Qualification Accredited

Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/04 Summer 2023 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.

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Paper 4 series overview

J259/04 Depth in Physics is one of the two examination components aimed at Higher tier candidates studying GCSE (9-1) Twenty First Century Science Suite. This paper assesses content across the teaching chapters P1 to P7 including assessment of P8 Practical Skills. Questions 1 to 3 are overlap questions with the Foundation paper. The examination assesses the three Assessment Objectives: AO1 demonstrating knowledge and understanding of scientific ideas, techniques and procedures; AO2 applying that knowledge to solve problems; and AO3 analysing information, drawing conclusions and improving experimental procedures. Most of the paper assesses candidates' demonstration and application of their knowledge with 20% of the paper assessing their ability to analyse, interpret and evaluate information. With all J259 examinations, there is a requirement to assess mathematical skills which comprise approximately 30% of the paper, and which include calculations and graphical interpretation. This paper includes two Level of Response (LOR) questions: Questions 2 (b) (i) and 7 and synoptic Questions 4 (b) (ii), 7 and 9 (a) (iv) where candidates are required to demonstrate and apply knowledge from the different teaching chapters in the specification.

Only a very small number of candidates achieved marks that indicated that the Foundation tier examination would have been a more appropriate paper for them. There was a broad spread of marks given, which indicates the accessibility of the paper and that candidates have been entered for the correct tier of entry.

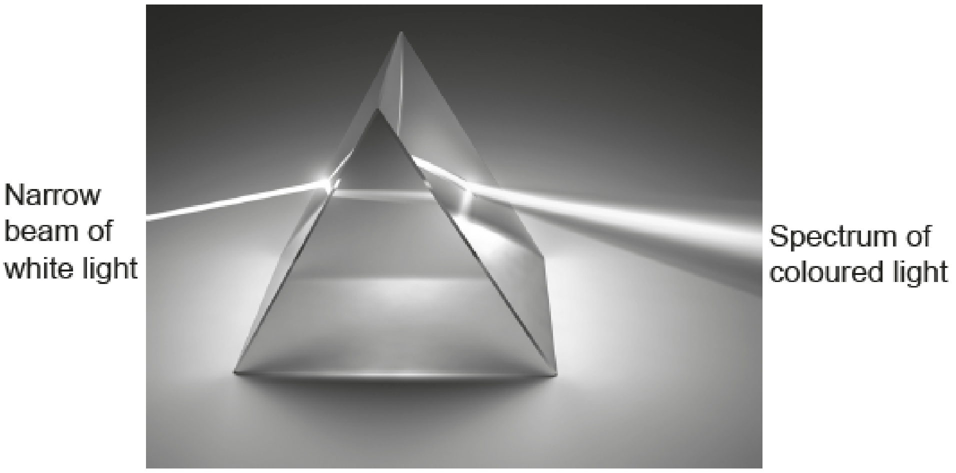
In the 2023 examination series, centres were given the J259 01/02/03/04 Equation sheet which included all the equations that are assessed in the J259 specification.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• selected, rearranged, and substituted numbers into equations with their working shown clearly • developed their reasoning or justifications with correct and suitable scientific terminology • generally, showed good comprehension of command terms such as 'describe', 'explain', 'evaluate', etc	• forgot or ignored unit conversions e.g., mT to T • made errors when rounding, for example, when giving a response to 2 significant figures where a calculated value ends with a recurring digit • showed limited familiarity with practical apparatus and techniques, for example not referring to appropriate use and methodology in using equipment to collect results and interpretation/observations of results.

Question 1 (a)

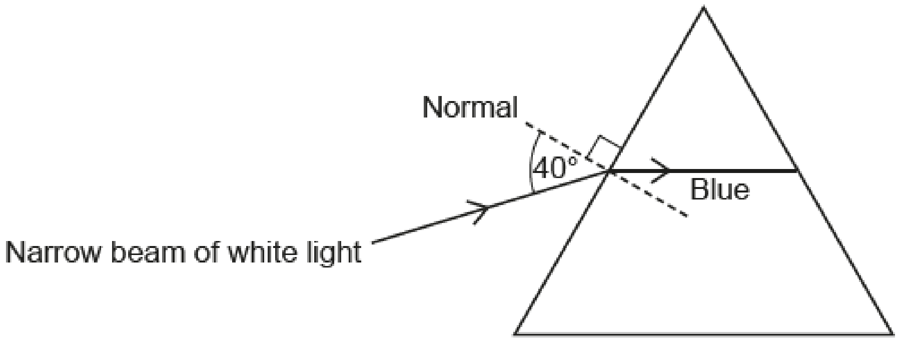
1 A student investigates the path of light passing through a triangular glass prism.

A narrow beam of white light is directed at the prism with an angle of incidence equal to 40°. The student observes a spectrum of different coloured light.



The two-dimensional diagram shows a narrow beam of white light directed at the side of a prism.

A line showing the path of a ray of blue light passing through the prism is partially drawn.



(a) Complete the line to show the path of blue light as it passes out the other side. **[1]**

Candidates did not perform well on this question, with only some correctly drawing the continuation of the blue ray as it refracted downwards when leaving the prism.

Question 1 (b)

(b) Estimate the size of the angle of refraction of the ray of blue light as it enters the prism.

Angle of refraction = ...° **[1]**

Candidates did not perform well on this question, with few correctly estimating the angle of refraction in the range of 15°–35°.

