ice

B Specific heat capacity of water and specific latent heat of vaporisation of water

C Specific heat capacity of water only

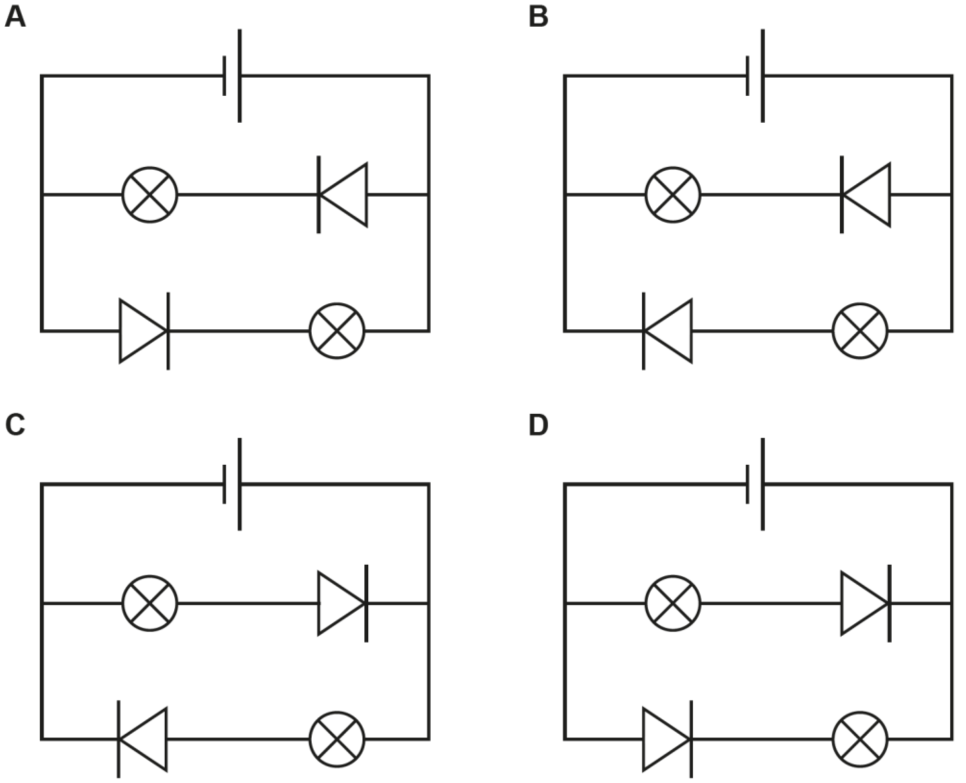
D Specific latent heat of fusion of ice and specific latent heat of vaporisation of water

Your answer ☐ **[1]**

Many candidates choose the correct response, clearly understanding that energy was needed to change the state of the ice to water, as well as to increase the temperature of the water. A common answer was option C, where candidates had not allowed for energy needed to change state. A small minority of candidates appear to be confused between the difference between the specific latent heat of fusion and the specific latent heat of vaporisation.

Question 9

9 In which circuit will both lamps light up?



Your answer ☐ **[1]**

There were two common responses to this question. The correct answer option B and the incorrect option D. It is expected the candidates should understand the conduction in both diodes and light emitting diodes.

Question 10

10 Which devices convert current variations in electrical circuits into pressure variations in sound waves?

A Loudspeakers and headphones

B Loudspeakers and microphones

C Microphones and headphones

D Microphones only

Your answer [ ] **[1]**

This question was well answered. Option B was a common incorrect response, where candidates perhaps did not fully understand what the question was asking. Some candidates, when answering multiple-choice questions, benefit from underlining key terms in the question.

Exemplar 1

10 Which devices convert current variations in electrical circuits into pressure variations in sound waves?

A Loudspeakers and headphones

~~**B**~~ Loudspeakers and microphones

~~**C**~~ Microphones and headphones

~~**D**~~ Microphones only

output = sound

Your answer [A] **[1]**

In this example the candidate has underlined the key parts of the question and sensibly used the white space surrounding the question with the comment 'output = sound.' The candidate has also then reviewed each of the options ruling out incorrect answers by placing a single line through the incorrect word and then through the letter.

The advantage of using a single line is that the candidate can still see what is written in case there is a change of mind.

Question 11

11 A large rock on the dwarf planet Pluto has a mass of 200 kg and a weight of 124 N.

What is the gravitational field strength on Pluto?

Use the Equation Sheet.

A 0.62 N / kg

B 1.61 N / kg

C 76 N / kg

D 24 800 N / kg

Your answer ☐ **[1]**

This question was answered well. Where errors were made it was invariably giving option B, i.e. candidates incorrectly rearranging the quantities from the equation sheet.

High-scoring candidates often used the white space to write down the equation they used, before rearranging it and calculating the answer.

Question 12

12 Which statement describes a **simple** model of the Earth's atmosphere?

A It covers the Earth to a height of about 700 km and is of uniform density.

B It covers the Earth to a height of about 700 km and its density increases as the distance from the Earth increases.

C It covers the Earth to a height of about 700 m and is of uniform density.

D It covers the Earth to a height of about 700 m and its density increases as the distance from the Earth increases.

Your answer ☐ **[1]**

Many candidates found this question challenging. A number of candidates incorrectly gave option B (with the density of the atmosphere increasing as the distance from the Earth increases). Another common incorrect answer was C, for the atmosphere covering the Earth to a height of 700 m.

Question 13

13 Which change of state releases energy?

A Condensing

B Evaporating

C Melting

D Sublimating

Your answer [ ] **[1]**

Many candidates found this question challenging. Low-scoring candidates often chose options B or C or D, perhaps not fully understanding the technical words used.

Question 14

14 A train accelerates from 20 m/s to 40 m/s in a distance of 1200 m.

What is the acceleration of the train?

Use the Equation Sheet.

A $0.17\ m/s^2$

B $0.50\ m/s^2$

C $0.67\ m/s^2$

D $1.0\ m/s^2$

Your answer [ ] **[1]**

The majority of the candidates answered this question correctly. High-scoring candidates often wrote the equation that they used in the white space before substituting in the values and rearranging.

