

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/03 Summer 2022 series

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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.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our [website](#).

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Paper 3 series overview

J260/03 is the written examination component for the physics content of the 21st Century Combined Science B GCSE. It is the Foundation Tier examination for knowledge and understanding of chapters P1-P6 and includes some ideas about Science and Practical Skills.

Candidates generally performed well on simple calculations (e.g. 1d, 2b, 3a, 3c, 5a, 5b and 7c and 8c). However many candidates were unable to deal with the units and unit conversions required by some calculations (e.g. 5a, 6c and 7c). Where candidates did not show the method of calculation, including equations, marks were frequently lost (see Q2b as an example of how this can happen).

While there were some very good responses to questions that asked for definitions or examples of the meaning of scientific words (e.g. 1a, 1bi, 1c and 11c), however most candidates performed very poorly. These types of questions are common on a Foundation Tier paper and practice at writing definitions or meanings would clearly benefit many candidates.

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

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
<ul style="list-style-type: none"> • were able to answer use data from various sources to answer questions • demonstrated a clear understanding of command words, e.g. describe, explain and discuss 	<ul style="list-style-type: none"> • misread the question • wrote generic answers without sufficient detail • did not include method or equation in calculations

Question 1 (a)

1 Some waves are transverse waves and some are longitudinal waves.

(a) Which of these waves are **longitudinal** waves?

Put a ring around the correct option.

Microwaves

Ripples on water

Sound waves

X-rays

[1]

Ripples on water and microwaves were common incorrect responses.

Question 1 (b) (i)

(b) (i) Complete the sentences about electromagnetic waves.

Put a ring around each correct option.

An example of an electromagnetic wave is **electricity / light / sound**.

Electromagnetic waves are emitted by all objects and the wavelengths emitted depend on the **mass / size / temperature** of the object.

[2]

Examples of an electromagnetic wave is electricity and wavelength depend on the mass/size were common incorrect responses.

Question 1(b) (ii)

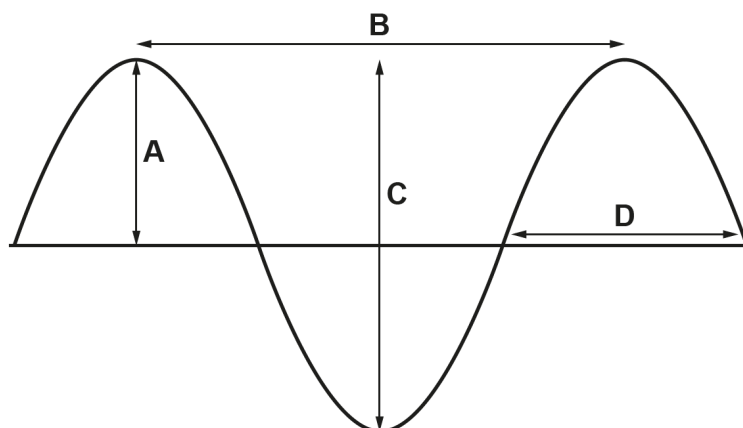
(ii) Give one **other** example of an electromagnetic wave.

..... [1]

Only about 50% of candidates answered this correctly. Phone and oven were some of the common incorrect responses.

Question 1 (c) (i)

(c) The diagram shows a wave on a rope with measurements labelled **A**, **B**, **C** and **D**.



(i) Which letter **A**, **B**, **C**, or **D** is the **wavelength** of the wave? [1]

This was answered well by most candidates

Question 1 (c) (ii)

(ii) Which letter **A**, **B**, **C**, or **D** is the **amplitude** of the wave? [1]

Misconception



A common misconception was that amplitude was from the top of a crest to the bottom of a trough resulting in an incorrect response of C rather than the correct A

Question 1 (d)

(d) A sound wave from a violin has a frequency of 196 Hz and wavelength of 1.75 m in the air.

Calculate the speed of the sound wave in air.

