

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2016

J250/06 Summer 2024 series

Contents

Introduction	4
Paper 6 series overview	5
Section A overview	6
Question 1	6
Question 2	7
Question 3	8
Question 4	8
Question 5	9
Question 6	9
Question 7	10
Question 8	10
Question 9	11
Question 10	12
Section B overview	13
Question 11 (a)	13
Question 11 (b)	14
Question 11 (c)	14
Question 11 (d)	15
Question 11 (e)	15
Question 12 (a)	16
Question 12 (b)	16
Question 12 (c)	17
Question 12 (d) (i)	18
Question 12 (d) (ii)	20
Question 12 (d) (iii)	20
Question 13*	21
Question 14 (a)	22
Question 14 (b)	22
Question 14 (c) (i)	23
Question 14 (c) (ii)	23
Question 14 (c) (iii)	24
Question 14 (c) (iv)	24
Question 15 (a)	25
Question 15 (b) (i)	26

Question 15 (b) (ii)27

Question 15 (c)27

Question 16 (a)28

Question 16 (b)28

Question 16 (c)29

Question 16 (d) (i)30

Question 16 (d) (ii)31

Question 16 (d) (iii)31

Question 16 (d) (iv)31

Question 16 (d) (v)32

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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. 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.

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Paper 6 series overview

J250/06 is the second physics Foundation Tier paper in the GCSE Gateway Science Combined Science suite. It assesses content from specification topics P4-P6. It also assumes knowledge of the topics in P1-P3. To perform well on this paper, candidates need to have a sound knowledge of the theory covered in topics P4-P6 and to be able to apply this to novel situations. They also need to apply the skills and understanding that they have developed in the practical activities covered in topic CS7. This paper also contains questions that have elements of synopticity, drawing on material covered by topics P1-P3. There are also questions that involve the examination of key mathematical requirements from Appendix 5f of the specification. The last question was an overlap question with the Higher Tier paper

Candidates attempted most questions, and answers showed candidates having good attempts at mathematical questions and those where information needed to be extracted.

It is important that candidates are trained to read the questions carefully, understand the command words and to make sure they are not just giving information from the question stem as their answers.

Candidates found questions requiring comparisons and relationships challenging as well as AO3 type questions that involved applying knowledge that was not provided to draw conclusions

Most candidates attempted the Level of Response question and were able to identify controlled variable and suitable precautions needed to get accurate and reliable results.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
<ul style="list-style-type: none"> performed calculations involving substituting into equations, for example, Questions 3, 4, 14 (b), 15 (a), 15 (c) and 16 (d) (iii) were able to apply given information and knowledge of required practical to an unfamiliar apparatus (Question 13) were able to read data from complex graphs to explain a trend, read off data and draw conclusions, Questions 16 (d) (i), (ii), (iii) and (iv) could apply and interpret data given in questions, for example, Questions 11 (a), 11 (e), 15 (b) (i) and (ii). 	<ul style="list-style-type: none"> could not convert units, for example, Question 14 (b), Question 16 (d) (iii) could not describe a trend shown in data, for example, Questions 14 (c) (i) and 16 (d) (i) found questions that depended on recall of prior knowledge difficult did not always give the correct unit, for example, Questions 15 (c) and 16 (d) (ii) found comparing two sets of data difficult, for example, Question 16 (d) (v).

Section A overview

This section consisted of 10 multiple choice questions. Virtually all candidates attempted all of these questions. Questions 1, 7, 8 and 9 that assessed AO1, requiring recall, and Questions 3 and 4 which used mathematical skills were generally well answered. It was pleasing to see candidates showing their working out on the mathematical questions. Questions 2, 5, 6 and 10, which required application of knowledge (AO2), candidates seemed to find more challenging.

Question 1

1 What is a typical speed of a vehicle on a road with a 30mph speed limit?

- A 0.01 m/s
- B 0.10 m/s
- C 10 m/s
- D 100 m/s

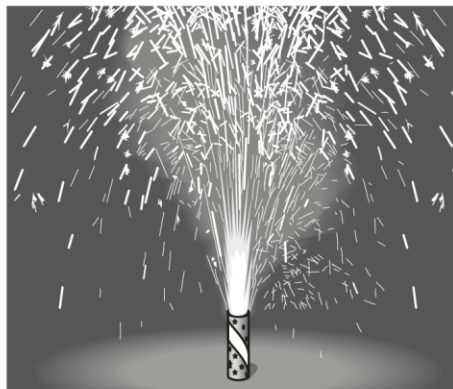
Your answer

[1]

Most candidates correctly answered this recall question. Option B was the most common incorrect answer.

Question 2

- 2 When some fireworks are lit, an explosive called gunpowder acts as a fuel and is ignited.



The gravitational potential store of the firework increases.

Which other energy changes take place when the firework is lit?

- A A chemical store decreases and a kinetic store increases.
- B A chemical store decreases and an elastic potential store increases.
- C A nuclear store decreases and a kinetic store increases.
- D A thermal store decreases and a chemical store increases.

