

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/01 Summer 2018 series

Version 1

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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. 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 can be downloaded from OCR.

Paper J259/01 series overview

J259/01 is the Breadth in Physics paper at Foundation Tier. It covers topics across the whole specification with short answer questions. This includes structured questions, calculations and questions based on practical skills. It counts for 50% of the marks for Foundation Tier GCSE qualification in Physics (21st Century Science). The other 50% is covered by J259/03 Depth in Physics.

Candidate performance overview

Candidates who did well on this paper generally did the following:

- Recalled and re-arranged equations correctly.
- Set out calculations clearly.
- Used scientific vocabulary appropriately.

Candidates who did less well on this paper generally did the following:

- Found it difficult to separate practical observations and conclusions.
- Showed limited understanding of what was being asked in some questions.
- Used incorrect scientific terminology.

Each of Assessment Objectives were tested in this paper and candidates performed better on those questions covering AO1 and AO2, as opposed to those covering AO3.

<i>Most successful topics</i>	<i>Least successful topics</i>
<ul style="list-style-type: none"> • Changes of state (question 6(b)(i)) • Velocity and acceleration (question 3) • Electrical resistance (question 9(b)) 	<ul style="list-style-type: none"> • Moments (question 5) • Energy transfers (questions 7(d) and 14) • Radioactivity (question 8)

There was little evidence that any time constraints had led to a candidate underperforming. Scripts where there was no response to the final question also had large sections of the paper which had not been tackled.

Question 1 (a)

1 Jamal is listening to the radio.

(a) He can hear a musical instrument playing a steady note.

What type of wave is the **sound** that Jamal hears?

Put a **ring** around the correct answer.

electromagnetic

longitudinal

radio

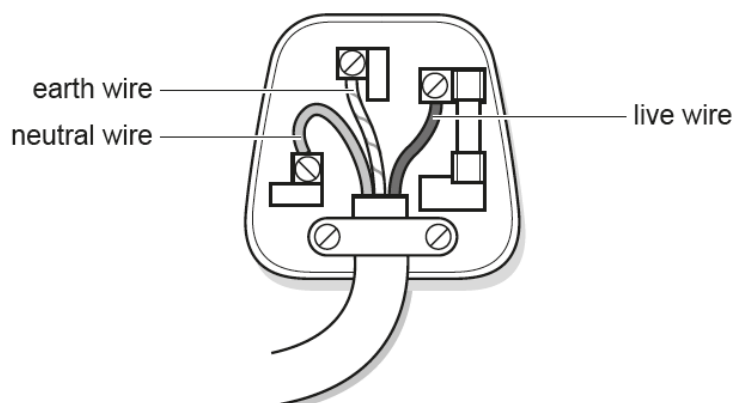
transverse

[1]

Candidates needed to read this question carefully not to be misled by the first sentence, as the most common error was to choose 'radio' as the response. The only type of waves which are 'heard' are sound waves and they are longitudinal.

Question 2 (a) (i)

2 The diagram shows the inside of a three-pin plug.



(a) (i) Put a **tick (✓)** in the correct box in each row to show the correct descriptions of the live, neutral and earth wires.

Wire	Connected to the National Grid	Is at the same voltage as the ground
Live		
Neutral		
Earth		

[2]

Candidates were credited one mark out of the two available if they put 2 ticks in the correct columns. Whilst most candidates recalled that the Live wire is connected to the National Grid, there was some confusion about the Neutral and Earth wires.

Question 2 (a) (ii)

- (ii) Put a
- ring**
- around the voltage between the live and neutral wires.

0 V 12 V 230 V 25 000 V

[1]

Although many candidates correctly chose 230V, a common error was to choose 12V.

Question 2 (b)

- (b) Batteries supply direct current (d.c).

Another type of current is alternating current (a.c).

Each statement in the table below may be **true** about d.c, or **true** about a.c, or **true** for both d.c and a.c.

Put a **tick** (✓) in the correct box in each row.

	True only for d.c	True only for a.c	True for both
The current always flows in the same direction.			
The domestic supply in the UK uses this.			

[2]

Many candidates were able to recall that the current flows only in one direction for d.c. circuits, but fewer recalled that the UK domestic supply uses a.c. Several thought that both a.c and d.c were used.

Question 3

- 3 Alex is planning his journey to school.

Question 3 (b)

- (b) He could travel by car.

A car travels at 36 km/h (kilometres per hour).

Which is the correct calculation to work out this speed in m/s (metres per second)?

Put a **ring** around the correct answer.