Use the equation: wave speed = frequency \times wavelength

Wave speed = m/s [2]

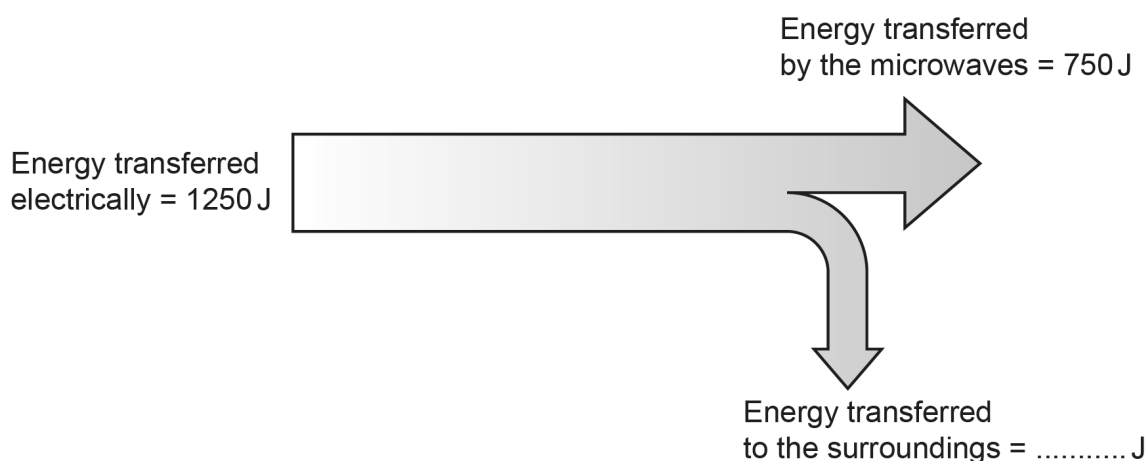
Almost all students used wave speed equation correctly.

Question 2 (a)

2 Jamal uses a microwave oven.



The diagram shows the energy transfers taking place inside the microwave oven when it is used.



(a) Complete the diagram to show the energy transferred to the surroundings.

[1]

Most candidates scored this mark

Question 2 (b)

(b) Calculate the efficiency of the microwave oven.

Use the equation: $\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy transferred}}$

Give your answer as a percentage.

Efficiency = % [3]

Assessment for learning



This question illustrates the need for candidates to show their working in calculations. If a candidate writes just the answer as 0.6 or 6 they will gain no marks. However if they include the calculation, they will almost certainly have gained the first 2 marking points.

Exemplar 1

Give your answer as a percentage.

$$750 + 500 = 1250$$

efficiency = ~~1250~~

$$\frac{750}{1250} = 0.6$$

Efficiency = ~~0.6~~ 6 % [3]

Most candidates were able to calculate the efficiency of the microwave oven correctly but often did not show their working as shown in this response.

Question 2 (c)

- (c) Jamal cannot switch the microwave oven on unless the door is closed.
This is because the microwaves can damage body cells.

Why do microwaves damage body cells?

Tick (✓) **one** box.

They are electromagnetic radiation.

☐

They are ionising radiation.

☐

They cause electric currents in the body.

☐

They transfer energy to cells heating them up.

☐

[1]

They are EM waves and they are ionising radiation were the most common incorrect responses.

Question 3 (a)

- 3 This diagram shows a greyhound accelerating at the start of a race.



- (a) A greyhound has a mass of 30 kg and accelerates at 6.3 m/s^2 .

Calculate the force the greyhound uses to accelerate.

Use the Data Sheet.