Your answer

[1]

Candidates seemed to find this question quite challenging, with all incorrect options being given as the answer.

Question 3

- 3 A motorcycle has a mass of 200 kg and travels at 5 m/s.

What is the kinetic energy of the motorcycle?

Use the equation: kinetic energy = $\frac{1}{2} \times \text{mass} \times (\text{speed})^2$

- A 2500 J
- B 5000 J
- C 100 000 J
- D 200 000 J

Your answer

[1]

This was well answered and it was encouraging to see candidates writing down their working.

Question 4

- 4 A 4 kg mass is lifted 3 m vertically onto a shelf.

How much gravitational potential energy is gained?

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

Gravitational field strength = 10 N/kg

- A 1.2 J
- B 7.5 J
- C 17 J
- D 120 J

Your answer

[1]

This was well answered. Again, many candidates wrote down their working.

Question 5

5 Material **X** has a **high** thermal conductivity. Material **Y** has a **low** thermal conductivity.

Each material is wrapped around a different identical beaker containing water at 60 °C.

Which beaker of water would have the **smallest** temperature decrease if all other variables are kept the same?

- A 1 layer of material **X** wrapped around the beaker
- B 1 layer of material **Y** wrapped around the beaker
- C 2 layers of material **X** wrapped around the beaker
- D 2 layers of material **Y** wrapped around the beaker

Your answer

[1]

Candidates seemed to find this question challenging. There were two common errors:

- option B: candidates correctly interpreted that low thermal conductivity was needed but not that two layers were better
- option C where candidates misunderstood thermal conductivity.

Question 6

6 What does **thinking distance** mean?

- A The distance travelled after pressing the brakes.
- B The distance travelled while reacting.
- C The time taken to react.
- D The time taken to stop after pressing the brakes.

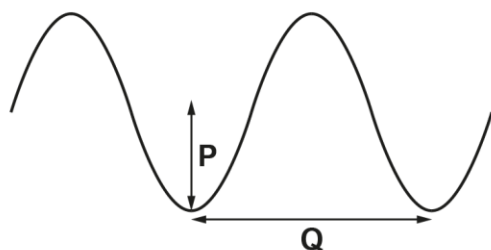
Your answer

[1]

Candidates most often gave option C, mistaking thinking distance with thinking time.

Question 7

7 The diagram shows a picture of a water wave in a ripple tank.



Which row shows the correct labels for the diagram?

	P	Q
A	amplitude	frequency
B	amplitude	wavelength
C	wavelength	amplitude
D	wavelength	frequency

Your answer

[1]

This was generally well answered. The common error was giving them the wrong way round (option C).

Question 8

8 An atom absorbs electromagnetic radiation.

What happens to some electrons in this atom?

- A They form a neutron.
- B They form a new element.
- C They move from a high energy level to a lower energy level.
- D They move from a low energy level to a higher energy level.

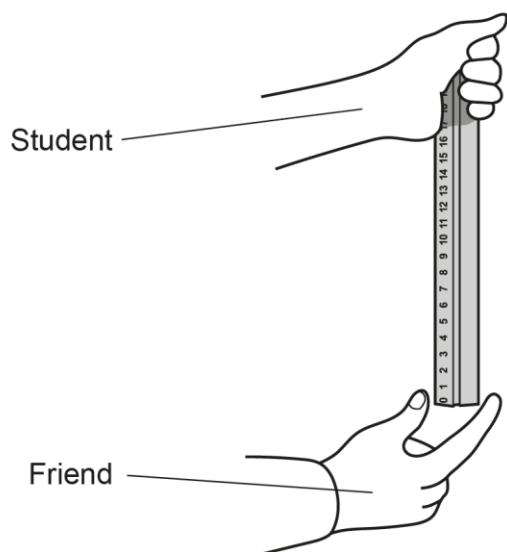
Your answer

[1]

Candidates answered this question reasonably well. The common error was giving them the wrong way round (option C).

Question 9

9 A student uses a ruler to measure a friend's reaction time.



How does the student determine the friend's reaction time?

- A Divide the length of the ruler by the time taken to catch the ruler.
- B Measure the length of the ruler where the friend catches it and convert to a time.
- C Multiply the length of the ruler by the time taken to catch the ruler.
- D Time how long it takes the ruler to hit the floor.

Your answer

[1]

Most candidates correctly answered this question, realising that the distance that the ruler falls needs to be converted to a time.

Question 10

10 Some students design a practical to model radioactive decay.

Which model is correct?

- A** Throw a coin in the air 100 times and count the number of heads or tails.
- B** Throw 10 dice in a tray 10 times and add up the scores.
- C** Throw 100 dice in a tray and remove the ones with a 6 facing up.
- D** Throw 100 identical wooden blocks in a tray.

Your answer

[1]

Candidates showed little understanding of this modelling activity, with all incorrect options seen as answers.

Section B overview

The questions in this section consist of multi-option questions (1-3 marks), structured questions requiring longer written answers (1-2 marks) and calculations (2-3 marks). There was one 6-mark Level of Response question.