Question 15

15 Water has a density of 1000 kg / m^3.

Water of volume 1 m^3 is frozen. The volume of the ice formed is 1.09 m^3.

What is the density of the ice?

Use the Equation Sheet.

A 0.917 kg / m^3

B 1.09 kg / m^3

C 917 kg / m^3

D 1090 kg / m^3

Your answer ☐ **[1]**

This question was generally well answered.

One common error was selecting D, perhaps confused by the quantities, the other common error was selecting A with a power of ten error.

Section B overview

Candidates should be encouraged to underline key information and data as they read a question.

When answering explanation type questions, candidates' responses should relate to the question, and correct terminology should be used.

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 answer, for example:

- equation
- rearrange the equation
- substitute the data
- evaluate
- consider the whether the answer looks right.

Candidates need to be proficient in both drawing graphs and also interpreting graphs.

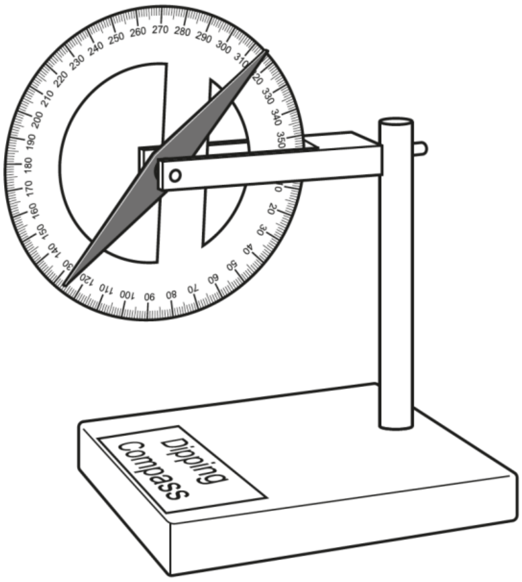
Question 16 (a) (i)

16

(a) **Fig. 16.1** shows a (dipping) compass used in schools.

It is currently showing the reading for the UK.

Fig. 16.1



(i) Describe how the position of the needle changes if the compass is moved from the equator to the poles of the Earth.

....

....

....

.... **[2]**

There were many vague answers seen for this question. It appears that the angle of dip is not fully understood. High-scoring candidates were able to describe that the position of the needle at the equator was horizontal, while at the poles the needle pointed vertically.

Question 16 (a) (ii)

(ii) What does your answer to **(a)(i)** suggest about the Earth's core?

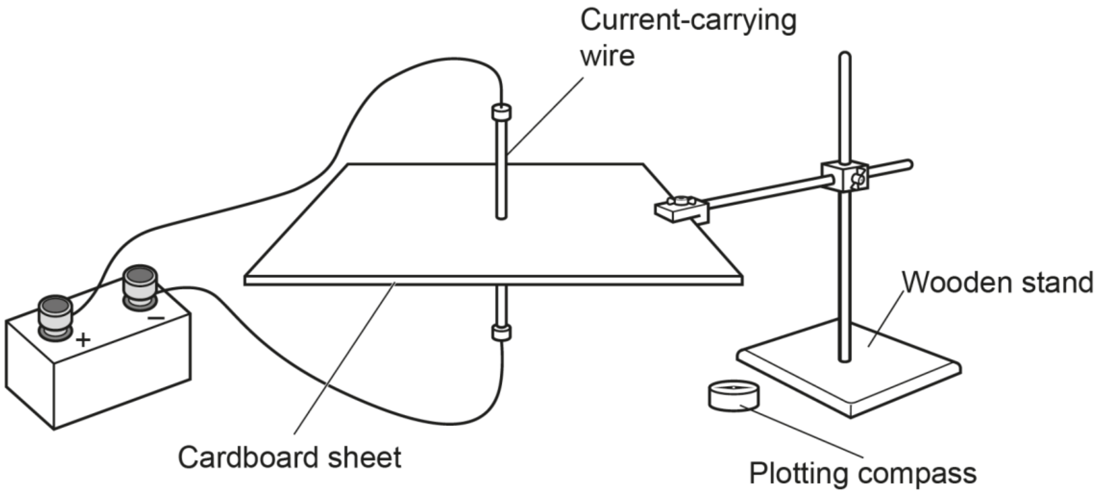
.... **[1]**

Most candidates stated that the core was magnetic.

Question 16 (b) (i)

(b) **Fig. 16.2** shows the equipment a teacher sets up to demonstrate using a plotting compass to investigate the magnetic field around a current-carrying wire.

Fig. 16.2



(i) Describe how the teacher uses this equipment to show the shape of the magnetic field around the current-carrying wire.

....

....

....

....

.... **[3]**

Many candidates did not describe the experiment using the equipment provided. Some responses were vague. High-scoring candidates stated that the plotting compass would be placed on the cardboard sheet. Using a pencil, the direction of the compass would be marked, then the plotting compass would be moved to the end of the mark and the new direction marked and that this process would be repeated. Candidates then stated that the marks would then be joined together to show the field.