$\frac{36 \times 60}{1000}$ $\frac{36 \times 1000}{60}$ $\frac{36 \times 3600}{1000}$ $\frac{36 \times 1000}{3600}$

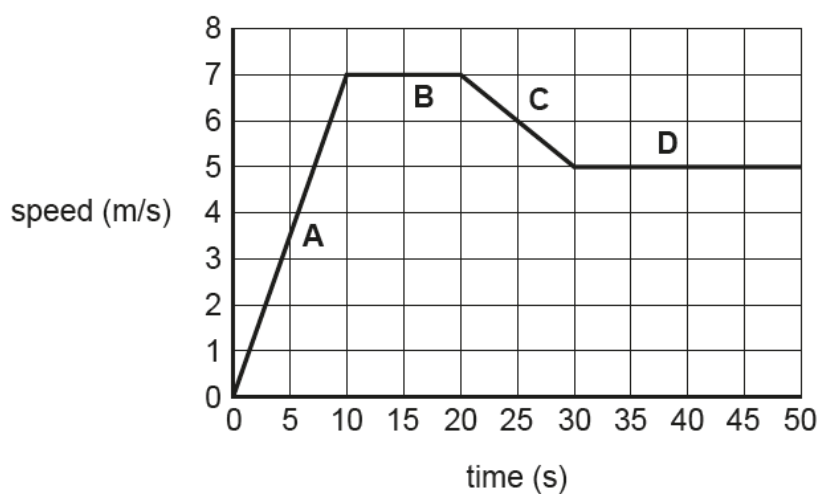
[1]

Some candidates showed some rough working in order to work out which calculation was correct, as it was clearly confusing for some of them. There was no common incorrect choice.

Question 3 (c) (i)

(c) In the end Alex decides to cycle to school.

The graph shows the first part of this journey.



Question 3 (c) (ii)

(ii) Calculate the acceleration in section A of the journey.

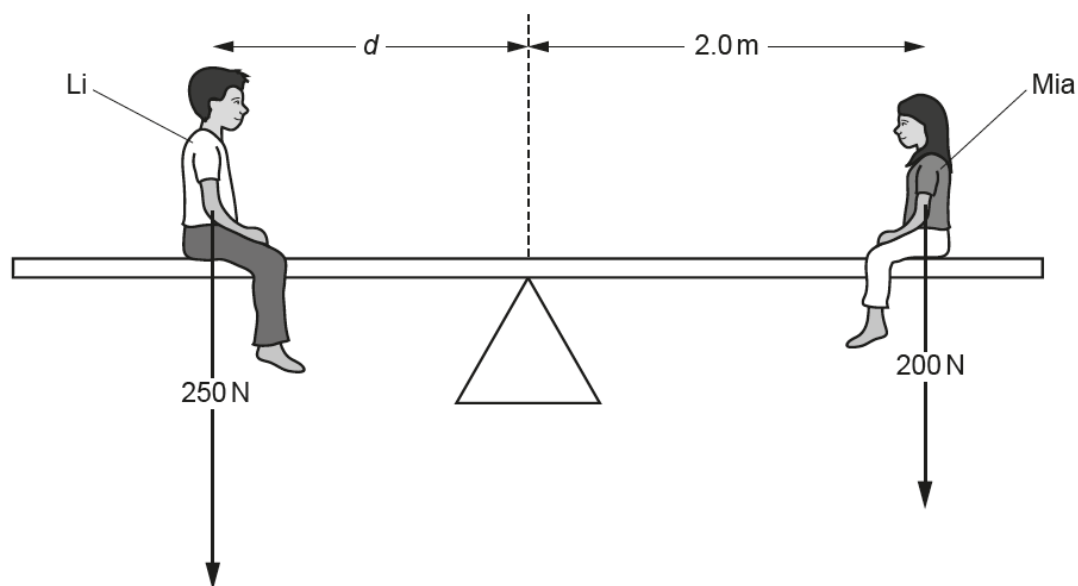
Use the equation: acceleration = change in speed \div time

Acceleration = m/s² [3]

Most candidates were able to read appropriate data from the graph in order to calculate acceleration. Most used the change in speed as 7 m/s and the time as 10s, but some used a change of speed of 3.5 m/s and a time of 5 s, showing good understanding of the speed-time graph.

Question 5 (a)

5 The figure shows Li and Mia balanced on a see-saw.



(a) Mia weighs 200 N.

Calculate the moment of Mia's weight about the centre of the see-saw.

Moment = Nm [3]

Question 5 (b)

(b) Li weighs 250 N.

To balance Mia as shown in the diagram, he needs to sit at a distance d from the centre of the see-saw.

Calculate the distance d .

Distance d = m [3]

The concept of moments seemed to puzzle many candidates. Only a few candidates were able to recall the equation to use. In part (a) the most common error was to divide the weight by the distance from the centre. Many candidates did not try to use the moment calculated in part (a), in order to find the distance, d in part (b). Candidates who correctly used their value calculated in part (a) in part (b) could be credited with both marks in part (b).

Exemplar 1

moment = weight ~~x~~ force distance

$$200 \times 2.0 = 400$$



Moment =4.00..... Nm [3]

Calculate the distance d .

distance = moment ~~area~~ \div weight

$$400 \div 250 = 1.6$$



Distance d =1.6..... m. [3]

This response shows clearly laid out calculations.