This section covers all Assessment Objectives. Question 16 is an 'overlap' question with J250/12, the corresponding Higher Tier paper. Almost all candidates attempted all questions. Questions 11 (d) and 15 (b) (i) were the least attempted, both AO1. Questions 14 (c) (iii) and 14 (c) (iv), AO3 questions which required application of knowledge of the electromagnetic spectrum, seemed to be found challenging.

There was no evidence that candidates ran out of time.

Question 11 (a)

11 This question is about radioactivity.

(a) Some atoms and isotopes of elements are shown.



Which statements are correct for these atoms and isotopes?

Tick (✓) **three** boxes.

${}^7_3\text{Li}$ and ${}^3_1\text{H}$ are isotopes.

☐

${}^7_3\text{Li}$ contains 3 protons and 4 neutrons.

☐

${}^{14}_7\text{N}$ and ${}^{15}_7\text{N}$ are isotopes.

☐

The atomic number of hydrogen is 3.

☐

The atomic number of nitrogen is 7.

☐

The mass number of lithium is 4.

☐

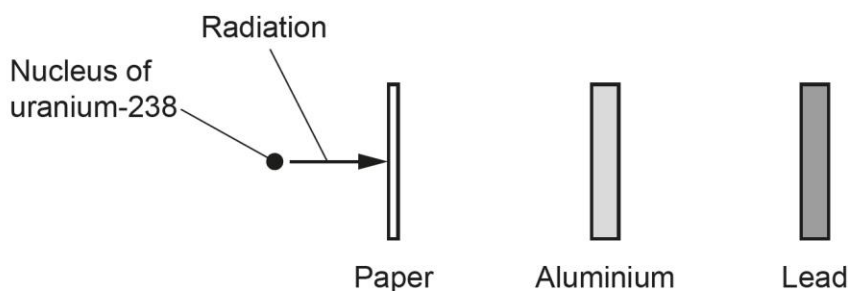
[3]

This was generally well answered with the majority of candidates scoring 2 marks but not always in the same way.

Question 11 (b)

(b) A nuclear scientist investigates the radiation emitted when a nucleus of uranium-238 decays.

The diagram shows the experiment.



Which type of radiation is emitted by uranium-238?

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

alpha particles

beta particles

gamma rays

[1]

The majority of candidates scored this mark but both incorrect options were seen regularly.

Question 11 (c)

(c) Thorium-234 decays by emitting beta radiation.

What happens to the mass number and charge of a nucleus of thorium-234 when it decays?

Draw **one** line from **each** quantity to what happens.

Quantity	What happens
Mass number	decreases by 4
	decreases by 1
	increases by 1
Charge	stays the same

[2]

It was very rare to find candidates scoring both marks. Charge increases by 1 was the most common mark awarded.

Drawing multiple lines

A small minority of the candidates drew one line from each of 'What happens' rather than from the 'Quantity' as instructed in the question.

Question 11 (d)

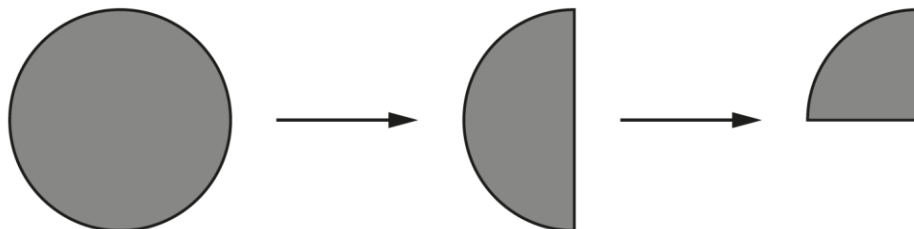
(d) Why do some atoms emit nuclear radiation?

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

Many candidates did not realise that all that was needed was the idea that it was 'unstable'. Many of the incorrect answers featured energy levels, electrons, charges or bonding between atoms. There were some correct answers that showed an understanding of the underlying physics that talked about 'too many neutrons/protons' leading to the nucleus being unstable.

Question 11 (e)

(e) The diagram shows how the amount of a radioactive element changes over a total of 30 days.



Calculate the half-life of this radioactive element.

Half-life = days [2]

It was uncommon for candidates to write down that the diagram showed 2 half-lives. The majority of candidates just wrote down the correct answer. The common incorrect answer was 7.5 (a quarter of 30).

Question 12 (a)

12 This question is about how electricity is generated.

(a) A student writes down advantages and disadvantages of wind turbines.

	Advantage		Disadvantage
A	do not need fuel	C	do not produce carbon dioxide
B	produce renewable energy	D	take up lots of land

The student has made **one** mistake.

State the **letter** of the statement that is in the wrong place.

Letter =

[1]

Most candidates answered this correctly. Option A was the most common incorrect answer.

Question 12 (b)

(b) The student writes down a list of renewable and non-renewable energy sources.

Renewable	Non-renewable
hydroelectric	coal
solar	wave

The student has made **one** mistake.

State the **name** of the energy source that is in the wrong place.