Misconception

A common response given by candidates across the full mark range was 40°, which is equal to the angle of incidence. This demonstrated a common misconception as candidates did not apply knowledge and understanding of refraction. When a ray of light travels from a less dense medium (e.g. air) to a more dense medium (e.g. glass), the angle of refraction is less than the angle of incidence (unless the incident ray is along the normal). The diagram was not drawn to scale, so candidates were not required to measure the angle of refraction, but to estimate that it was less than 40° and within a range of 15°–35° which was consistent with understanding that it refracted towards the normal when it entered the prism.

Question 1 (c)

(c) Add another line to the diagram to show the path of a ray of red light as it passes through the prism and out the other side. **[2]**

Candidates did not perform well on this question, and many candidates did not gain a mark. It was mostly higher performing candidates who gained marks, and this was usually for drawing the ray of red light when it left the prism with less refraction compared to the ray of blue light. Many candidates did not label the ray of red light, only drew the ray when it left the prism and omitted how the ray of red light would travel through the prism.

Assessment for learning

This question demonstrated a lack of depth of understanding and application of knowledge of PAG 8 Interaction of Waves Practical Activity. PAG 8 states that candidates are required to 'Make observations of the effects of the interaction of electromagnetic waves with matter' with a suggested activity of 'Investigating the refraction of light through prisms' which was assessed in Question 1.

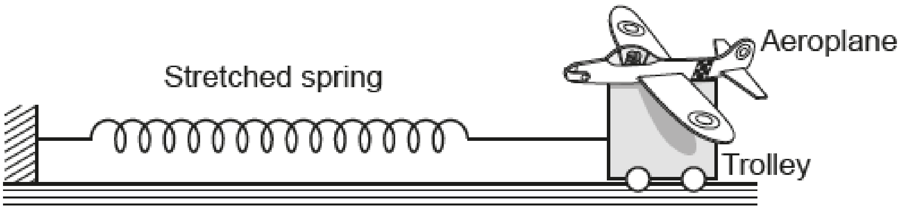
Support is available at Teach Cambridge with the planning and teaching of Practical Activities.

Practical Activities

Question 2 (a)

2 Jamal is making a model aeroplane that can be launched from a moving trolley.

One end of a spring is connected to the trolley. The other end of the spring is held stationary.



The aeroplane is placed on the trolley. Jamal pulls the trolley and the aeroplane to the right so that the spring stretches. When Jamal lets go, the trolley and the aeroplane accelerate to the left.

(a) Explain how Jamal can make the trolley and aeroplane accelerate more quickly using the same apparatus.

....

....

....

....

....

.... **[3]**

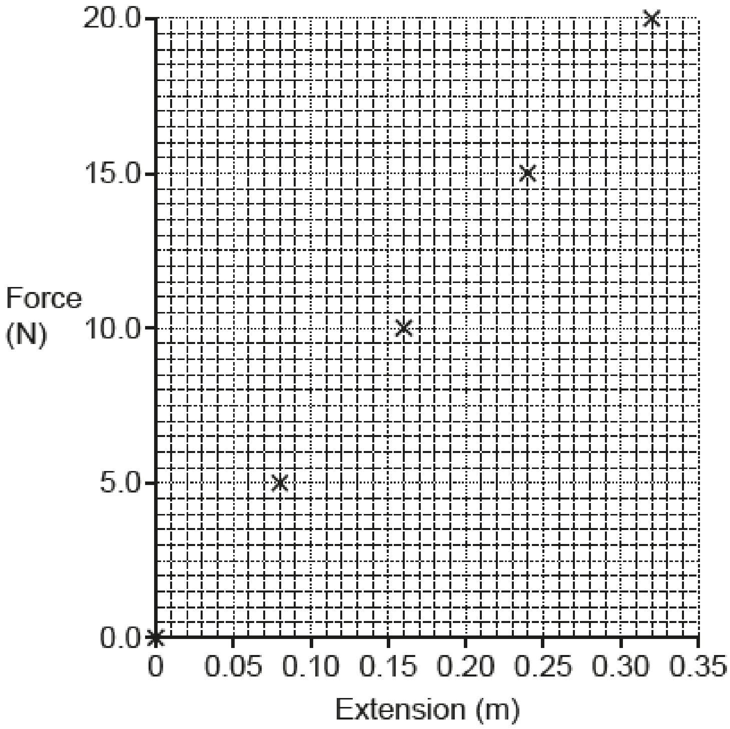
Generally, candidates performed well on this question, with many candidates gaining at least 1 mark. The most common response that was given was for describing how to increase the extension of the spring by pulling the trolley further to the right, but only some of these candidates further developed this response by explaining the effect on the acceleration in terms of forces ($F = k\,x$ and $F = m\,a$) or transfer of energy stores (elastic to kinetic store).

Many candidates gave sensible explanations in reference to using a different spring(stiffer), using lubrication to minimise friction to give a greater resultant force, or a smaller mass (aeroplane and trolley). Although these responses were valid, they were not given marks as they did not answer the question which clearly stated that the 'same apparatus' was to be used.

Question 2 (b) (i)*

(b) Jamal investigates the relationship between force and extension for the spring. The results of the investigation are shown in the table and the graph.

Force (N)	Extension (m)
0.0	0
5.0	0.08
10.0	0.16
15.0	0.24
20.0	0.32



(i)* Describe how Jamal gets these results safely **and** how he uses the results to calculate the work done in stretching the spring.

....

....

....

....

....

.... **[6]**

Candidates' performance on this overlap LOR question was variable, with some candidates giving Level 2 and 3 responses. Most candidates were able to describe how results could be collected, either by describing a valid method to measure the extension of the spring for loads applied, and/or describing how they would use any equipment safely. Very few candidates correctly described how to calculate the work done in stretching the spring by equating it to the area under the graph or describing/applying $E = \frac{1}{2} k x^2$ where k is calculated from the gradient of the graph.