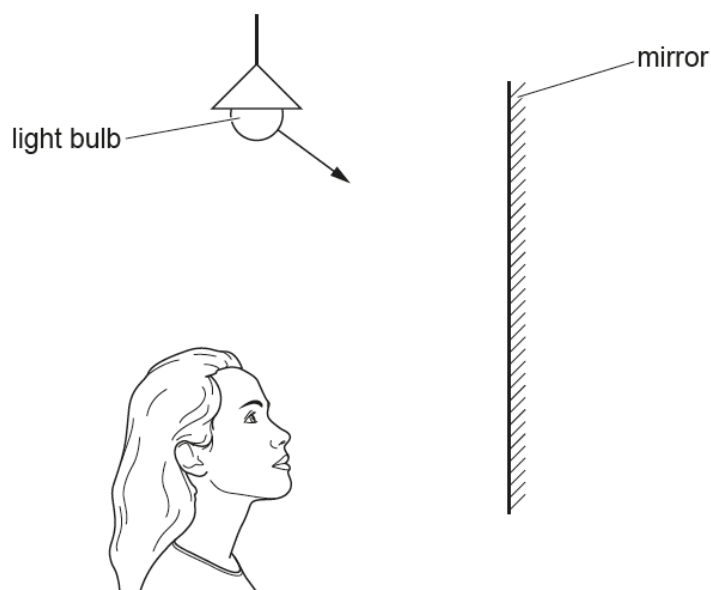
In part (a), the equation is written out, and then it is clear which numbers have been substituted into the equation. The final answer is written on the answer line. Here the units are included on the answer line, and candidates who cannot recall the equation may be able to use the units as a clue. The units for moment are given as Nm, which means that a force or weight in Newton should be multiplied by a distance in metre.

In part (b) the candidate has correctly re-arranged the equation to calculate the distance from the centre, and then substituted the value for moment calculated in part (a) and Li's weight to find the distance of 1.6 m.

Question 6 (a)

6 Jane sees the reflection of the light bulb in her bathroom mirror.

(a) Complete the diagram to show the path taken by the reflected light.



[2]

Candidates were expected to extend the arrow already shown on the diagram, ideally using a ruler, so that the line reached the surface of the mirror. The reflected ray should then be drawn from the point of intersection to the Jane's face, but there was no expectation for candidates to use a protractor to ensure the angles of incidence and reflection were identical. As long as there was no gap between the two rays on the mirror and the reflected ray went to any part of Jane's face it was acceptable.

Question 6 (b) (i)

(b) Jane fills the bath with hot water. The mirror 'steams-up' and is now covered in tiny drops of water. This makes the surface of the mirror look white.

(i) Jane says, 'The water on the mirror came from the bath'.

Explain how this happened.

.....

.....

.....

..... [2]

Responses to this question were on the whole quite good. Most candidates were able to use the terms evaporate and condense correctly.

Question 6 (b) (ii)

(ii) Explain why the water droplets covering the mirror make it look white.

.....

.....

.....

..... [2]

This is a synoptic question, and some candidates found it difficult to relate ideas about the states of matter with ideas about reflection of light. Some candidates were able to explain something about light being reflected from the water droplets being different from reflecting light from a mirror, but few mentioned anything about white light being made up of the whole spectrum or that the water made the light rays travel in all directions.

Exemplar 2

Since the mirror is covered in tiny drops of water light from source doesn't reflect in one direction it travels in all direction hence mirror look white [2]

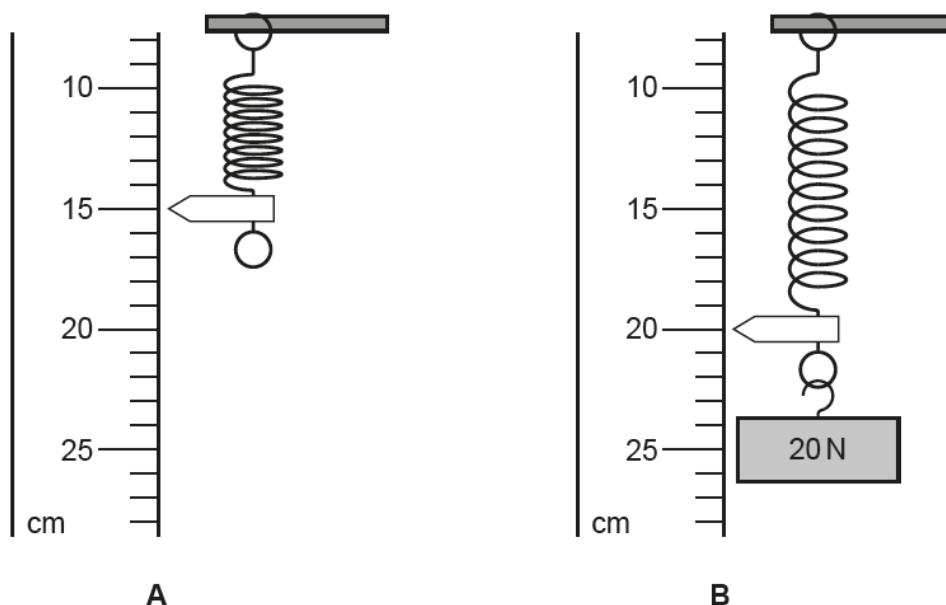
This response has explained that the light is reflected in all directions so gains the second marking point but has not stated that the light is reflected from the water droplets covering the mirror.

Question 7 (a) (i)

7 Ali hangs a spring next to a ruler with a centimetre scale, as shown in the diagram **A**.

He attaches a 20 newton (N) weight to the bottom of the spring.

The spring stretches as shown in **B**.