Name =

[1]

Most candidates answered this correctly. Solar and hydroelectric were the most common incorrect answers.

Question 12 (c)

- (c) It might not be possible to replace all non-renewable energy sources with renewable energy sources to generate **enough** electricity in the future.

Suggest **two** reasons why this might not be possible.

- 1
-
- 2
-

[2]

It was common for candidates to score for either the idea of weather dependent, unreliable or taking up too much land. Common mistakes were confusion between renewables and non-renewables, e.g. 'renewables may run out' and cost, 'too expensive to replace existing power stations'.

Assessment for learning



It was common to see candidates giving text in the stem of the question back as an answer, e.g. 'may not give enough electricity to power everything'. This scores 0 marks.

Candidates need to learn to spot this in their own answers while preparing for examinations.

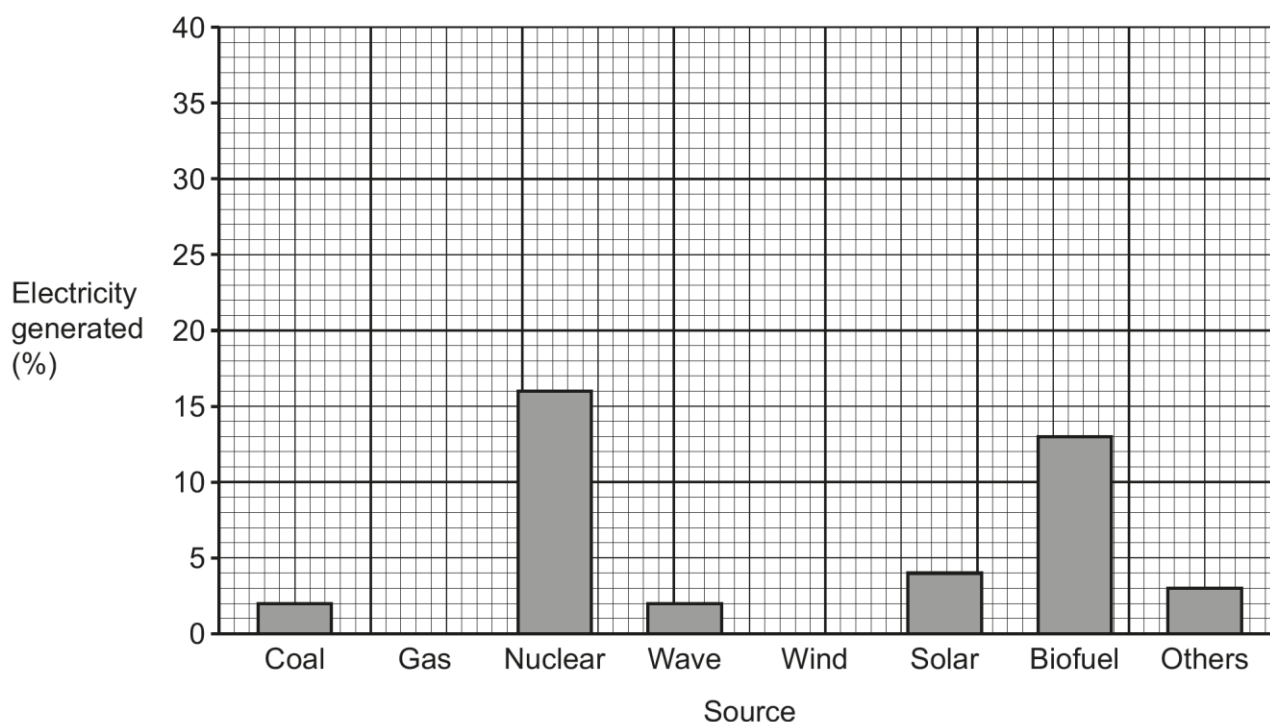
Question 12 (d) (i)

- (d) The table shows the percentages of electricity generated by different energy sources in the UK in 2020.

Source	Electricity generated (%)
Coal	2
Gas	36
Nuclear	16
Wave	2
Wind	24
Solar	4
Biofuels	13
Others	3

- (i) The student plots a bar chart using the data in the table.