Exemplar 1

the work done in stretching the spring.

·Place/~~the sprin~~ Hook one ~~side~~ end of the spring on a metal frame.
↳ Vertical ~~the~~ to the ground.
·Measure the original length of the spring using a ruler.
·Slowly hook a weight (with unit ~~of~~ Newton, e.g. 5N) onto the other end of the spring and wait until the spring stops ~~sp~~ swinging / comes to a stationary.
·Measure the extended length of the spring using a ruler.
·~~Sto~~ Drag the end of the spring and take of the weight, then slowly let the spring go back to original position.
·Extension = Extended length of the spring − original length of the spring.
·Work done in stretching = area under the graph = $\frac{1}{2}$ × Force (of the weight) × extension. **[6]**

Exemplar 1 shows a Level 3 response where the candidate has clearly described a safe method including appropriate equipment for obtaining results of force and extension of a spring. The candidate has correctly described how these results would be used to calculate the work done in stretching the spring. Calculations of the work done in stretching the spring were not required to gain marks, but when candidates carried out correct calculations e.g., spring constant from the gradient of the graph and/or application of $E = \frac{1}{2} k x^2$ these were equally given as a description of how the results are used to calculate the work done in stretching the spring.

Question 2 (b) (ii)

(ii) The kinetic energy of the trolley must be at least 1 J for the aeroplane to launch from the trolley.

Jamal concludes that the aeroplane can launch from the trolley when the spring has an extension of 0.16 m.

Use the graph to explain why Jamal's conclusion is **wrong**.

....

....

....

.... **[2]**

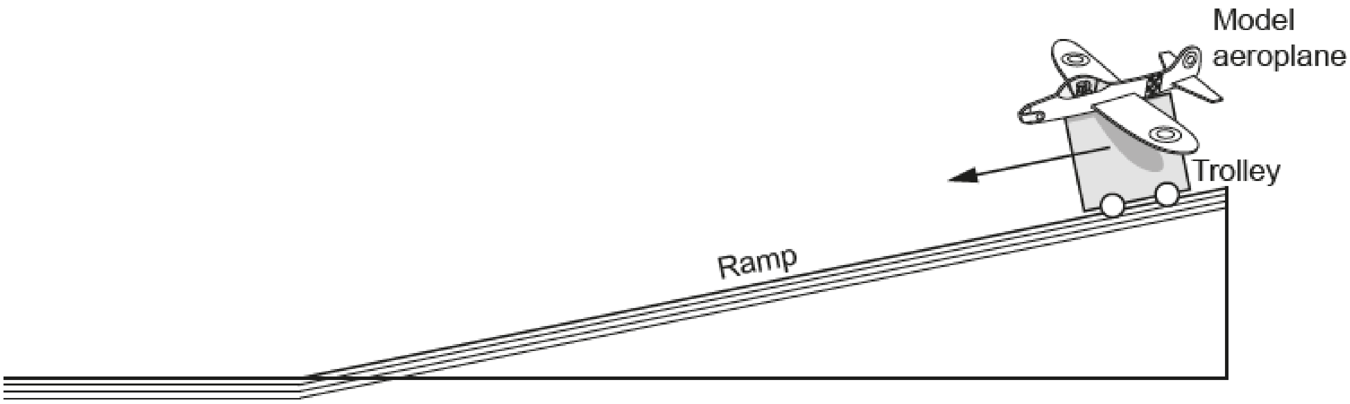
Candidates did not perform well on this question, as most candidates gave qualitative responses with no use of the graph. When candidates used the graph, they correctly determined that a force of 10 N gave an extension of 0.16 m but calculated the work done in extending the spring as 10 x 0.16 m = 1.6 J and not the area under the graph. Some higher achieving candidates correctly selected and applied the equations $F = kx$ and $E = \frac{1}{2}kx^2$ to calculate the spring constant (62.5 N / kg) then subsequently the store of elastic potential energy of the spring, to give a value of 0.8 J which supported that the conclusion was wrong as stated in the question.

Misconception

A common misconception was to select and apply the equation work done = force × distance to calculate the energy stored in the spring when it was extended by 0.16 m. Candidates were required to use the graph and to apply understanding that the work done is found by 'calculating the appropriate area on the force-extension graph'.

Question 2 (c)

(c) Jamal investigates using a ramp instead of a spring to launch the aeroplane.



Jamal releases the trolley and the trolley accelerates down the ramp. The aeroplane is launched when the trolley reaches the bottom of the ramp.

Describe how Jamal can accurately measure the speed of the trolley at the bottom of the ramp.

You should include the equipment Jamal uses.

....

....

....

....

....

.... **[3]**

Candidates performed well on this question. Most candidates gained marks on the question for correctly describing a method and equipment to measure distance and/or time, but when describing how to use these measurements, candidates described how to calculate the average speed of the trolley rather than the speed of the trolley at the bottom of the ramp. Many candidates described using light gates (usually at the top and the bottom of the ramp) but as a method of measuring time rather than as a method to calculate the speed of the trolley at the bottom of the ramp.

Question 3 (a)

3 A ball is placed in a dark room. White light from a lamp is shone on the ball. The ball appears yellow.

(a) A green filter is placed between the lamp and the ball.

Explain why the ball appears green.

....

....

....

.... **[2]**

Performance on this question was variable, with many candidates gaining no marks. Higher achieving candidates performed better, demonstrating a more confident understanding of transmission of light when it passed through a filter, as they understood that the filter only transmitted green light, with all other colours in white light being absorbed. Candidates who used correct scientific language and terminology to explain the behaviour of light (through a filter and incident on an object) were more generally given marks for their explanations. A significant number of candidates attempted to use scientific terminology but did so incorrectly, as they explained the behaviour of light with reference to either reflection off the filter or refraction as the white light passed through the filter.