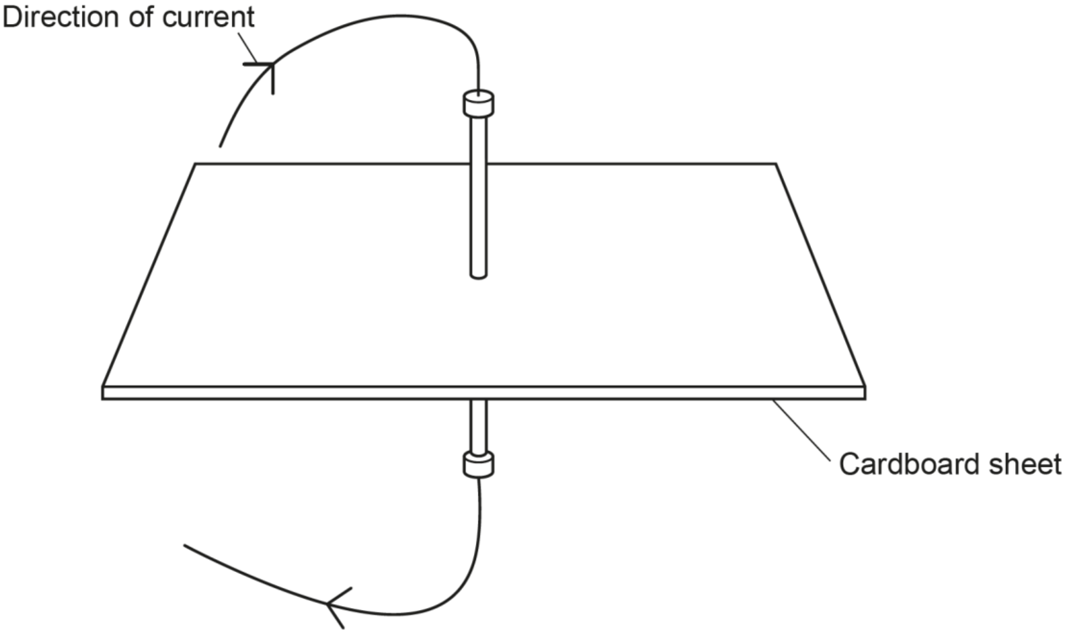
Assessment for learning

Candidates should be able to describe a practical method. They should practise writing descriptions of experiments including how measuring instruments are used.

Question 16 (b) (ii)

(ii) On **Fig. 16.3** sketch the magnetic field around the current carrying wire.

Fig. 16.3



[2]

Most candidates drew circular field lines around the wire. Some low-scoring candidates drew the pattern for a bar magnet. Some candidates drew the field lines in different vertical positions around the wire rather than on the cardboard sheet. Fewer candidates marked the correct direction onto the field lines. High-scoring candidates drew circles with increasing distances to indicate the weaker magnetic field at greater distances.

Assessment for learning

Candidates need to understand that magnetic fields have direction and that the strength of the field can be represented by the relative spacing of the field lines.

Question 17 (a) (i)

17 An engineer investigates the properties of a spring.

This is their method:

- Carefully add different loads to the spring.
- Measure the extension of the spring for each load.
- Repeat the experiment three times for each load.

The table shows the engineer's results.

Load (N)	**Extension (cm)**			
	Test 1	**Test 2**	**Test 3**	**Mean**
100	2.1	2.2	2.2	
200	4.2	4.2	4.2	4.2
300	6.3	6.5	6.4	6.4
400	8.6	8.6	8.6	8.6
500	10.6	10.4	10.8	10.6

(a)
(i) Calculate the missing value of the mean extension for a load of 100 N to a suitable degree of accuracy.

Mean = ... cm **[1]**

Most candidates correctly stated 2.2 or 2.17. Candidates who wrote down a representation of the calculator display "$2.1\dot{6}$" (using the dot to indicate 'recurring') did not gain credit.

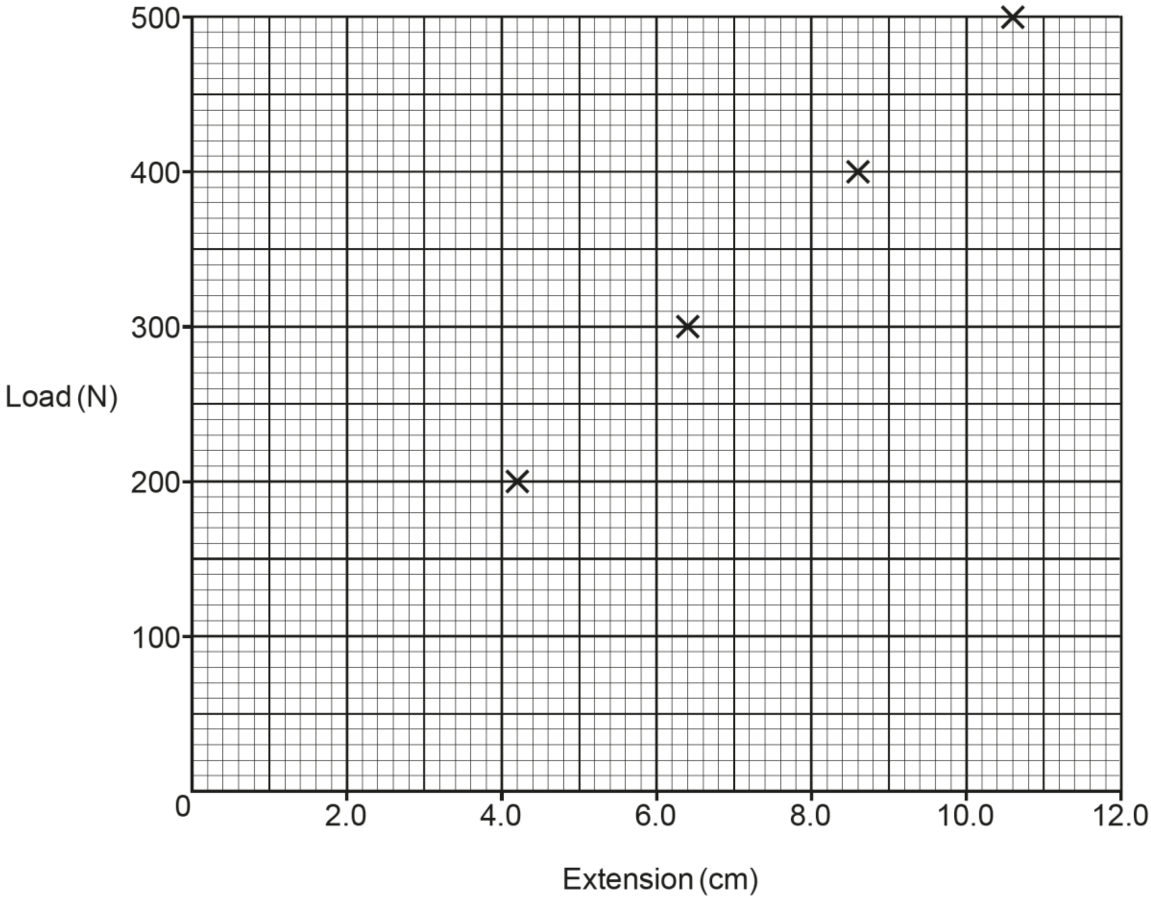
Assessment for learning

Candidates should be what constitutes an appropriate number of significant figures. When a mean is calculated, the value should be given to the same number as (or one more than) the number of significant figures in the raw data. Teachers may wish to refer to section 2.4 of the ASE publication The Language of Mathematics in Science.