(a) (i) What is the correct extension (in **metres**) of the spring in diagram **B**?

Question 7 (a) (ii)

(ii) Show that the spring constant is 400 N/m.

[3]

In a 'show that' question, it is even more important for candidates to write down all their working. Here they need to recall and rearrange the equation to find the spring constant. However many of them select the equation to calculate the energy stored in a stretched spring from the formula list, as it refers to the spring constant. Candidates clearly know that the answer they should get is 400 N/m, so many of them just suggest multiplying 20 by 20 which does not gain credit.

Question 7 (b)

- (b) Calculate the **energy stored** in the spring when it is stretched as in (a).

Energy stored = J [3]

Most candidates were able to correctly select the equation to calculate energy stored in a spring and use the value 400 N/m given in part (a)(ii). This part of the question was well answered. Common errors were to use 20 as the value for spring constant or to forget to square the value for extension.

Question 7 (c)

- (c) When Ali adds another 20 N weight, the extension doubles.

Describe the relationship between force and extension.

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

As this was a standard demand question, candidates were expected to realise that as the force doubles from 20 N to 40 N, the extension doubles, or that force is proportional to extension. Just stating that as force increases, extension increases was insufficient to gain the mark in this question.

Question 7 (d)

(d) Ali pulls the spring in diagram **B** downwards a further 2 cm and then lets go.

Ali

I did work on the spring when I pulled it downwards. This increases the energy stored in the spring. When I let go of the spring, the mass moves up and down several times, with smaller and smaller movements. Eventually the mass stops moving.



Describe what happens to the energy stored in the spring when Ali lets go.

.....

.....

.....

.....

.....

..... [3]

Candidates struggled with this topic as they found it difficult to identify both the way energy is stored and how it is transferred from one type of store to another. They often did not use the correct terminology. There were a number of suggested ways to gain marks in this question. The easiest way to gain a mark was to state that the energy stored in the spring was elastic potential energy, but the others required the candidate to state both the type of energy store and how it was being transferred. For example, it was insufficient just to say that there was kinetic energy in the spring; candidates needed to say that there was kinetic energy because the spring or mass was moving.

Exemplar 3

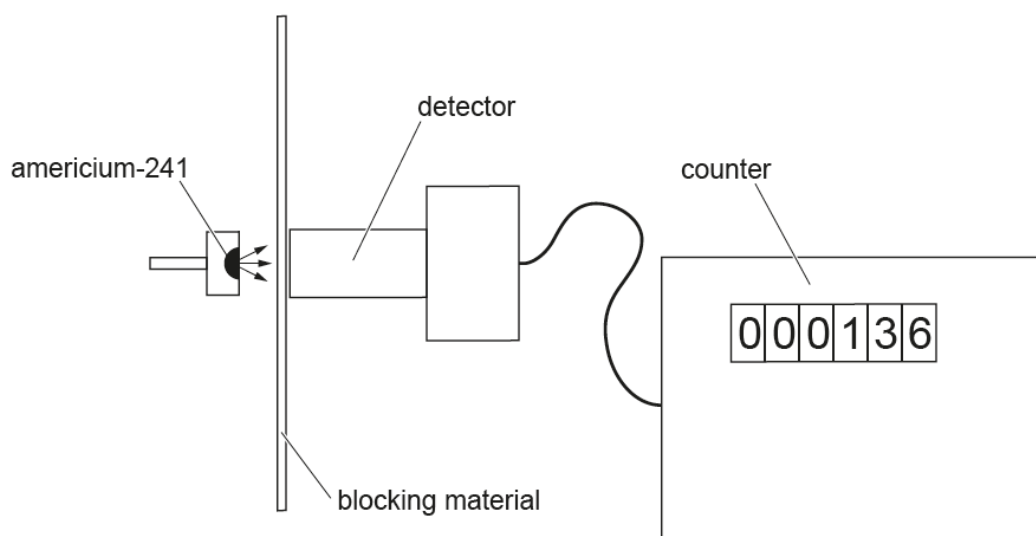
the energy stored is elastic. But
then it is transferred into kinetic
and gravitational which causes the
spring to move up and down.

This response makes 3 valid comments. First it states that the energy store in the spring is initially an elastic store of energy. It then refers to both kinetic and gravitational energy stores while the spring is moving up and down. There is a kinetic store of energy while the spring is moving and a gravitational store when the spring is higher up, so this statement gains another two marks.

Question 8 (b) (i)

(b) Two students investigate the radiation emitted by americium-241.

The diagram shows their equipment.



They recorded the number of counts detected in one minute with different blocking materials.

The table shows their results.

Blocking material	Counts per minute
nothing (just air)	620
paper	23
thin aluminium	23

(i) The students agree that americium-241 emits alpha radiation but not beta radiation.

Explain how the evidence supports this conclusion.

.....

.....

.....

..... [2]

Candidates seemed to find the questions assessing AO3 difficult. Candidates first had to interpret the information given about the experiment to identify a relevant observation and then link it to knowledge about the different types of radiation. There were several ways to gain the marks in this question, but many candidates tended to confuse the penetrating powers of alpha and beta or did not understand the significance of using two different blocking materials.