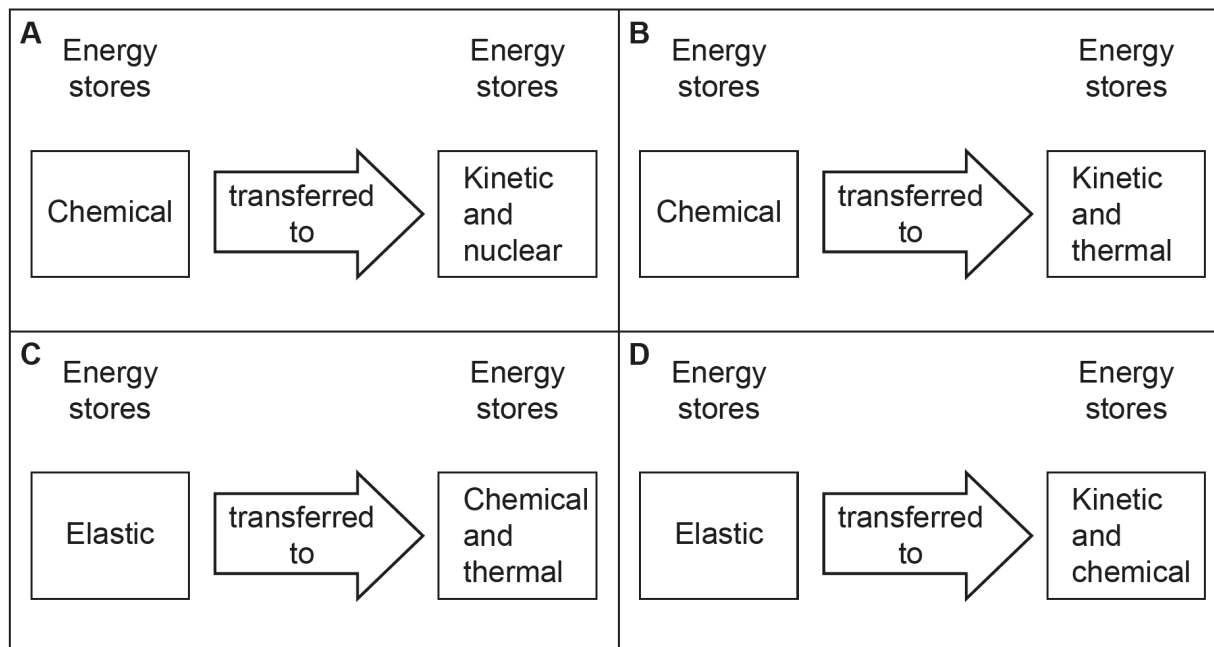
Force = N [3]

This was calculated correctly by most candidates. If not, in many cases they squared the acceleration and got the incorrect answer.

Question 3 (b)

(b) The force to accelerate the stationary greyhound is provided by its muscles.

Which diagram describes the transfer between energy stores when the greyhound does work to accelerate?



Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

Candidates were often confused by this question. D was a common error.

Question 3 (c)

- (c) The greyhound runs for 540 m in 30 s.

Calculate the average speed of the greyhound.

Use the Data Sheet.

Average speed = m/s [3]

This question was answered well, with a few candidates incorrectly using speed = distance x time.

Question 4 (a)

- 4 The scientific model of matter states that elements are made of atoms.

- (a) Complete the sentences to describe the nucleus of an atom.

Put a ring around each correct option.

All atoms have a positively charged nucleus because the nucleus contains

electrons / neutrons / protons.

The diameter of the nucleus is approximately 10^{-5} m / 10^{-15} m / 10^{-100} m .

[2]

The most common correct answer was protons; however few knew the diameter of the nucleus was 10^{-15} m

Question 4 (b)

(b) The scientific model of the atom has changed over time.

Draw lines, to connect the scientist to the description of the model they developed and the order in which it was developed.

Scientist	Description of model	Order
Thomson	The atom contains small negative particles. They are spread through the positive atom.	The first model of the atom.
Dalton	Atoms are small solid particles. Every atom of an element is the same.	The second model of the atom.
Rutherford	Most of the mass of the atom is concentrated in the centre of the atom. Very small particles orbit the mass at the centre.	The third model of the atom.

[4]

Most of the candidates wrongly connected the scientist to the description of the model they developed however they got the order in which the models were developed correct.

Question 4 (c)

(c) Describe how Bohr's model of the atom is different to Rutherford's model of the atom.

.....

.....

.....

..... [2]

This was very rarely answered correctly as there was little awareness of Bohr's model and many thought Rutherford's model was the final model.

Question 4 (d)

(d) Which statements about atoms and electromagnetic radiation are **true** and which are **false**?

Tick (✓) one box in each row.