Question 17 (a) (ii)

(ii) Plot the missing value on the graph for a load of 100 N.

Draw a line of best fit.



[2]

Most candidates correctly plotted the value for when the load was 100 N. Where errors occurred, it was when 2.2 was plotted at 2.4 (i.e. one square out). The line of best fit was usually drawn correctly.

Question 17 (a) (iii)

(iii) Calculate the gradient of the graph. Show your workings on the graph.

Gradient = ... N / cm **[2]**

The majority of the candidates determined a gradient, possibly helped by the line passing through the origin. The question did require candidates to show workings on the graph.

Assessment for learning

To determine a gradient from a line of best fit, candidates should:

1. Choose two points on the line which are far apart from each other (at least half the length of the line).
2. Ideally the points chosen should lie on at least one gridline so that it is easy to read off the value.
3. Substitute the data points into the equation gradient = $\frac{y_2 - y_1}{x_2 - x_1}$.
4. Calculate the gradient.

Question 17 (a) (iv)

(iv) Use your answer to **(a)(iii)** to determine the spring constant for the spring.

Spring constant = ... N / cm **[1]**

The requirement in this question was to use the answer to part iii. A significant minority of candidates did not realise that the spring constant was equal to the gradient and calculated a different value.

Question 17 (b)

(b) When the engineer repeats the experiment, they use the same method and the same equipment.

The engineer says the results show that the experiment is reproducible.

Suggest **two** reasons why the engineer is **incorrect**.

1 ....

....

2 ....

....
[2]

Many candidates clearly understood the term 'reproducible' and gave detailed answers. Some candidates did not gain credit since they just repeated the stem of the question, stating that the engineer uses the same method and the same equipment. Similarly, some candidates stated that the experiment was repeatable (not reproducible) without answering the question. Other candidates incorrectly gave answers relating to the individual equipment (springs being damaged) or the results (graph may change).

Question 17 (c)

(c) Identify **one** possible hazard for this experiment and the precaution the engineer should take.

Hazard ....

Precaution ....

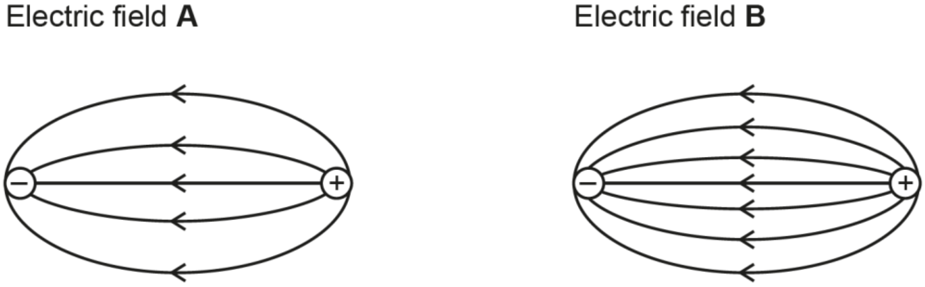
....
[2]

This question was generally well answered. It is helpful for candidates to explain that the spring may hit the eyes so eye protection or standing behind a safety screen is the precaution. Vague responses such as 'be careful with the equipment' were not credited.

Question 18 (a)

18 This question is about electricity.

(a) The diagrams show the electric fields between different charges. The charges are the **same distance** apart in both electric fields.



An identical charged particle is placed in each electric field.

Explain in which electric field, **A** or **B**, the particle experiences the **strongest** force.

....

....

.... **[2]**

This question required candidates to explain that electric field B was stronger as shown by the field lines being closer together. Candidates should be encouraged to consider the number of marks available in the question.

A common error was candidates referring to magnetic field lines.

Question 18 (b)

(b) Which conditions are needed for charge to flow?

Tick (✓) **two** boxes.

closed circuit ☐

open circuit ☐

source of potential difference ☐

source of resistance ☐

[2]

Most candidates ticked the correct boxes. A few candidates appeared to be confused between open circuit and closed circuit.

Question 18 (c)

(c) A student has written two sentences about the resistance of different electrical components.

The resistance of a filament lamp is so high in one direction, that no current can pass through.

The resistance of a thermistor changes as the light intensity changes.

The student has made **two** mistakes about the components.

Identify the mistakes and write the correct word or words to replace each of them.

Mistake 1 ....

Correct word(s) 1 ....

Mistake 2 ....

Correct word(s) 2 .... **[4]**

Candidates should be encouraged to read the question carefully – in this case reference was made to the components.

The majority of candidates identified that the thermistor should be replaced with a light dependent resistor or the thermistor changes as the temperature changes. Heat intensity did not gain credit.

Identifying the diode for the filament lamp appeared to be more challenging. In a number of scripts, 'no current' was suggested as the mistake with 'a little current' as the correction.

Question 18 (d)

(d) Calculate the current in a 180 W resistor when the potential difference across the resistor is 12 V.

Use the equation: power = potential difference × current

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

This was very well answered.

Candidates should be encouraged to show their working.

Question 18 (e)

(e) Calculate the energy transferred when 20 C of charge moves through a potential difference of 12 V.

Use the equation sheet.

Energy transferred = ... J **[3]**

This question was very well answered.