Exemplar 4

From the table we can see that the counts per minutes decreases to 23 when paper is used as blocking material hence americium 241 emits alpha radiation but not beta radiation. [2]

This response identifies a relevant observation that the count rate is reduced when paper is used as a blocking material so gains the first marking point. In order to gain the second mark the response should have stated that as alpha radiation is blocked by paper or as beta is not stopped by paper, the radiation emitted must have been alpha.

Question 8 (b) (ii)

- (ii) They cannot tell from their results whether americium-241 emits gamma radiation.

What should they do to decide whether the source emits gamma radiation?

.....

 [2]

Many candidates did suggest using lead as a blocking material so were able to gain the first marking point. The second mark was more subtle as candidates couldn't just state that if the radiation was stopped by lead, there must be gamma radiation, as both alpha and beta radiation would also be stopped by lead. Candidates needed to specifically state that gamma radiation is absorbed by lead.

Question 8 (c)

- (c) In fact, americium-241 emits both alpha radiation **and** gamma radiation.

Evaluate how dangerous it is to have a small amount of americium-241 in a smoke alarm.

.....

 [2]

This was another AO3 question which candidates found difficult. Many did state that having americium-241 in smoke detectors was very dangerous, or that it would mean that the smoke detector would be unable to detect a fire. The first marking point could have been gained by making a statement about the relative penetrating power of alpha or gamma radiation, and the second mark was for some analysis about why that meant it was not considered to be dangerous.

Exemplar 5

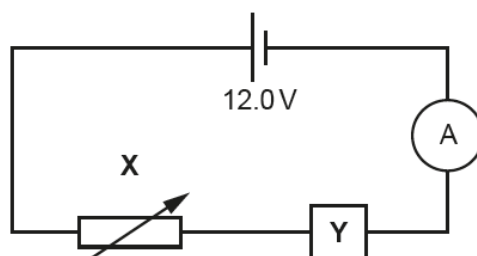
It is not very dangerous as the alpha radiation will most likely be blocked by the plastic on the smoke alarm and by your skin. Gamma radiation will pass through you and will not become dangerous unless you stand under it for a long time.

This response gains one mark for giving information about the penetrating power of alpha radiation – it can be stopped by plastic. In order to gain the second mark it needs to go on to state that this means that it would not come out of the smoke detector, which makes it safe enough.

Question 9 (a) (i)

9 Sundip builds a circuit to investigate a mystery component.

(a) She builds this circuit. The mystery component is the box labelled Y.



(i) Add a voltmeter to the circuit to measure the potential difference across component Y. [1]

The majority of candidates used the correct symbol for a voltmeter in the circuit but many of them put it in series, instead of in parallel across component Y.

Question 9 (a) (ii)

- (ii) Describe how to use component
- X**
- to vary the current in the circuit.

.....

.....

.....

..... [2]

Although candidates did not specifically need to state that component X was a variable resistor, they did need to state that the resistance could be varied, rather than just switched on or off in order to gain the first marking point. The second marking point here seemed much more difficult as candidates needed to state the direction of change i.e. increasing resistance means that the current is reduced.

Question 9 (b) (i)

- (b) The table shows Sundip's results.

Potential difference (V)	Current (A)	Resistance (Ω)
1.0	0.68	1.47
2.0	0.93	2.15
3.0	1.13	2.65
4.0	1.30	3.08
5.0	1.45	3.45
6.0	1.59	

- (i) Calculate the resistance when the potential difference is 6.0 V.
- Give your answer to **3** significant figures.

Resistance = Ω [4]

This question was generally well answered, and for those candidates who were able to recall and rearrange the equation to calculate resistance it was a relatively easy 4 marks to achieve. Nearly all the candidates who did the calculation correctly were also able to give the answer to the correct number of significant figures as well.

Question 9 (b) (ii)

- (ii) Describe the relationship between current and resistance.

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

This question was often misinterpreted as many candidates knew that increasing resistance in a circuit reduces the current flowing, but they needed to realise here that this question related to the results given above.

Question 9 (b) (iii)

- (iii) Suggest what component Y is.

Explain your answer.