	True	False
Infrared radiation is emitted from the nuclei of atoms.	<input type="checkbox"/>	<input type="checkbox"/>
Visible light is generated when electrons in atoms lose energy.	<input type="checkbox"/>	<input type="checkbox"/>
X-rays have enough energy to ionise some atoms.	<input type="checkbox"/>	<input type="checkbox"/>
Radio waves are absorbed by oxygen in the atmosphere to produce ozone.	<input type="checkbox"/>	<input type="checkbox"/>

[3]

Most students gained 1 or 2 mark(s).

Generally, candidates got the true statements correct:

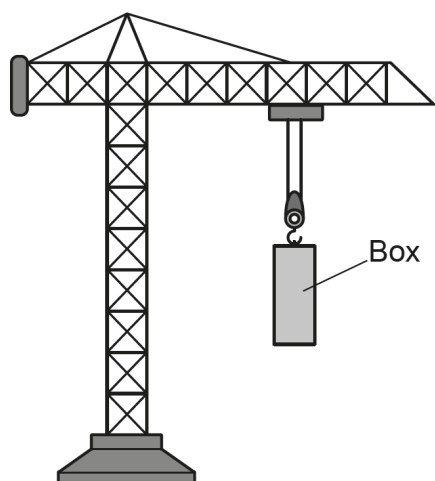
- visible light is generated when electrons in atom lose energy
- X-rays have enough energy to ionise some atoms.

But got the false statement wrong:

- infrared radiation is emitted from the nuclei of atoms
- Radio waves are absorbed by oxygen in the atmosphere to produce ozone.

Question 5 (a)

- 5 Kai has a model crane that is powered by a battery. The model crane is used to lift a box.



- (a) A constant current of 1.1 A flows through the battery when the crane is switched on.

Calculate the charge that flows through the battery in 2 minutes.

Use the equation: charge = current \times time

Charge = C [3]

This calculation was generally done well. However many candidates forgot to change the units from minutes to seconds and only scored 2 marks.

Question 5 (b) (i)

(b) Kai uses the crane to lift the box of 0.25 kg from the floor to a height of 0.84 m.

(i) Calculate the gravitational potential energy gained by the box.

Use the equation:

gravitational potential energy = mass \times gravitational field strength \times height

Gravitational field strength = 10 N/kg

Gravitational potential energy = J [2]

This calculation was performed correctly by the vast majority of candidates.

Question 5 (b) (ii)

(ii) The box is then dropped and falls back down to the floor.

How much kinetic energy does the box have just before it hits the floor?

Kinetic energy = J [1]

Misconception

It was common for candidates to attempt a kinetic energy calculation here and get an incorrect answer. Candidates should be aware that when an object falls, the decrease in gravitational potential energy will be equal to the increase in the kinetic energy (assuming air resistance is negligible).

Question 6 (a)

6 Layla drives her car.

- (a) The speed of the car increases from 22 m/s to 28 m/s in 3 s.
Use the Data Sheet.
Calculate the acceleration of the car.

Acceleration m/s² [3]

Generally answered correctly. A few candidates successfully selected the acceleration formula (acceleration = change in speed ÷ time taken) but substituted wrongly, they were mostly confused about the change in speed.

Question 6 (b)

- (b) Complete the sentences to describe how energy is transferred as the car changes speed.

Use words from the list.

chemical	elastic	gravitational	kinetic	nuclear	thermal
----------	---------	---------------	---------	---------	---------

The car increases its speed when energy is transferred from the fuel's store, to the car's store. Some energy from the fuel will be wasted when energy is transferred to the store of the car and its surroundings.

When the car brakes, energy is transferred from the car's store to the store of the brakes, raising their temperature.

[5]

Candidates seemed unsure about the energy stores. Many got the initial **chemical** correct but fewer identified the car's **kinetic store**. That **thermal** energy was the last place to store energy was recognised by many. Common errors were using **nuclear** and **gravitational** anywhere.

Question 6 (c)

(c) Layla travels on the motorway at a speed of 108 km/h.

Which is the correct method to calculate the speed in metres per second (m/s)?