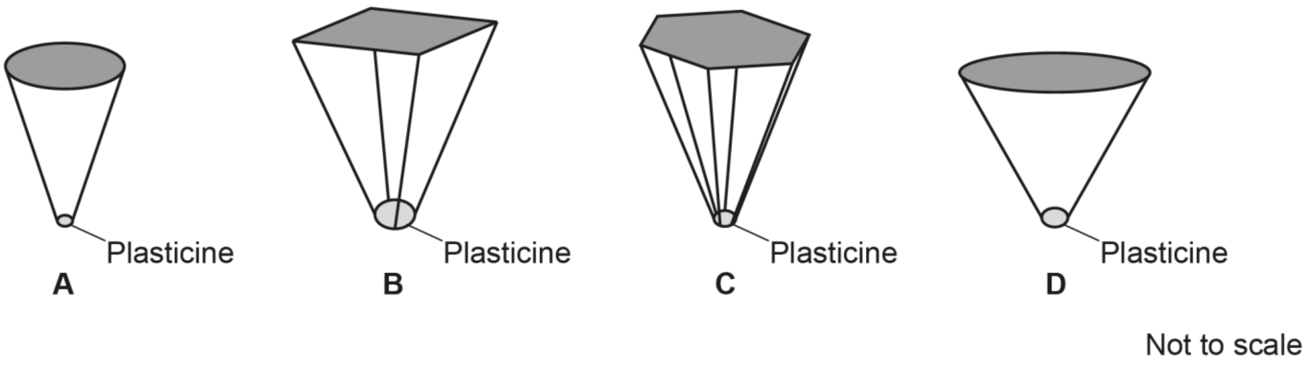
Candidates should be encouraged to show their working

Question 19*

19* A student investigates how the surface area of a parachute affects the time taken for the parachute to fall.

The student drops parachutes with different surface areas from a height of approximately 2 m and records the time taken to fall using a stopwatch.

The diagram shows the parachutes used by the student.



The table shows the data obtained from the experiment.

Parachute	Surface area of parachute (cm^2)	Time of fall (s)		
		Attempt 1	Attempt 2	Mean
A	10	0.84	1.04	0.94
B	15	1.02	1.18	1.1
C	20	1.09	1.11	1.1
D	30	1.2	1.3	1.25

Describe the trend shown in the student's results.

Explain how the experimental procedure could be improved.

....

....

....

....

....

....

.... **[6]**

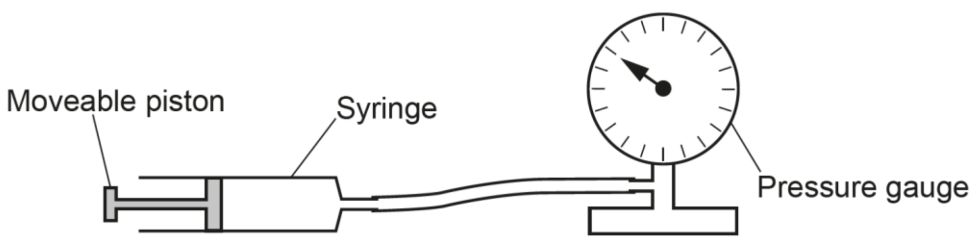
Most candidates were able to describe a simple trend in the results. Few candidates analysed the results further to consider whether there was a linear relationship or directly proportional relationship between the area and the time.

Many candidates gave a sensible list of improvements. Candidates who explained these improvements were able to access the higher range of marks.

Question 20 (a)

20
(a) A teacher connects a sealed syringe of gas with a moveable piston to a pressure gauge as shown in **Fig. 20.1**.

Fig. 20.1



State **one** way the teacher can increase the reading on the pressure gauge.

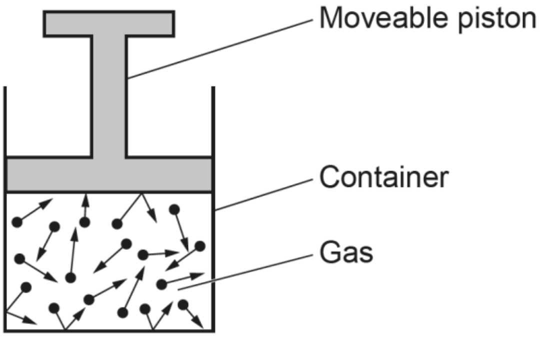
.... **[1]**

This question was well answered.

Question 20 (b) (i)

(b)
(i) The teacher also has a gas enclosed in a container as shown in **Fig. 20.2**.

Fig. 20.2



The teacher slowly moves the piston outwards until the gas has twice its original volume. The temperature of the gas is kept constant.

Explain how and why the pressure in the container changes.

....

....

....

....

....

.... **[3]**

Most candidates were able to state that the pressure decreases. It was hoped that more candidates would have stated that the pressure halves.

The explanation of why the pressure changes in the container was not always detailed. Many candidates did not state that it was the collisions with the walls of the container (as opposed to each other) and the rate (or frequency) of the collisions that decreased.

Assessment for learning

Candidates need to know how to explain the effect of inverse proportionality when one quantity doubles or increases by a factor, in that the other quantity halves or decreases by the same factor.

Question 20 (b) (ii)

(ii) When the volume of a gas is $2.4 \times 10^{-4}\,m^3$, the pressure is $2.5 \times 10^4\,Pa$.

Calculate the volume when the pressure is $1.5 \times 10^5\,Pa$.

Use the Equation Sheet.

Volume = ... m^3 **[4]**

This question was answered well. There were a few power of ten errors.

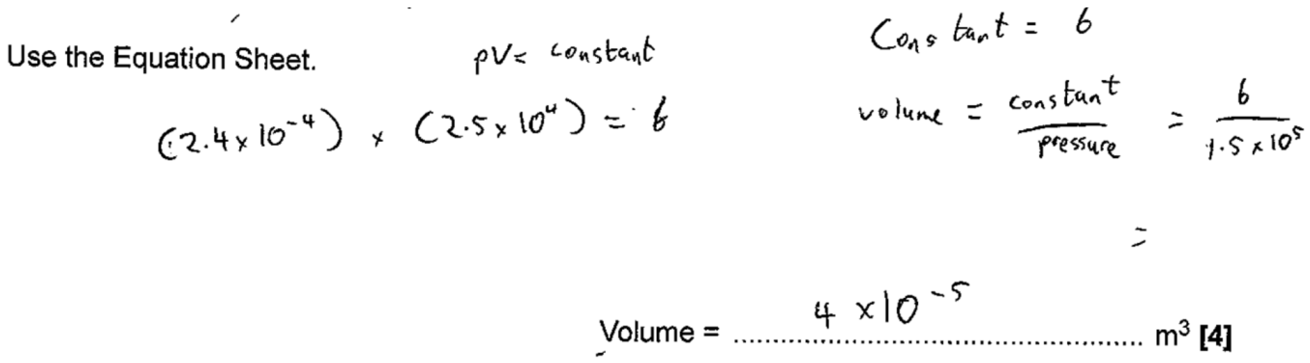
High-scoring candidates clearly showed their method, substituting in the correct data.