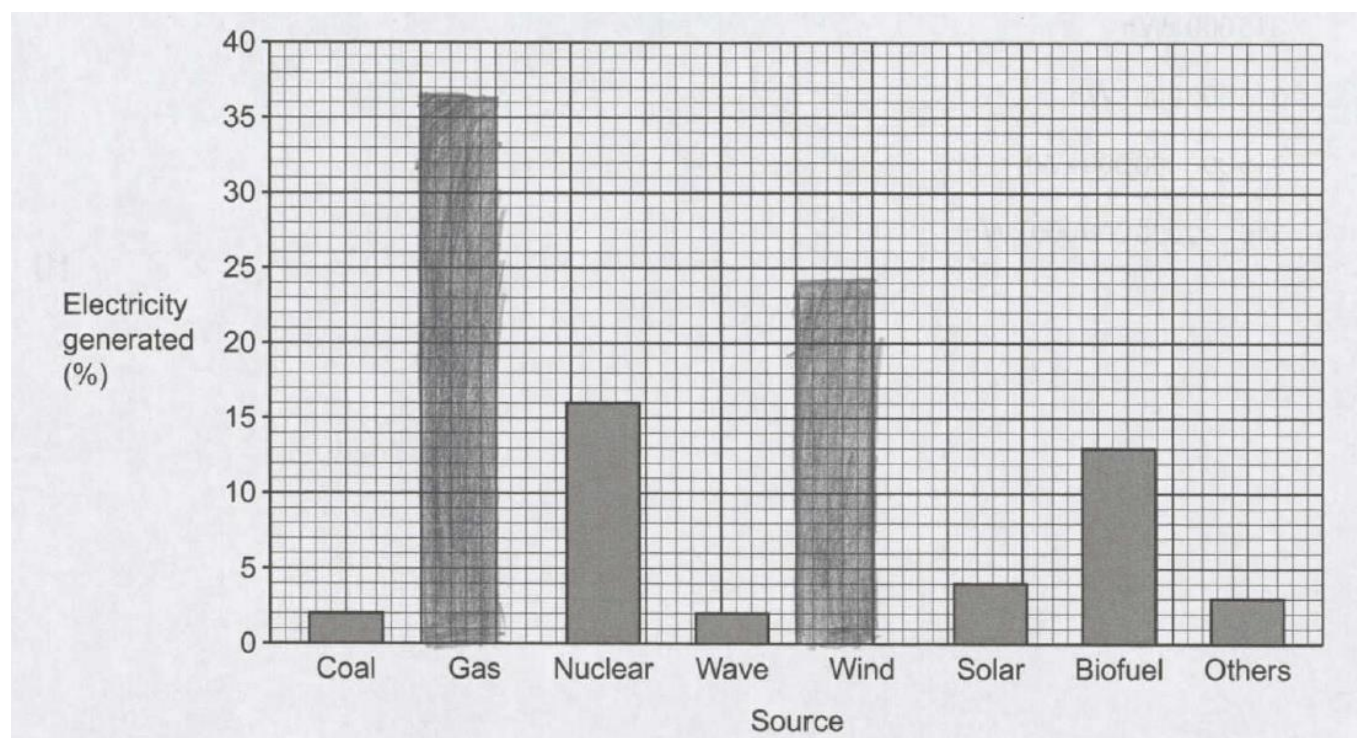
Draw a bar for gas and a bar for wind on the bar chart.



[2]

This was a very well answered question, with the majority of candidates using a ruler to draw the bars. Candidates only tended to lose marks by not drawing one or both of the bars or by drawing freehand, thereby going outside the tolerance as in the following exemplar.

Exemplar 1



The majority of the line at the top of the first column is more than the allowable half square from the 36 line so no mark awarded.

Question 12 (d) (ii)

(ii) The total electricity generated in the UK in 2020 was 315TWh.

Solar produced 4% of the total electricity generated.

Calculate the amount of electricity generated in TWh from solar.

Amount of electricity = TWh **[2]**

Most candidates wrote 12.6 on answer line for 2 marks.

A common error was just multiplying the numbers to get 1260.

Very rarely did candidates score the working mark. Generally $4\% \times 315$ was written down, but this does not explain how to calculate the % so scored 0 marks.

Question 12 (d) (iii)

(iii) The total electricity generated in the UK in 2020 was 315TWh.

1 TWh = 1 000 000 000 kWh

What is the total amount of electricity generated in kWh?

Tick (✓) **one** box.

315 000 kWh

☐

315 000 000 kWh

☐

315 000 000 000 kWh

☐

315 000 000 000 000 kWh

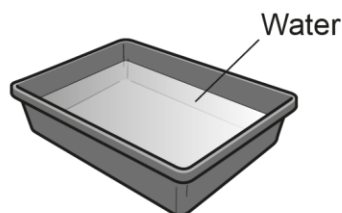
☐

[1]

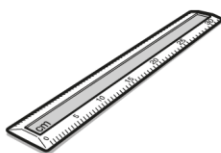
Most candidates answered this question correctly. The second box down was the most common incorrect answer.

Question 13*

13* A student investigates the speed of a water wave using this equipment.



Plastic tray



Ruler



Stopwatch

The student lifts one side of the plastic tray and drops it to make a wave.

Describe how the student can use this equipment to measure the speed of a water wave.

In your answer you should include:

- the measurements they should take
- the variables they need to keep constant
- any precautions they should take to obtain accurate and precise results.

.....

.....

.....

.....

.....

.....

..... [6]

There was a good range of answers to this Level of Response question with very few no responses. Some otherwise low scoring candidates managed to get Level 1 (2 marks) by clearly stating a correct measurement, a control or a precaution.

The most common mistake was attempting to use $v = \text{frequency} \times \text{wavelength}$ instead of $v = \text{distance} \div \text{time}$. This led to trying to 'measure the length of the wave' without a clear method to do so. It was also common for candidates to 'time until wave ran out/disappeared'.