Question 3 (b)

(b) Which **two** statements are correct about green light?

Tick (✓) **two** boxes.

It has a shorter wavelength than red light ☐

It travels faster than yellow light in a vacuum ☐

It is a longitudinal wave ☐

It has a higher frequency than blue light ☐

It has a lower energy than violet light. ☐

[2]

Candidates performed well on this question, with many gaining 1 mark for correctly identifying that either green light has 'a shorter wavelength than red light' or 'it has lower energy than violet light'. The most common incorrect statements ticked were 'it travels faster than yellow light in a vacuum' and 'it has a higher frequency than violet light'.

Misconception

A common misconception highlighted by the incorrect response 'it travels faster than yellow light in a vacuum' was the misunderstanding that the speed of light (in a vacuum) varies for different colours of light.

Question 3 (c)

(c) The ball is placed inside a bell jar and the air is removed.

Explain why the ball can still be seen when there is no air in the jar.

....

....

....

.... **[2]**

Many candidates gained marks on this question, with some gaining 1 mark for explaining that light does not need a medium to travel or can travel through a vacuum. Only a small number of candidates qualified this response by explaining that light is an electromagnetic wave. A significant number of candidates stated that light could travel when there was 'no air', but this just repeated the stem of the question and did not explain for the mark to be given.

Question 4 (a)

4 Two radioactive isotopes of actinium are actinium-225 ($^{225}_{89}Ac$) and actinium-227 ($^{227}_{89}Ac$).

(a) Compare the structures of the nuclei of actinium-225 and actinium-227.

....

....

....

.... **[2]**

Candidates performed well on the question, with some candidates gaining 2 marks for correctly comparing the structure of the two isotopes with reference to the number of protons and neutrons. To gain both marks, candidates had to specify that the difference between the two isotopes was either 2 more or less neutrons in the nucleus, as well as having the same number of protons.

Question 4 (b) (i)

(b) Actinium-225 ($^{225}_{89}Ac$) decays to francium-221

Actinium-227 ($^{227}_{89}Ac$) decays to thorium-227

(i) State why a nucleus might decay.

....

.... **[1]**

Higher achieving candidates tended to perform better on this question with most of these candidates correctly stating that the nucleus might decay due to being 'unstable'.

Question 4 (b) (ii)

(ii) Name the electromagnetic radiation that is emitted in both cases.

.... **[1]**

Candidates performed well on this question, with many candidates correctly naming 'gamma' as the electromagnetic radiation emitted.

Question 4 (b) (iii)

(iii) Name one **other** ionising radiation emitted in each case.

Actinium-225: ....

Actinium-227: ....

[2]

Overall, candidates performed well on this question, with many candidates gaining at least 1 mark. Higher performing candidates tended to perform better on this question with most correctly naming 'alpha' radiation for Actinium-225 and 'beta' radiation for Actinium-227.

Question 5 (a)

5 The table shows some data for the thinking distance, braking distance and stopping distance of a car travelling at different speeds.

Speed (miles per hour)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
30		14	
40	12	24	36
50	15	38	53
60	18		
70	21	75	96

(a) When the speed doubles, the thinking distance doubles, and the braking distance quadruples.

Use this information to complete the table. **[2]**

Candidates performed well on this question, with many candidates correctly calculating the thinking, braking and stopping distances at 30mph and 60mph. Some candidates correctly determined the missing thinking distance (30mph) or braking distance (60mph), but did not complete the table to calculate the stopping distance at each speed.

Question 5 (b)

(b) A student concludes that the stopping distance must be at least triple when the speed doubles.

Use data from the table to explain why the student is correct.

....

.... **[1]**

Only some candidates correctly used data from the table to explain that the student's conclusion was correct by quantitatively comparing the stopping distance at 30mph and 60mph. Some candidates attempted a quantitative comparison between 40mph and 70mph, but this was not given marks, as the speed was not doubled, so a correct conclusion could not be determined. Qualitative responses were not given marks, as candidates had not used data from the table.

Question 5 (c)

(c) Convert 40 miles per hour to m/s.

1 mile = 1609 m.

40 miles per hour = ... m/s **[2]**

Candidates performed well on this question, with many gaining 2 marks for a correctly calculated conversion of 40 miles per hour to m/s. Most correctly converted miles to metres, but a significant number of candidates made subsequent rounding errors and gave a response of 17.87 m/s rather than the correctly rounded answer of either 17.88 m/s or 17.9 m/s.

Question 5 (d)

(d) Estimate the typical speed of a cyclist in m/s.

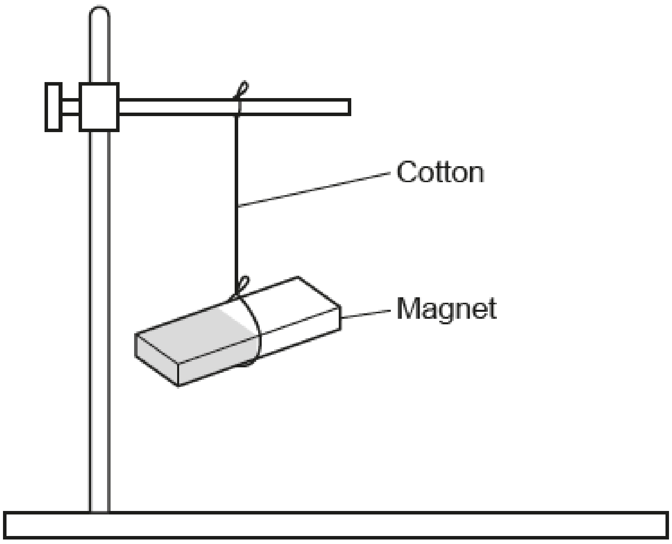
.... m/s **[1]**

Candidates did not perform well on this question. Some candidates attempted to calculate the typical speed, but this was not required as they were only expected to recall the typical speed of a cyclist.