Put a ring around the correct option.

$$\frac{108 \times 1000}{60 \times 60}$$

$$\frac{108 \times 60 \times 60}{1000}$$

$$\frac{108 \times 1000}{60}$$

$$\frac{1000 \times 60 \times 60}{108}$$

[1]

The third option was the most common incorrect answer, with candidates forgetting that there are 60 x 60 seconds in an hour

Question 6 (d)

Layla applies the brakes to stop the car.

The braking distance is the distance the car travels before it stops.

(d) Give **two** factors that affect the braking distance.

1

2

[2]

Answers involved many ideas about factors affecting the braking distance. Some of the common misconceptions:

- How much pressure/force is applied to the brake
- Braking faster/slower
- Time taken to react
- The gravitational force / field
- Weather conditions without specific example (e.g. snow/ice/rain)
- Road surface condition without specific examples (e.g. wet/mud/oil)

Question 6 (e)

- (e) Layla makes an emergency stop. The braking force is 17 000 N and the car travels 75 m before it stops.

Calculate the work done by the brakes.

Use the equation: work done = force \times distance

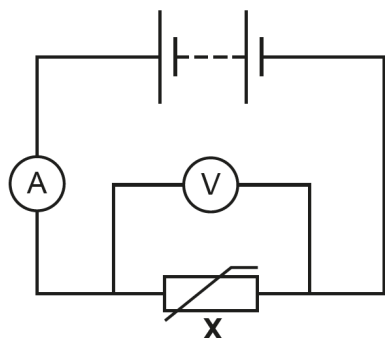
Give your answer to **2** significant figures.

Work done = J [3]

Most candidates correctly did the calculation to get 1 275 000. However far fewer could give this to 2 significant figures 1 300 000.

Question 7 (a)

7 Beth makes the circuit shown in the diagram using component **X**.



(a) What is component **X**?

Tick (✓) **one** box.

Diode

☐

Light dependent resistor

☐

Thermistor

☐

Variable resistor

☐

[1]

Few candidates were familiar the circuit symbols.

Question 7 (b)

(b) Suggest how Beth can change the circuit so that the potential difference across component **X** can be varied.

.....

..... [1]

Very few candidates were familiar with simple electric circuits. Examples of incorrect answers are:

- swamp the position of ammeter and voltmeter
- add a light bulb/battery/ammeter/voltmeter

Question 7 (c)

(c) Beth changes her circuit and records the results shown in the table.

Potential difference (V)	Current (A)
0.10	0.01
0.30	0.03
0.50	0.05
0.67	0.07
0.81	0.09
0.89	0.10

Calculate the resistance of component **X** when the current passing through it is 0.09A.

Use the table and the equation: resistance = potential difference ÷ current

State the unit.

Resistance = Unit = [4]

Candidates could often correctly calculate the resistance, but only a few could give the correct unit, common errors, where A, V, J, W and R

Question 8 (a)

8 Ben is a food scientist. He melts some solid chocolate.

(a) Describe what happens to the particles in the chocolate when it melts.