'Keep the amount of water the same' was the most common way for gaining credit for the control variable. A lot of candidates said 'repeat' the experiment but omitted to say 'calculate the mean/look for anomalies'; in doing this, they did not fully address the 'precautions' bullet point of the guidance provided.

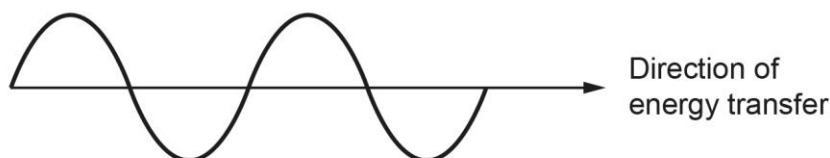
Question 14 (a)

14 This question is about electromagnetic waves.

(a) Electromagnetic waves are transverse waves.

Describe what a transverse wave is.

You can label the diagram of a transverse wave to help explain your answer.



[1]

Candidates found this recall question challenging, with very few correct answers seen. Many candidates labelled the diagram rather than giving the definition of a wave.

Question 14 (b)

(b) A radio wave has a frequency of 7 500 kHz and a wavelength of 40 m.

Calculate the speed of this radio wave.

Use the equation: wave speed = frequency \times wavelength

Give your answer in metres per second.

Speed =m/s [3]

Most candidates scored 2 out of the 3 available marks for 300,000, not converting the kHz to Hz before substituting into the equation.

Question 14 (c) (i)

(c) The table shows some different radio waves.

Type of radio wave	Frequency range (Hz)	Wavelength range (m)
HF	3 000 000–30 000 000	10–100
VHF	30 000 000–300 000 000	1–10
UHF	300 000 000–3 000 000 000	0.1–1
SHF	3 000 000 000–30 000 000 000	0.01–0.1

(i) What is the relationship between frequency range and wavelength?

Use the table.

.....
 [1]

A trend is required, but many candidates gave a statement comparing the ranges with the frequencies, e.g. 'The relationship is that they are both displayed in numbers' or 'Frequency are bigger numbers than wavelength'.

Question 14 (c) (ii)

(ii) Which type of radio wave has a frequency of 15 MHz **and** a wavelength of 20 m?

Tick (✓) **one** box.

HF	<input type="checkbox"/>
VHF	<input type="checkbox"/>
UHF	<input type="checkbox"/>
SHF	<input type="checkbox"/>

[1]

Most candidates scored this mark. VHF was a common incorrect answer.

Question 14 (c) (iii)

(iii) High frequency radio waves are similar to microwaves.

Suggest how high frequency radio waves can harm the human body.

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

Candidates seemed to find this question challenging, either mistaking radio waves with high volume sound or with ionising radiation (with most focusing on cancer). Those candidates who obtained the mark scored it for the idea of heating or burning skin.

Question 14 (c) (iv)

(iv) Complete the sentence about high frequency radio waves.

Put a ring around the correct option.

High frequency radio waves are **more** / **less** dangerous than microwaves.

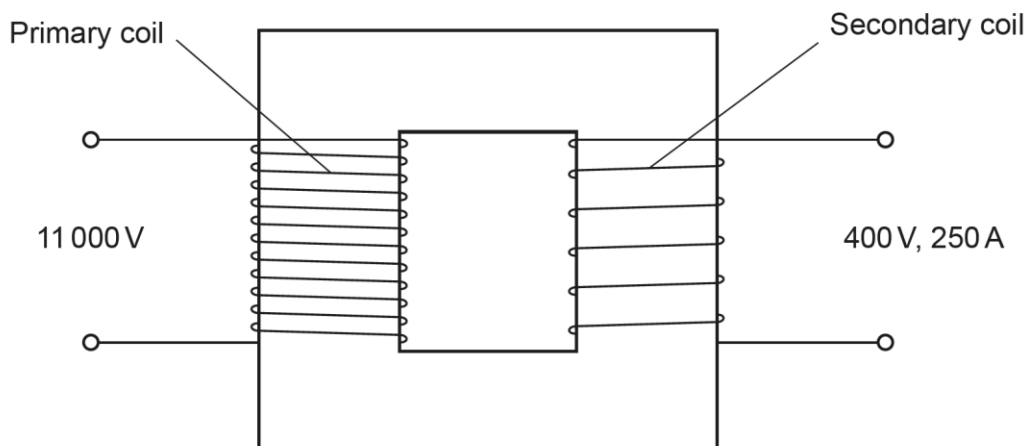
Suggest a reason for your answer.

Reason
..... [1]

The majority of candidates selected 'more' and thus did not score this mark. Many candidates were confused by the idea that high frequency radio waves had lower frequency than microwaves. For those who chose 'less' it was still common to see 'could cause cancer'.

Question 15 (a)

15 This is a diagram of a transformer.




(a) Calculate the power output from the secondary coil.