Question 6 (a)

6 Sara is investigating magnetism. She suspends a small bar magnet from a length of cotton as shown in **Fig. 6.1**.

Fig. 6.1



(a) The magnet hangs horizontally and can rotate freely.

Explain why the magnet will always come to rest lying in the same direction.

....

....

....

.... **[2]**

Candidates did not perform well on this question; only some candidates gained a mark. Few candidates understood that the suspended magnet behaved as a compass, so aligned with the Earth's magnetic field. Many candidates did try to describe that the magnet would point to the Earth's poles but were not given marks, as they did not specify and refer to magnetic **poles**. Candidates also gave incorrect responses in terms of forces in gravitational fields or that the magnet was attracted to the clamp stand.

Exemplar 2

Because of the Earth's magnetic field, the magnet's 'north' pole will be attracted towards the Earth's magnetic south pole (The North Pole), and the magnet's 'south' pole toward Earth's magnetic North pole (The South Pole). [2]

Exemplar 2 demonstrates a correct response, as the candidate has understood the behaviour of a magnetic compass aligning with the Earth's magnetic field.

Question 6 (b)

(b) Sara has a second magnet with the north and south poles labelled. She brings it up close to the suspended magnet in **Fig. 6.1**.

Explain how she can identify the poles of the suspended magnet.

....

....

....

.... **[2]**

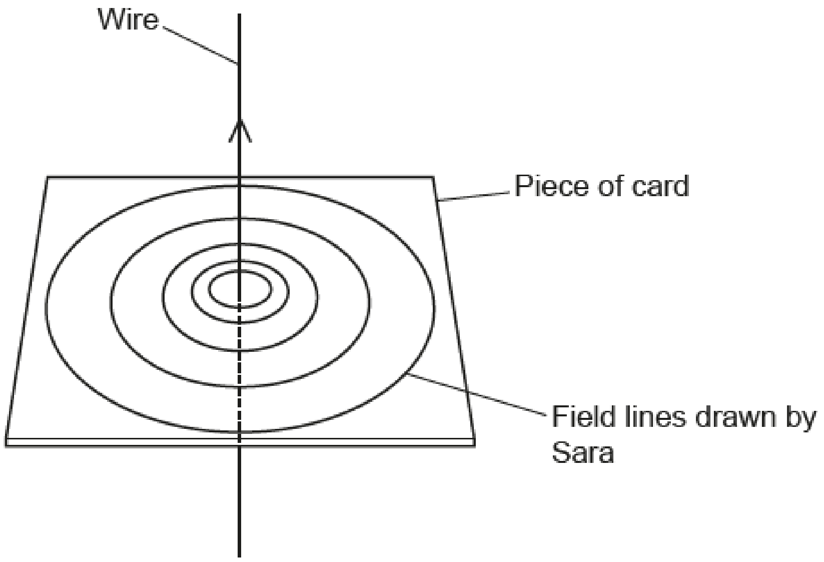
Candidates performed well on this question, with many candidates gaining 1 mark and some giving a complete, correct response for 2 marks. Candidates were able to explain how the poles of the suspended magnet could be identified, but where candidates did not gain the mark, it was due to a lack of correct scientific language, as they did not include the term 'poles' which was clearly stated in the question. Instead, some candidates used simple language such as 'ends' or 'sides' to describe the poles which was not scientifically specific to be given with marks.

Question 6 (c) (i)

(c) Sara investigates the magnetic field around a wire which has a current passing through it.

She puts the wire through a horizontal piece of card. From her investigation she draws field lines to show the pattern of the magnetic field around the wire as shown in **Fig. 6.2**.

Fig. 6.2



(i) Suggest a method Sara uses to observe the pattern of the magnetic field.

....

....

....

....

....

.... **[3]**

Candidates did not perform well on this question, with only some gaining marks; very few gained 3 marks for a completely correct response. Good responses described a method using iron filings or plotting compasses, but many candidates wrote about Fleming's left hand rule or the right-hand grip rule which is used to determine the direction of the magnetic field rather than a method to observe the pattern of a magnetic field.

Question 6 (c) (ii)

(ii) Draw an arrow on **Fig. 6.2** to show the direction of the magnetic field. **[1]**

Most candidates correctly determined the direction of the magnetic field as anticlockwise by recalling and applying the right-hand grip rule to the diagram of the upwards current.

Question 6 (c) (iii)

(iii) Describe how the field lines in **Fig. 6.2** show that the strength of the magnetic field decreases as the distance from the wire increases.

.... **[1]**

Candidates performed well on this question, with many correctly describing that the distance between the field lines increased with increasing distance from the wire.

Question 6 (c) (iv)

(iv) Sara increases the size of the current in the wire.

Explain how the pattern of the field lines changes.

....

....

....

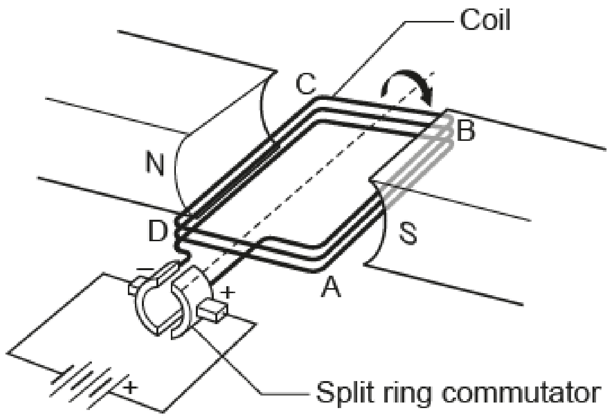
.... **[2]**

Candidates performed well on this question, with most candidates gaining 1 mark and some candidates gaining 2 marks for correctly describing the pattern of the magnetic field and explaining the pattern with reference to the increasing strength of the magnetic field as the size of the current increased.