Component Y is

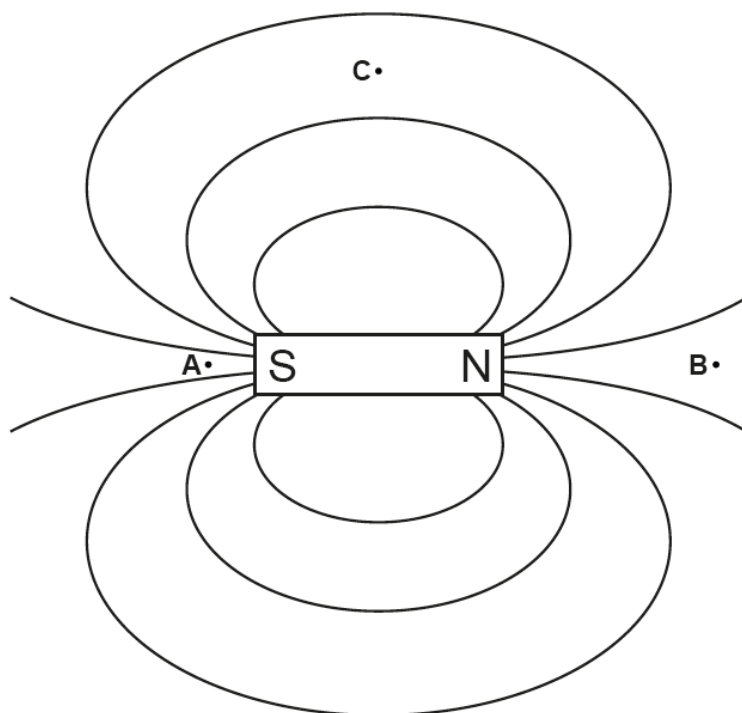
Explanation

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

This was yet another AO3 question which proved to be very difficult, linking the observations given to knowledge. Although many candidates did suggest that component Y was a filament bulb, most were unable to explain why. Common incorrect responses included the following; circuits usually have bulbs in, so you can tell if the circuit is working. Candidates needed to appreciate that the resistance of a bulb varies because the current flowing causes it to get hot.

Question 10 (a) (i)

- 10 The diagram shows the field around a bar magnet. Three points are labelled **A**, **B** and **C**.



- (a) (i) Where is the field strongest?

Tick (✓) **one** box.

A	<input type="checkbox"/>
B	<input type="checkbox"/>
C	<input type="checkbox"/>

[1]

Question 10 (a) (ii)

- (ii) Where would a magnetic compass point to the right?

Tick (✓) **two** boxes.

A	<input type="checkbox"/>
B	<input type="checkbox"/>
C	<input type="checkbox"/>

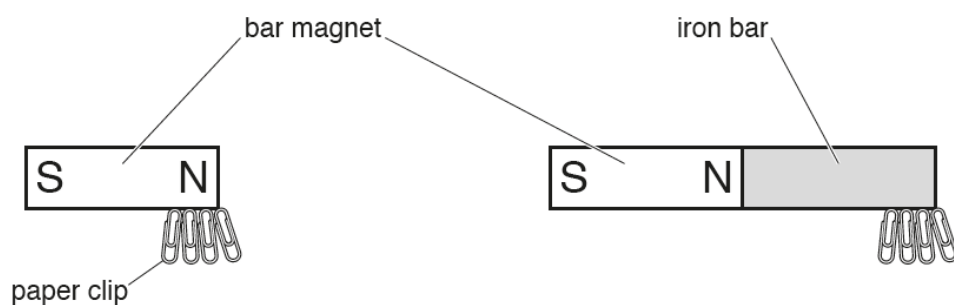
[1]

More candidates were able to answer part (i) correctly. There were a significant number of candidates who only ticked one box in part (ii), which could imply that the question was not read properly.

Question 10 (b)

- (b) The bar magnet can pick up paper clips.

An iron bar can also pick up paper clips if it is held next to a bar magnet.



Describe the difference in magnetism between the bar magnet and the iron bar.

.....

.....

..... [1]

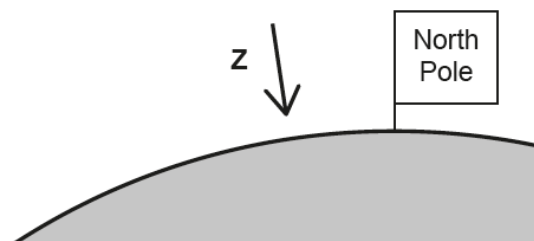
Many candidates realised that the iron bar was not a permanent magnet and were given credit if they were able to explain this without using the words permanent or induced. Comments regarding the relative strength of the magnetic field were ignored in this question. Some candidates did mention positive or negative here, so were probably confusing ideas about magnetism with ideas about electric charge.

Question 10 (c)

(c) The diagram shows a section through the Earth.

The flag marks the position of the geographic north pole of the Earth.

The arrow **Z** shows the point at which a compass needle would point vertically down at the surface.



Here are some statements about the Earth's magnetism, some are **true**, and some are **false**.

Put a **tick (✓)** in the correct box after each statement.

	True	False
A compass will always point towards the centre of the Earth.	<input type="checkbox"/>	<input type="checkbox"/>
The Earth's magnetic north pole is in the same place as the Earth's geographic north pole.	<input type="checkbox"/>	<input type="checkbox"/>
The core of the Earth is magnetic and produces a magnetic field.	<input type="checkbox"/>	<input type="checkbox"/>
The compass points down because the surface at the north pole is covered with iron.	<input type="checkbox"/>	<input type="checkbox"/>
[2]		

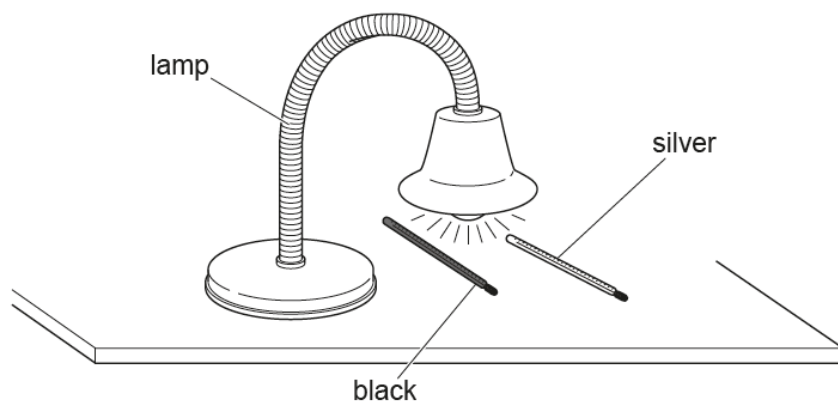
Two marks were available here for 4 correct ticks, and candidates who got two or three correct were credited one of the two marks. The most common incorrect response was to identify the first statement and/or the second as true.