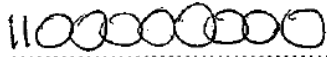
Use the equation: power = potential difference \times current

Power output = W [2]

Many candidates were confused by the 11 000 V and tried to incorporate it into their calculation, demonstrating a misunderstanding of the equation they were given, as shown in the exemplars below.

Exemplar 2


 400×250
 $= 100000$
 100000×11000

Power output =  W [2]

The candidate has multiplied the correct values, but then lost the answer mark by trying to incorporate the 11000 V. They got the 'working' mark for showing 400×250 .

Exemplar 3

$$11000 \div 400 = 10600$$
$$10600 \times 250$$

Power output =2650000..... W [2]

This was seen very often. The candidate here subtracted the voltages given before multiplication and scored 0 marks.

Question 15 (b) (i)

(b)

(i) Name the type of transformer shown in the diagram.

..... [1]

Candidates seemed to find this recall question challenging, with many seeming to guess, while others opted for step-up, not noticing the smaller voltage and fewer coils on the secondary coil.

Question 15 (b) (ii)

(ii) Where can this type of transformer be used in the national grid?

Tick (✓) **one** box.

Between the power lines and homes

☐

Between the power station and power lines

☐

In a phone charger

☐

In the power station

☐

[1]

Many of the candidates who couldn't name the transformer in the previous part scored this mark.

Question 15 (c)

(c) The energy input to the primary coil is 200 kJ.

The energy output from the secondary coil is 180 kJ.

Calculate the efficiency of the transformer.

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

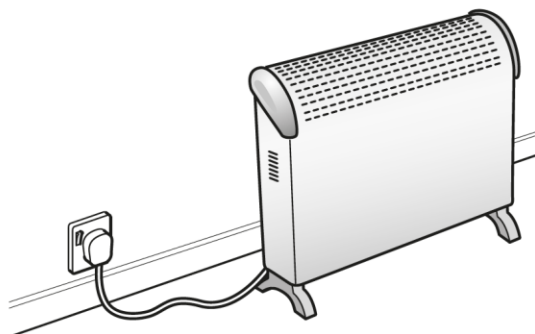
Efficiency = [2]

This was a very well answered question. A few candidates added the percentage sign without converting their answer into a percentage, or wrote the percentage without the percent sign. Responses of 0.9 or 90% were correct; 0.9% and 90 were given 1 mark.

Question 16 (a)

16 Fig. 16.1 shows a heater plugged into an electrical socket.

Fig. 16.1



(a) The heater is operating normally.

What are the names of the two wires in the plug that carry a current?

Tick (✓) **one** box.

Earth and fuse

☐

Earth and neutral

☐

Live and fuse

☐

Live and neutral

☐

[1]

Most candidates answered this correctly. The most common incorrect answer was 'Live and fuse'.

Question 16 (b)

(b) A live wire is accidentally connected to the earth wire in the house. This causes a large current to flow in the earth wire.

This can cause electrocution.

Suggest **another** reason why this is dangerous.

.....

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

Many candidates scored the mark for the idea of causing fire, melting wires or sparks. Common mistakes were just repeating the question stem about large current and electrocution, or suggesting an explosion would occur.

Question 16 (c)

(c) A 2.4 kW heater is used for 2.5 hours each day for 1 week.

Calculate the energy transferred in kWh by the heater in 1 week.

Use the equation: energy transferred = power \times time

Energy transferred in 1 week = kWh [2]

This was answered well, with most candidates managing to multiply by 7 days as well. Among those candidates who didn't multiply by 7, many scored 1 mark for showing $2.4 \times 2.5 = 6$. An answer of 6 without working scored 0 marks, highlighting the general benefit of always showing working.