Other combinations of using pV = constant also gained credit.

Some candidates correctly used $p_1 V_1 = p_2 V_2$.

Some candidates correctly worked out the constant but then inverted the final equation – it is this latter case where the earlier working still enables two marks to be scored.

Exemplar 2



In Exemplar 2, the candidate has stated the equation pV = constant.

They have clearly worked out the constant by substituting the correct data into their equation. Then they have rearranged the equation before substituting in the data again to calculate the final volume.

Question 20 (c)

(c) Explain why a bicycle pump gets warmer when it is used to inflate a tyre.

....

....

....

....

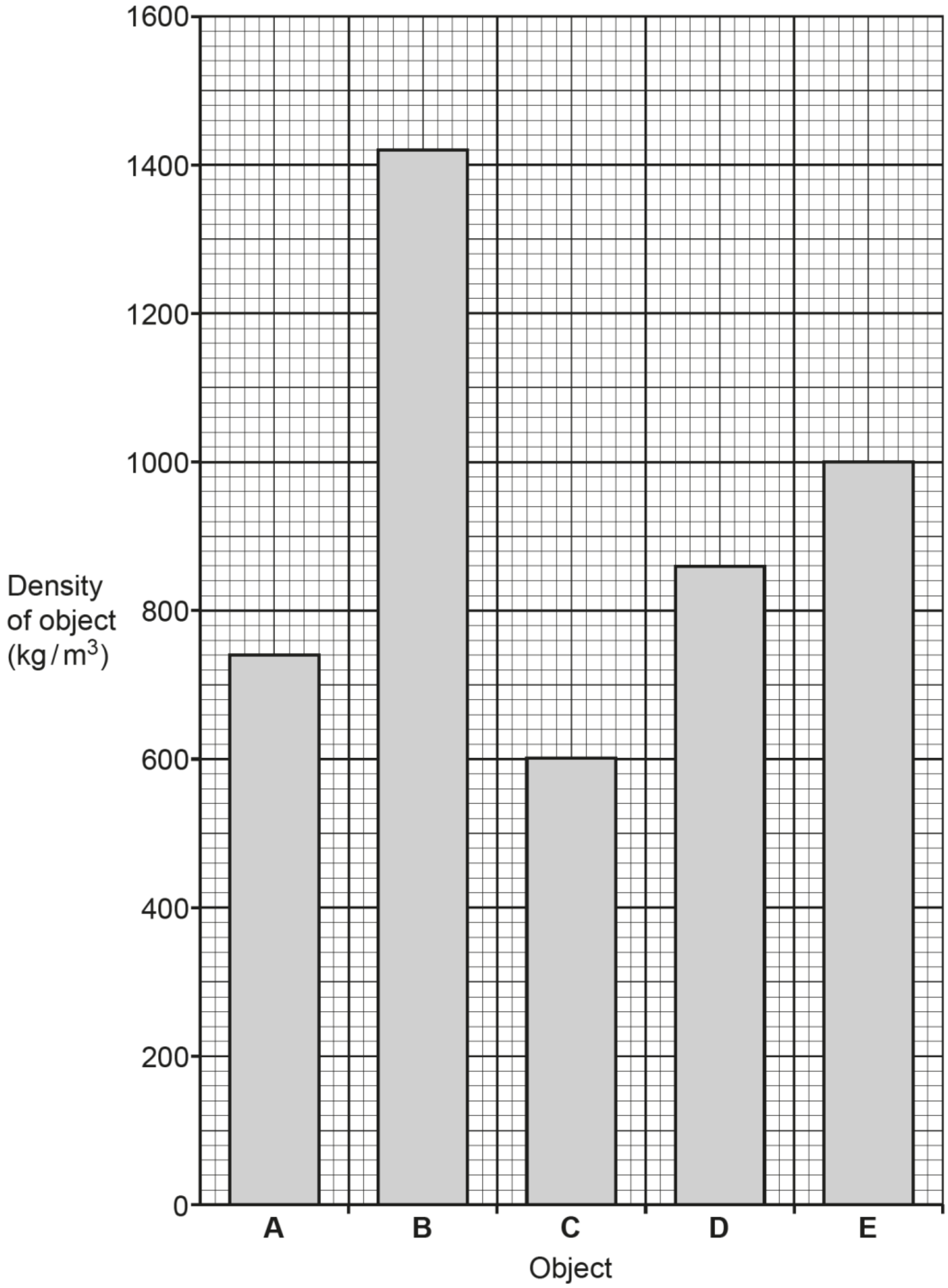
.... **[3]**

Candidates found this question challenging. The responses were often vague and lacked the necessary detail. For example, many candidates mentioned work being done without stating the effect of doing work, or that the energy of the gas increases without stating that the mean speed of the gas particles increases (so the kinetic energy of the particles increased).

Question 21 (a)

21 A student investigates floating and sinking.

The student draws a bar chart to show the densities of five objects, **A**, **B**, **C**, **D** and **E**.



The student places the five objects into an unknown liquid and observes if each object floats or sinks.

- Objects **A** and **C** float.
- Objects **B**, **D** and **E** sink.

(a) Explain why some objects float and some objects sink in a liquid.

....

....

....

.... **[2]**

Most candidates who answered in terms of density scored both marks.

Some candidates used the quantities 'weight' and 'upthrust' for the explanation. Most correctly stated that an object sinks when the weight is larger than the upthrust, but then stated incorrectly that an object floats when the upthrust is larger than the weight.

Misconception

An object floats when the upthrust is equal to the weight of the object.

If the upthrust was greater than the weight, there would be a resultant force upwards.

Question 21 (b)

(b) Use the bar chart to estimate the density of the liquid used.

Density = ... kg / m^3 **[1]**

Most candidates gave an answer of 800 kg / m^3 which is sensibly midway between the two bars for A and D.

Question 21 (c)

(c) The student uses the internet to research the densities of five different liquids.