Question 11

11 Ben investigates how much radiation is absorbed by different coloured surfaces.

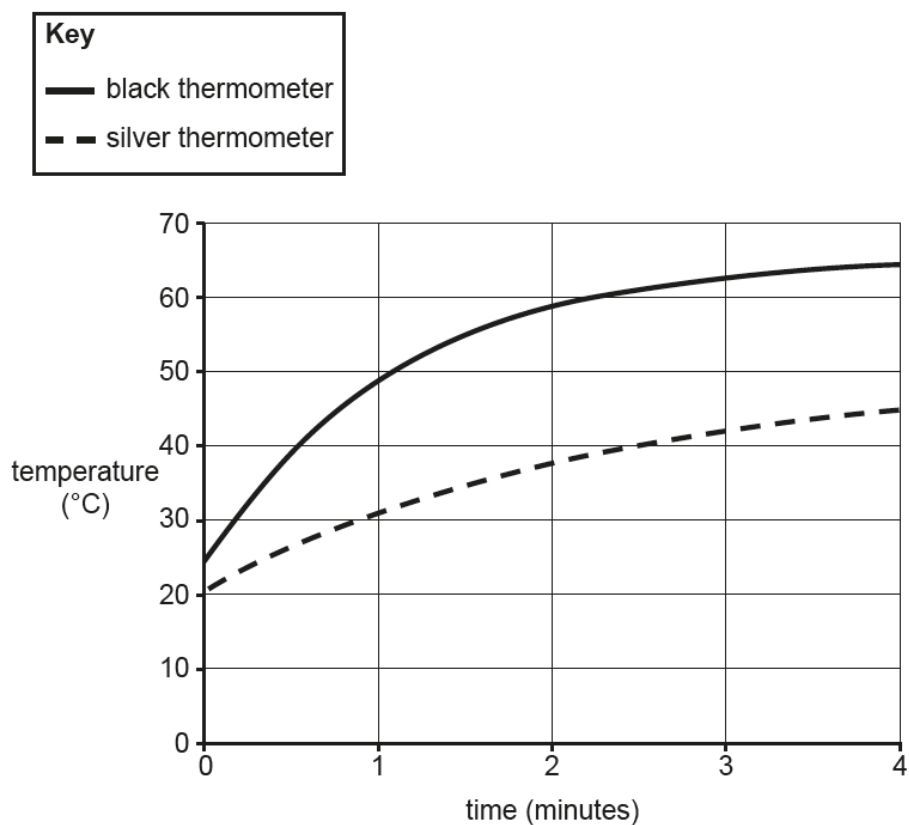
He uses two thermometers and a lamp.

He paints one thermometer black and the other thermometer silver and places them under the lamp.



He records how the temperature of each thermometer changes over four minutes.

The graph shows his results.



Question 11 (a)

- (a) Describe **similarities** and **differences** between the results for the black thermometer and the silver thermometer.

Similarities

.....

Differences

.....

.....

..... [3]

Part (a) is another AO3 question which some candidates found difficult. The command word in part (a) is 'describe' so candidates do not need to try to explain the results here, that is what part (b) is about. Many candidates did describe the similarity in the pattern on the graph that the temperature increases. However, some candidates tried to explain the results instead of describing the differences between the results from the two thermometers.

Question 11 (b)

- (b) Explain the results of the experiment.

.....

.....

.....

..... [2]

In part (b) candidates are expected to use the correct terminology so needed to use either absorb or reflect. Many candidates stated that black attracts heat, which is not using the correct scientific words so did not gain any credit. The second marking point was to refer to the idea that increasing temperature is linked to the amount of energy gained by the thermometers.

Exemplar 6

Similarities Both thermometer shows increase in temperature with time ✓

Differences In Black thermometer increase in temperature is rapid and in Silver thermometer increase in temperature is slow ✓

The rise in temperature in black thermometer rapid because black absorbs a maximum radiation where as silver reflect maximum radiation ✓

In part (a) this candidate correctly identifies the similarity that the temperature increases for both thermometers. Although the candidate gives two statements as differences; that the black thermometer increases rapidly, and the silver thermometer rises slowly, they describe the same difference. For the third mark to be credited the candidate needs to make another observation such as that the black thermometer reaches a higher temperature.

In part (b) this candidate correctly states that the black thermometer absorbs radiation and that the silver thermometer reflects radiation, this is again two ways of getting the first marking point. In order to gain the second marking point the candidate needs to refer to the fact that either of these statements mean that the black thermometer gains more energy than the silver one.