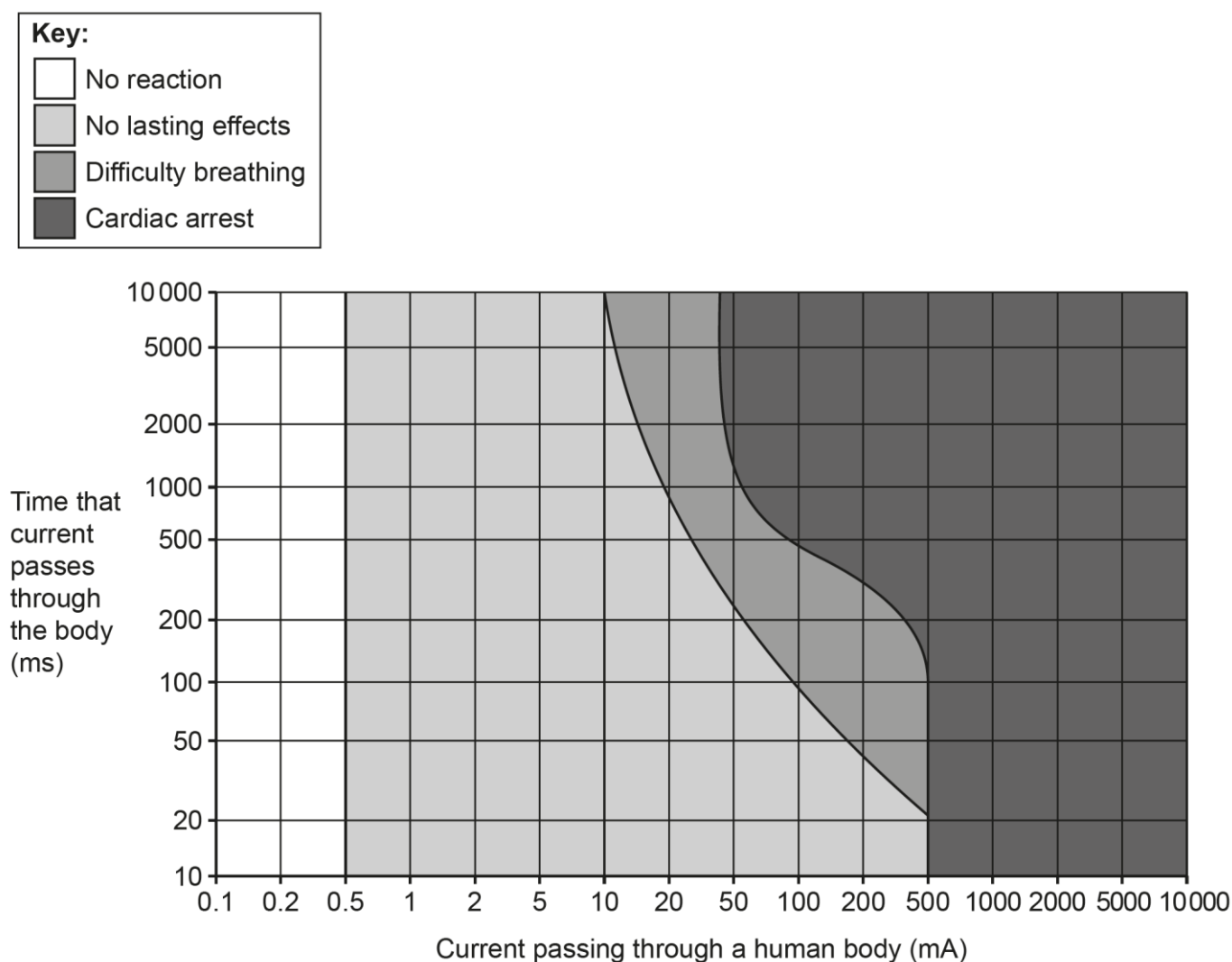
Question 16 (d) (i)

(d) A residual current device (RCD) is a safety feature found in homes.

The RCD turns off the electricity quickly if it detects a fault due to a difference between the current in the live wire and the current in the neutral wire.

Fig. 16.2 shows the effects that mains current has on a human body.

Fig. 16.2



(i) Describe **one** trend shown by Fig. 16.2.

.....

..... [1]

This was similar to the wavelength/frequency question (Question 14 (c) (i)). Candidates found writing a trend difficult. Where the mark was not given, the response sometimes did not include a trend, for example, 'As long as no more than 0.5 mA passes through the body, there will be no reaction' is an oversimplified description that doesn't include a trend. In other responses, candidates linked time and current together, instead of the linking either factor to the severity of the effect, e.g. 'the higher the current, the longer it passes through the body'.

Question 16 (d) (ii)

- (ii) A current of 10 mA is passing through a human body.

How long can the current pass through the body before the person has difficulty breathing?

..... [1]

Most candidates answered this correctly. Marks were sometimes lost for giving a wrong unit, e.g. m/s. Candidates should be aware that m/s and ms are distinct units.

Question 16 (d) (iii)

- (iii) Calculate the charge flowing when 150 mA is in the human body for 0.3 s.

Use the equation: charge flow = current \times time

Charge flow = C [3]

Most candidates scored 2 marks; the majority did not attempt (or remember) the conversion from mA to A.

Question 16 (d) (iv)

- (iv) Sensitive RCDs are designed to shut off the electricity supply within 40 ms.

Suggest why this is an important feature for currents below 200 mA. Use **Fig. 16.2**.

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

Prevent difficulty breathing was the common mark obtained. Lower scoring candidates struggled with the language skills needed to express their answers here and even though in some cases we could see what they were alluding to, they were not clear enough to gain the mark.

Question 16 (d) (v)

(v) An electrician has a choice of two different RCDs, **A** and **B**, to use in a house.

	RCD A	RCD B
Minimum difference in current needed between the live wire and neutral wire before electricity turns off (mA)	10	30
Time taken to turn off electricity (ms)	100	40

Suggest which RCD the electrician should use in the house.

Give **two** reasons. Use **Fig. 16.2**.

1

.....

2

.....

[2]

The most common correct answer was to choose RCD B and get 1 mark for ‘shuts off quicker’ with some others obtaining a mark for choosing A and ‘less current’. Many candidates had an issue giving comparative answers. All but the most high scoring candidates struggled to gain the fourth marking point, not expressing ‘Will not keep shutting off supply accidentally’ with sufficient clarity to gain the mark.

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