Liquid	**Density (kg/m^3)**
Alcohol	800
Diesel	870
Vegetable oil	910
Dishwashing soap	1120
Treacle	1430

In which liquid would **all five** of the objects **A**, **B**, **C**, **D** and **E** float?

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

Most candidates correctly answered treacle. A small number of candidates gave alcohol – possibly thinking about the answer to the previous part. Candidates should be encouraged to underline key words in the question.

Question 21 (d)

(d) A swimmer in a pool dives from a depth of 0.5 m to a depth of 2.0 m.

Calculate the change in pressure the swimmer experiences.

Use the Equation Sheet.

Gravitational field strength = 10 N/kg

Density of water = 1000 kg/m^3

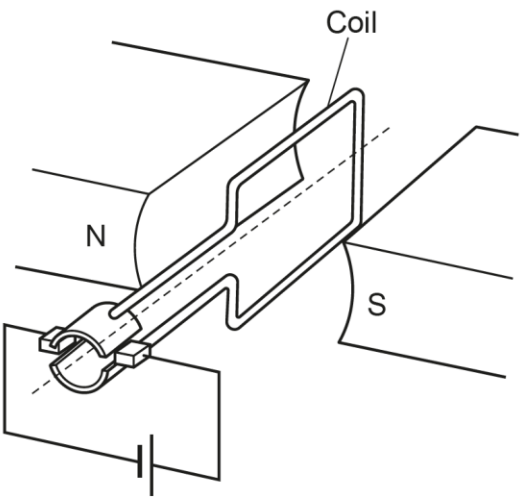
Change in pressure = ... Pa **[2]**

The majority of the candidates correctly substituted the data in the equation and gained full marks.

Question 22 (a)

22
(a) **Fig. 22.1** shows a diagram of a simple electric motor.

Fig. 22.1



Explain why the coil rotates when a current passes through it.

....

....

.... **[2]**

Candidates found this question challenging, and there were many vague responses. Some referred to the motor effect without explaining what was meant by the motor effect. Many candidates did not discuss the magnetic field due to the current in the coil, and that it is the interaction of the magnetic field due to the current and the magnetic field due to the magnets that results in a force. Few candidates explained that the forces would act in opposite directions on the sides of the coil to cause the rotation.

Question 22 (b) (i)

(b)
(i) **Fig. 22.2** shows a diagram of a dynamo and **Fig. 22.3** shows a diagram of an alternator.

Describe **two similarities** and **two differences** between how these devices work.

Fig. 22.2

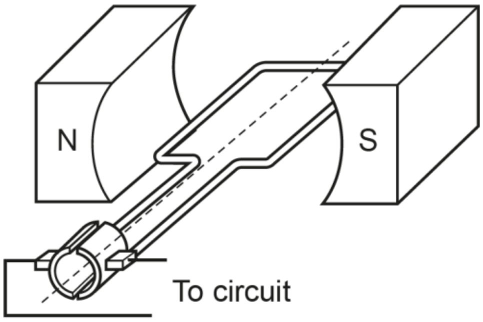
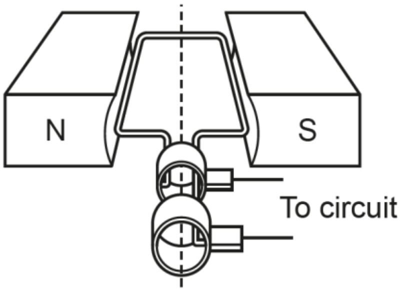


Fig. 22.3



Similarities

1 ....

2 ....

Differences

1 ....

2 ....
[4]

The question required candidates to compare 'how the devices work.'

Few candidates scored marks for the similarities, often stating that the similarities were 'they both have magnets' and 'they both have coils.' Few candidates stated that the coils were rotated in a magnetic field.

For the differences, many incorrectly stated that the alternator 'used' a.c. and the dynamo 'used' d.c.

Misconception

Many candidates did not appear to understand that the dynamo and alternator are generators and produce an electromotive force (emf) or current. For a generator, movement (or rotation) of coils in a magnetic field produces an emf.

A current in a coil in a magnetic field is the motor effect.

Question 22 (b) (ii)

(ii) Suggest **one** way to increase the output of these devices.

.... **[1]**

Many candidates gave the answer of "increase the current" not realising that both the alternator and dynamo are generators.

Misconception

Many candidates did not realise that both the alternator and dynamo are generators and work on the principle of the relative movement of magnets, or that coils produce an induced electromotive force (emf) or current.

Question 22 (c)

(c) A conductor in a magnetic field of magnetic flux density 1.5 T experiences a force of 0.81 N.

The current in the conductor is 1.2 A.

Calculate the length of the conductor.

Use the Equation Sheet.

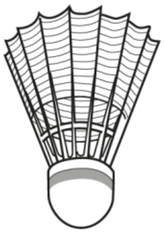
Length = ... m **[3]**

The majority of the candidates correctly selected the equation, rearranged it and substituted in the data to obtain the correct answer.

Question 23 (a)