Question 6 (d)

(d) Sara makes an electric motor using a length of wire and a magnet with a magnetic flux density of 20 mT.

She winds the wire into a coil and connects the ends of the wire to a split ring commutator. She places the coil between the poles of the magnet.



The current in the wire is 1.5 A.

When the coil is horizontal, a magnetic force of 0.3 N acts on each side of the coil labelled AB and CD.

Calculate the total length of wire that needs to be on side CD of the coil.

Use the Equation Sheet.

Length = ... m **[4]**

Candidates performed well on this question, with many candidates gaining marks for a correct selection and rearrangement of the equation $F = B I l$ to give a calculated length of the wire. Some candidates gave a correct calculated length of 10 m which required a correct conversion of mT to T.

Question 6 (e) (i)

(e) (i) Describe how Sara can use the motor as a generator.

....

.... **[1]**

Candidates found this question challenging. They had to describe the idea of mechanical work being done in moving the coil to be able to use the motor as a generator, but many candidates gave responses referring to the motor moving the coil, rather than Sara or something else doing mechanical work in moving the coil in a magnetic field.

Question 6 (e) (ii)

(ii) Sara replaces the split ring commutator with slip rings.

Describe how the output of the generator changes.

....

.... **[1]**

Most candidates found this question challenging, although the highest achieving candidates often gave good responses. Most responses referred to the output either decreasing or increasing which demonstrated a lack of understanding of the role of split ring commutators and of slip rings when converting a generator from a d.c. to an a.c. output.

Question 7*

7* Uranium (U) and hydrogen (H) can be used to release energy in a nuclear reaction.

Typical nuclear equations for each are:

$${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{89}_{36}\text{Kr} + {}^{144}_{56}\text{Ba} + 3\,{}^{1}_{0}\text{n}$$

$${}^{3}_{1}\text{H} + {}^{2}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + {}^{1}_{0}\text{n}$$

Compare and contrast these **two** processes, explaining how energy is released in both cases.

....

....

....

....

....

.... **[6]**

Most candidates gained marks on this Higher tier Level of Response question, with many candidates achieving Level 1 and 2 marks (ranging from 1 to 4 marks), for comparing the two processes of nuclear fission and fusion reactions, and for describing them each in terms of nuclei formed and the release of neutrons. Higher achieving candidates also made good attempts to explain how energy is released in each process, which meant that they accessed Level 3 marks. Attempts at explanations of energy released at Level 1 and 2 were mostly superficial, with simple statements that each process released lots of energy, but without further qualification with reference to gamma radiation, kinetic energy of the formed/resulting particles or the process that some of the mass may be converted into the energy of radiation. Some candidates did not gain marks, usually for confused responses, in terms of alpha and beta radiation, which was often poorly communicated.

Exemplar 3

- In ~~ffs~~ nuclear fission, large unstable nuclei are split apart into smaller nuclei, whereas in nuclear fusion two smaller nuclei fuse to make a larger ~~nuclei~~ nucleus

- In nuclear fission an unstable uranium ~~nuclei~~ nucleus absorbs a neutron which causes ~~the~~ ~~so~~ the nucleus to split, producing ~~fo~~ 3 more neutrons, and ~~gamm~~ electrons, and gamma radiation. These neutrons will then be absorbed by more unstable nuclei and cause a chain reaction. Whereas in fusion, ~~the~~ ~~sta~~ two hydrogen nuclei finally overcome their electrostatic repulsion, come together and fuse, releasing lots of energy. The mass of the nucleus after fusion is less than the mass before.

[6]

Exemplar 3 shows a Level 3 response, gaining 6 marks where the candidate has compared the two processes by clearly contrasting the fission process of Uranium and the fusion process of Hydrogen. The candidate has also explained how energy is released by gamma radiation and recalled the process of mass difference in nuclear fusion.

Question 8 (a)

8 A metal disc has a weight of 4.0 N. The disc is suspended from a spring and the extension of the spring is measured. The measurement is made three times.

The results are shown in the table.

Reading	Extension (m)
1	0.050
2	0.050
3	0.040

(a) Calculate the spring constant of the spring.

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

Use the Equation Sheet.

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

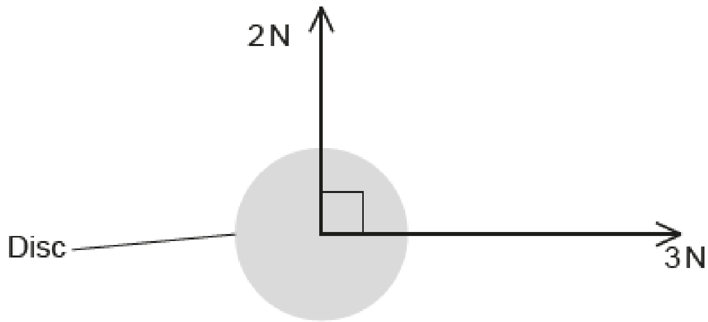
Candidates performed well on this question with about many candidates correctly calculating the spring constant to gain 5 marks. Only a small number of candidates did not gain marks. Most gained marks for either correctly calculating the average extension, or for correctly selecting and applying the equation $F = k x$. There were some candidates who correctly calculated the spring constant but did not give their final value to 2 significant figures to gain full marks.