Question 11 (c)

- (c) Identify a weakness with Ben's method and suggest how it could be improved using information from the diagram or from the graph.

.....

 [2]

Many candidates did identify that the thermometers do not look equidistant from the lamp or that they start at different temperatures. However, few candidates were able to explain how to improve the experiment. In order to ensure the thermometers were the same distance away, some method of measuring would be needed e.g. a ruler. It is probably more difficult to explain how to ensure they started at the same temperature.

Question 12 (a)

12 Nina is writing a report about the Solar System.

She has written an introduction.

The planets in our Solar System all move around the Sun.
They orbit in perfect circles and in the same direction.
Each planet has at least one moon orbiting it.
The planets and their moons are all made of rock.



(a) Identify **two** mistakes in Nina's introduction.

- 1
- 2

[2]

Some candidates here wrote out the incorrect statements to identify them, whilst others re-wrote correct statements. Both of these approaches to identification gained credit and on the whole this question was quite well answered. Those candidates who identified the whole of the second line of the paragraph did not gain a mark, as only part of the statement is incorrect. Some candidates incorrectly confused the Moon (Earth's Moon) with the general term of moon and suggested that there was only one Moon in the whole Solar System.

Exemplar 7

- 1 They orbit in perfect circle and in the same direction 
- 2 The planets and their moons are all made of rocks 

This candidate has identified the incorrect statement by just copying them out. However, the statement 'They orbit in perfect circles in the same direction' is not wholly incorrect as all the planets do orbit in the same direction. The second suggestion 'The planets and their moons are all made of rocks' is an incorrect statement so this candidate gains one mark.

Question 12 (b)

- (b) Nina wants to include a section about how the Solar System was formed.

Describe how the Solar System was formed.

.....

.....

.....

..... [2]

Candidates frequently confused the creation of the Universe with the formation of the Solar System, but could still gain some credit for stating that the Solar System began as a cloud of gas and/or dust.

Question 12 (c)

- (c) Nina researches how the Sun releases energy. She finds this information in a textbook.

The Sun releases energy by nuclear fusion. The Sun emits about 4×10^{26} J of energy every second. As a result, its mass falls by about 4 billion kilograms every second.

Explain why nuclear fusion causes the mass of the Sun to decrease.

.....

..... [1]

Most candidates were unable to recall that during fusion reactions mass is converted to energy. This is from a different part of the specification than the previous two parts of this question.

Question 13 (a)

- 13 A toothbrush uses a rechargeable battery.

- (a) The energy that is stored in the battery comes from a power station.

State how the energy is transferred from the power station to the chemical store in the battery.

.....

..... [1]

For this question many candidates referred to various stages of the power network, such as transformers and cables rather than simply stating that the energy was transferred by an electric current.

Question 13 (b) (i)

- (b) The potential difference across the battery is 1.2V.

During a typical use, 360C of charge moves through the toothbrush motor over a time of 2 minutes.

- (i) Calculate the total energy transferred by the toothbrush in one day if it is used **two** times a day.

Energy transferred = J [3]

Candidates were on the whole unable to recall the equation to use in the question. Some candidates did multiply the potential difference by the charge, but many of them were confused about the time. Some only calculated the amount of energy used each time the toothbrush was used and some multiplied the 2 times per day as well as the 2 minutes each time it is used.

Question 13 (b) (ii)

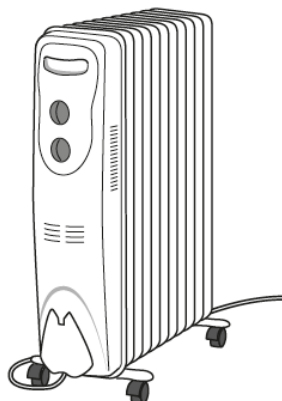
- (ii) Calculate the current in the toothbrush when used for 2 minutes each time.

Current = A [4]

More candidates were able to recall and rearrange this equation than the previous one, and most of them realised that time had to be converted into seconds for the calculation.

Question 14 (a)

- 14 The diagram shows a common type of electric heater. It contains oil which is heated by an electrical element.



The table shows some information about the heater.

Electrical power	1500 W
Voltage rating	230 V
Specific heat capacity of oil	1600 J/kg °C
Mass of oil	4.5 kg

- (a) Show that more than 700 000 J of energy is needed to heat the oil from 20 °C to 120 °C.

Use the equation:

change in internal energy = mass × specific heat capacity × change in temperature

[2]

On the whole candidates were able to substitute the correct numbers into the given equation, and nearly all of them realised that it was the temperature change which was needed. This question was well answered.

Question 14 (b) (i)

- (b) (i) Use your answer to (a) to calculate the minimum time for the oil to reach a temperature of 120°C , starting at 20°C .

Minimum time = s [3]

Candidates found this question difficult as it required use of the data given on the previous page. The question stem referred to the rise in temperature so many candidates divided the value calculated in the previous part by the temperature difference as they were unable to recall and rearrange the equation.

Question 14 (b) (ii)

- (ii) In practice, it will take longer than this for the heater to reach 120°C .

State the reason for this.

.....

..... [1]

This question was not well answered. Most candidates simply stated that the heater would not start at 20°C for instance or that the calculation was only approximate.

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