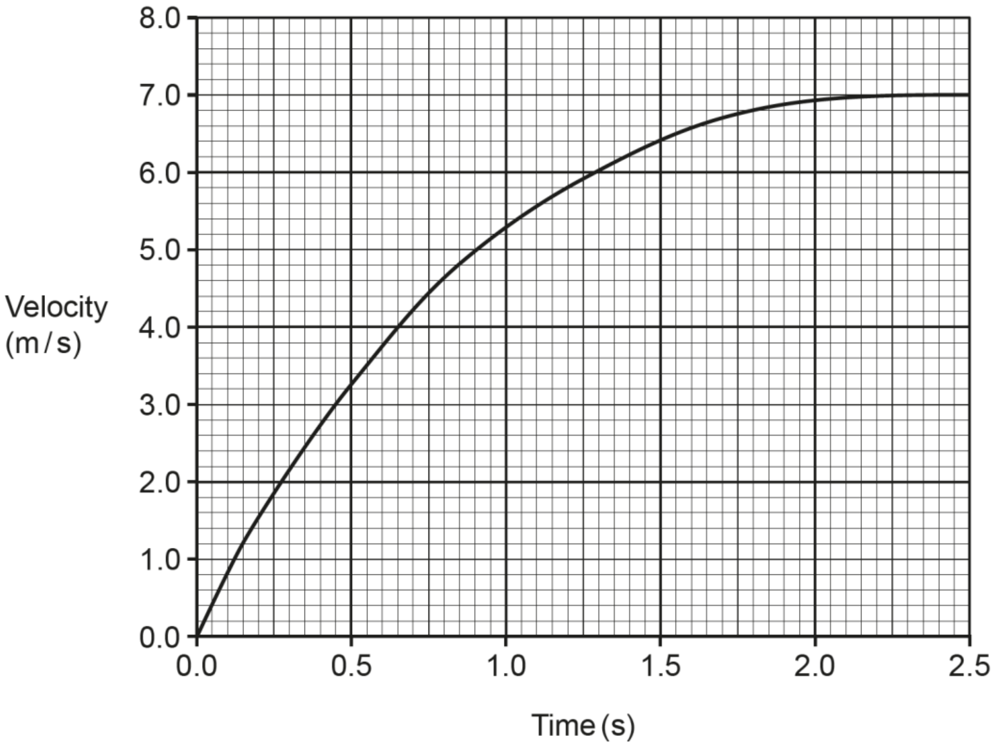
23 A badminton player investigates how the velocity of a shuttlecock varies as it falls vertically to the ground.

The player drops the shuttlecock and records the velocity of the shuttlecock as it falls.



A shuttlecock

The graph shows their results.



(a) Explain why the shuttlecock reaches a maximum velocity.

....

....

....

....

....

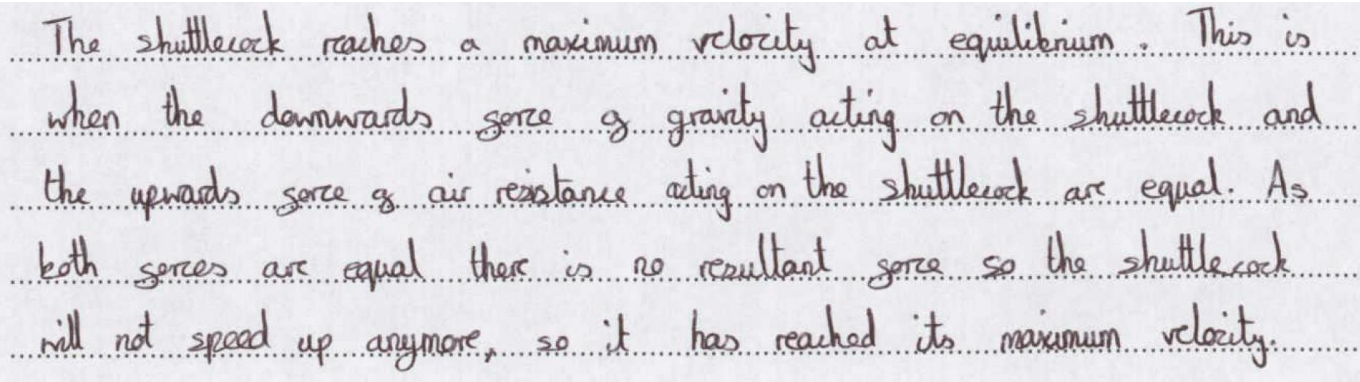
.... **[3]**

There were many vague responses. For example, candidates often referred to the force upwards rather than air resistance or drag and the force downwards rather than weight. Many candidates also did not state that the drag increased with the speed at which the shuttlecock fell.

More candidates used the technical terms weight or force due to gravity correctly rather than just referring to 'gravity.'

Other common errors included 'as air resistance equals acceleration.'

Exemplar 3


The shuttlecock reaches a maximum velocity at equilibrium. This is when the downwards force of gravity acting on the shuttlecock and the upwards force of air resistance acting on the shuttlecock are equal. As both forces are equal there is no resultant force so the shuttlecock will not speed up anymore, so it has reached its maximum velocity.

The candidate starts the answer by mentioning equilibrium, but does not explain at this stage what is in equilibrium.

The answer then continues by naming the upwards and downwards forces correctly and stating clearly that these are equal, for 1 mark. The candidate then clearly states that the resultant force is zero, for the second mark.

To have improved the answer, the candidate could have included that the air resistance was less than the weight initially so that the shuttlecock was accelerating. As the speed of the shuttlecock increased, the air resistance increased (until the weight the air resistance equalled the weight). The candidate could also have stated that since the result force was zero, there would be zero acceleration.

Question 23 (b)

(b) The gradient of a tangent drawn to the curved line of the graph gives the acceleration of the shuttlecock at that time.

Draw a tangent to the curved line at 1.0 s.

Use this tangent to find the acceleration of the shuttlecock at 1.0 s.

Acceleration = ... m/s^2 **[4]**

The majority of the candidates made a good attempt at drawing a tangent to the line and then correctly calculated the gradient.

Candidates should be encouraged to draw the tangent as large as possible so that the size of the triangle used to calculate the gradient could also be as large as possible.

Credit was not given to candidates who did not draw a tangent. A small number of candidates drew the tangent starting from the origin.

A common error for lower-scoring candidates was to calculate the gradient by using the point (1.0, 5.3) which would not work in this case since the tangent does not pass through the origin.

Question 23 (c)

(c) Use the graph to find the approximate distance travelled by the shuttlecock during the 2.5 s of the experiment.

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

This question required candidates to use the graph. High-scoring candidates stated that the distance was equal to the area under the graph and then marked relevant areas on the graph paper. The two common approaches by candidates were either to calculate the distance of a 1 cm × 1 cm square and multiply this by an estimate of the number of 1 cm^2 under the graph, or to split the area into several trapeziums (with time intervals of 0.5 s), work out the distance for each shape and add them together.

Some candidates incorrectly approximated the graph to one triangle. Other candidates either used distance = speed × time, for example, 7 × 2.5 = 17.5 (m) (assuming that the speed was constant) or distance = $\frac{v^2 - 0^2}{2a}$ where *a* was the answer to the previous part, assuming that the acceleration was constant.

Misconception

Some candidates did not understand that the area under a velocity time graph is displacement, or did not know how to calculate the area under the graph from a non-linear line (curve).

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