Question 8 (b)

(b) The disc is placed flat on a smooth surface. Two perpendicular forces, 2 N and 3 N, are applied to the disc parallel to the surface, as shown in **Fig. 8.1** when viewed from above.

Fig. 8.1 is **not** to scale.

Fig. 8.1



Draw a scale diagram to find the size of the resultant force on the disc.

Use the scale 1 N = 2 cm

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

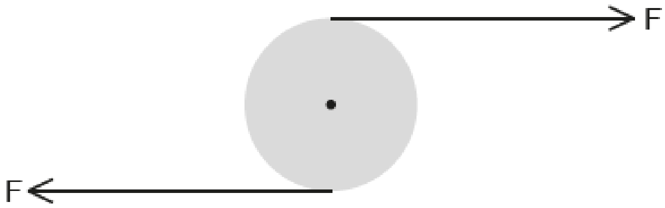
Generally, candidates performed well on this question. Many gained marks, with the most common mark being given for correctly drawing the two perpendicular forces of 2 N and 3 N to scale. Often candidates did not further develop their response to identify that the hypotenuse represented the resultant force. Some candidates gained 3 marks for correctly determining the resultant force within the range of 3.5 N and 3.7 N from a correct scale drawing, with some candidates correctly calculating the resultant force by applying Pythagoras's theorem. While candidates were not expected to recall and apply this method of Pythagoras's theorem, candidates were given 3 marks if they calculated the resultant force of 3.6 N.

Question 8 (c)

(c) The centre of the disc is pinned to the surface. The disc can rotate but its position on the surface cannot change.

Two forces are applied to the disc as shown in **Fig. 8.2**.

Fig. 8.2



Explain how these two forces cause the disc to rotate about its centre.

....

....

....

.... **[2]**

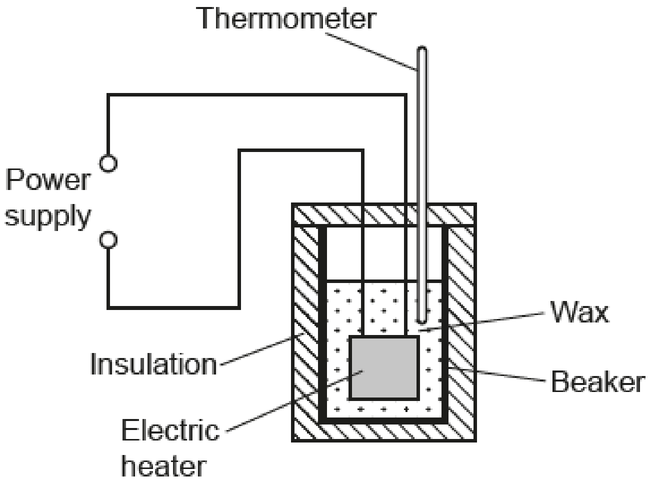
Performance for this question was similar across the mark range, with some candidates gaining marks for stating that the two forces applied to the disc were acting in opposite directions. Only a small number of candidates explained that the disc rotated due a resultant moment being produced by the two forces causing the disc to rotate/turn in a clockwise direction. Many candidates stated that the disc rotated in a clockwise direction, but did not apply understanding that this motion was caused by the turning effect of each force acting on the disc.

Question 9 (a) (i)

9 Li makes wax candles.

(a) Li needs to calculate the specific heat capacity of the wax.

This is the apparatus used:



(i) Name **two** other pieces of equipment that are needed so Li can calculate the specific heat capacity, **and** describe what each piece of equipment is used for.

1. ....

....

....

2. ....

....

.... **[4]**

Candidates performed well on this question, with some correctly identifying and the describing the use of two pieces of equipment. They demonstrated an understanding of $E = m c \Delta\theta$ that the energy/power, mass of the wax and the change in temperature needed to be measured to calculate the specific heat capacity of the wax.

Question 9 (a) (ii)

(ii) Explain how the calculated value for the specific heat capacity would be different if the beaker was **not** insulated.

....

....

....

.... **[2]**

Some candidates gained 1 mark on this question, with only the highest achieving candidates gaining 2 marks for correctly explaining that the calculated value of specific heat capacity would increase if the beaker was not insulated. Some candidates explained that the thermal store of the surroundings increased for the uninsulated beaker. Typical responses that were not given marks were vague, such as 'heat is lost' or that insulation 'keeps heat in' or for simple statements that the calculated value of the specific heat capacity would change (without any further qualification).

Misconception

A common misconception was that the calculated value of the specific heat capacity decreased for an uninsulated beaker. This demonstrated that candidates did not understand that, in order to achieve the same temperature rise, the energy supplied for an uninsulated beaker (by electrical working) would be larger than for an insulated beaker (some increasing the thermal store of the wax, but some increasing the thermal store of the surroundings).

Question 9 (a) (iii)

(iii) Explain why it is important that Li does **not** exceed the melting point of the wax.

....

....

....

.... **[2]**

Candidates did not perform well on this question, with only a few candidates gaining marks for explaining that energy would be transferred to increase the internal energy of the wax to change its state from solid to liquid when it melts.

Question 9 (a) (iv)

(iv) In a different investigation Li connects a 12 V d.c. power supply to a heater. 0.02 kg of wax is heated.

The temperature of the wax increases by 18 °C in 120 s.

Calculate the current in the heater.

The specific heat capacity of the wax is 2890 J / kg °C.

Use these equations:

- change in internal energy = mass × specific heat capacity × change in temperature
- power = energy ÷ time
- power = potential difference × current

Current = ... A **[4]**

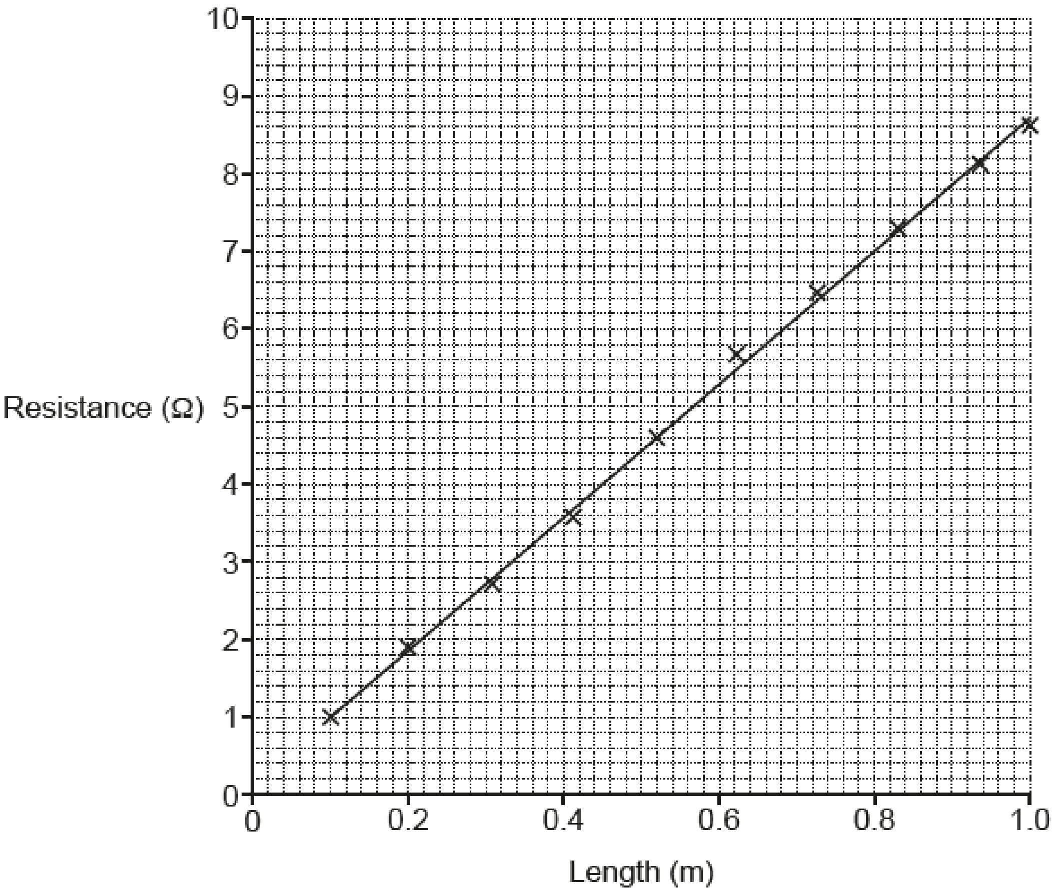
Candidates performed well on this question, with most correctly manipulating the given equations to calculate the current to give a value of 0.722 5 A. The large majority of candidates correctly calculated the change in thermal energy of the wax and the power of the electric heater.

Question 9 (b) (i)

(b) Li designs an electric heater using nichrome wire.

Li connects the wire in a circuit with a power supply, an ammeter and a voltmeter. He makes measurements and calculates the resistance of different lengths of the wire.

He produces a graph as shown.



(i) Describe how Li calculates the resistance of different lengths of the wire.

Your answer should include a circuit diagram.

....

....

....

....

[3]

Many candidates gained marks on this question, but very few gained 3 marks by including a correctly drawn and labelled circuit diagram to describe how the resistance of a length of wire would be calculated from measurements of current and potential difference. Most candidates correctly understood and applied $V = IR$ to describe that both the current and potential difference were to be measured to be able to then calculate the resistance of the wire at different lengths.

Misconception

?

The most common error included attempts at drawing a circuit diagram. A significant number of candidates drew a voltmeter in series in the circuit rather than in parallel.

Question 9 (b) (ii)

(ii) Suggest why Li switches off the power supply between each measurement.

....

....

....

.... **[2]**

Candidates did not perform well on this question; the most typical reason given for switching off the power supply was to prevent any risk from electric shocks. This demonstrated a lack of understanding of practical technique, that when a current flows through a wire it causes a heating effect which results in the resistance of the wire increasing (so changing the quantity that is to be measured).

Question 9 (b) (iii)

(iii) Li uses a length of the nichrome wire as a heater connected to a different power supply.

This heater supplies a power of 20 W when the current is 2.5 A.

Calculate the length of the wire.

Use the Equation Sheet and the graph.

Length = ... m **[4]**

Candidates performed well on this question with most correctly selecting and rearranging the equation $P = I^2 R$ to calculate the resistance of the wire to give a value of 3.2 Ω. Many of these candidates correctly used the graph to determine a correct value of the length of the wire as 0.36 m. The most common error was either not interpretating the graph correctly, or selecting an incorrect equation, most commonly $F = B I l$.

Copyright information

Question 1: Image of a triangular glass prism, Alamy, www.alamy.com

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Access to Scripts

For the June 2023 series, Exams Officers will be able to download copies of your candidates' completed papers or 'scripts' for all of our General Qualifications including Entry Level, GCSE and AS/A Level. Your centre can use these scripts to decide whether to request a review of marking and to support teaching and learning.

Our free, on-demand service, Access to Scripts is available via our single sign-on service, My Cambridge. Step-by-step instructions are on our website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals.

Find out more.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.