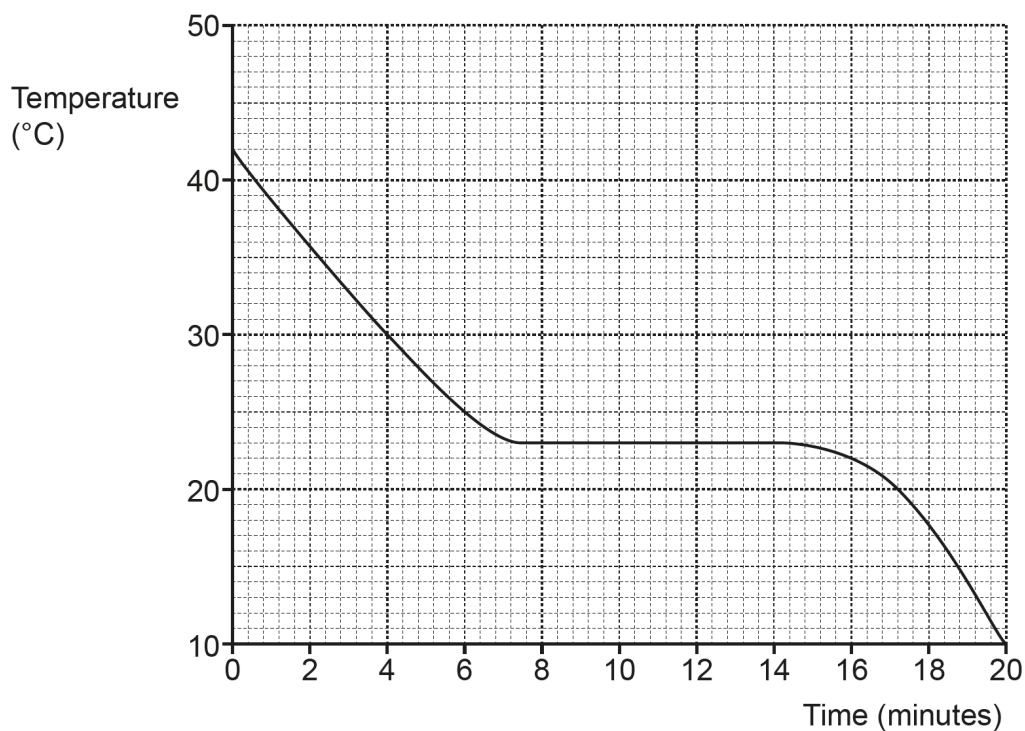
.....
 [1]

Few candidates answered this in terms of the change in motion of particles. Many gave ideas about change of state, particles vibrating more and particles moving far apart.

Question 8 (b) (i)

(b) Ben places the chocolate in a fridge.

The graph shows how the temperature of the chocolate changes as it cools.



(i) What happens to the chocolate at 23°C?

..... [1]

Some candidates misread the question; it stated that 'the graph shows how the temperature of the chocolate changes as it cools' (it is clearly a cooling curve). Some common incorrect answers were:

- Starts to melt / melting
- temperature stays the same
- stay in the same state

Question 8 (b) (ii)

(ii) What is the change in temperature over the first 4 minutes?

Change in temperature = °C [2]

This was well answered by most candidates. The most common errors involved reading the temperature at time zero.

Question 8 (c)

(c) The mass of the chocolate is 0.15 kg.

The specific heat capacity of chocolate is 1600 J/kg °C.

Calculate the change in the internal energy of the chocolate in the first 4 minutes.

Use the equation:

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

Use your answer to **(b)(ii)**.

Change in internal energy = J [2]

This was answered well by most candidates. Answers based on the candidate's response to Question 8(b)(ii) were given full marks.

Question 9 (a)

9 A radioactive source emits ionising radiation.

Kareem uses the equipment shown in **Fig. 9.1** to investigate how different absorbing materials affect the amount of radiation received by a radiation detector.

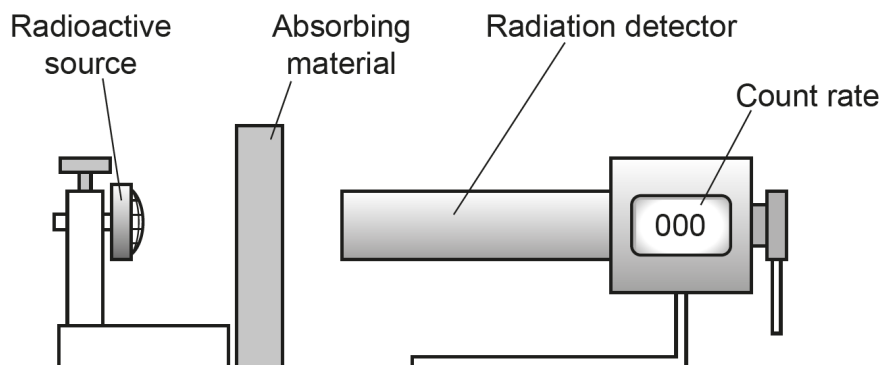


Fig. 9.1

This is the method:

- measure the count rate with no absorbing material
- measure the count rate with different absorbing materials placed between the source and the radiation detector.

He plots his results on the bar chart in **Fig. 9.2**.

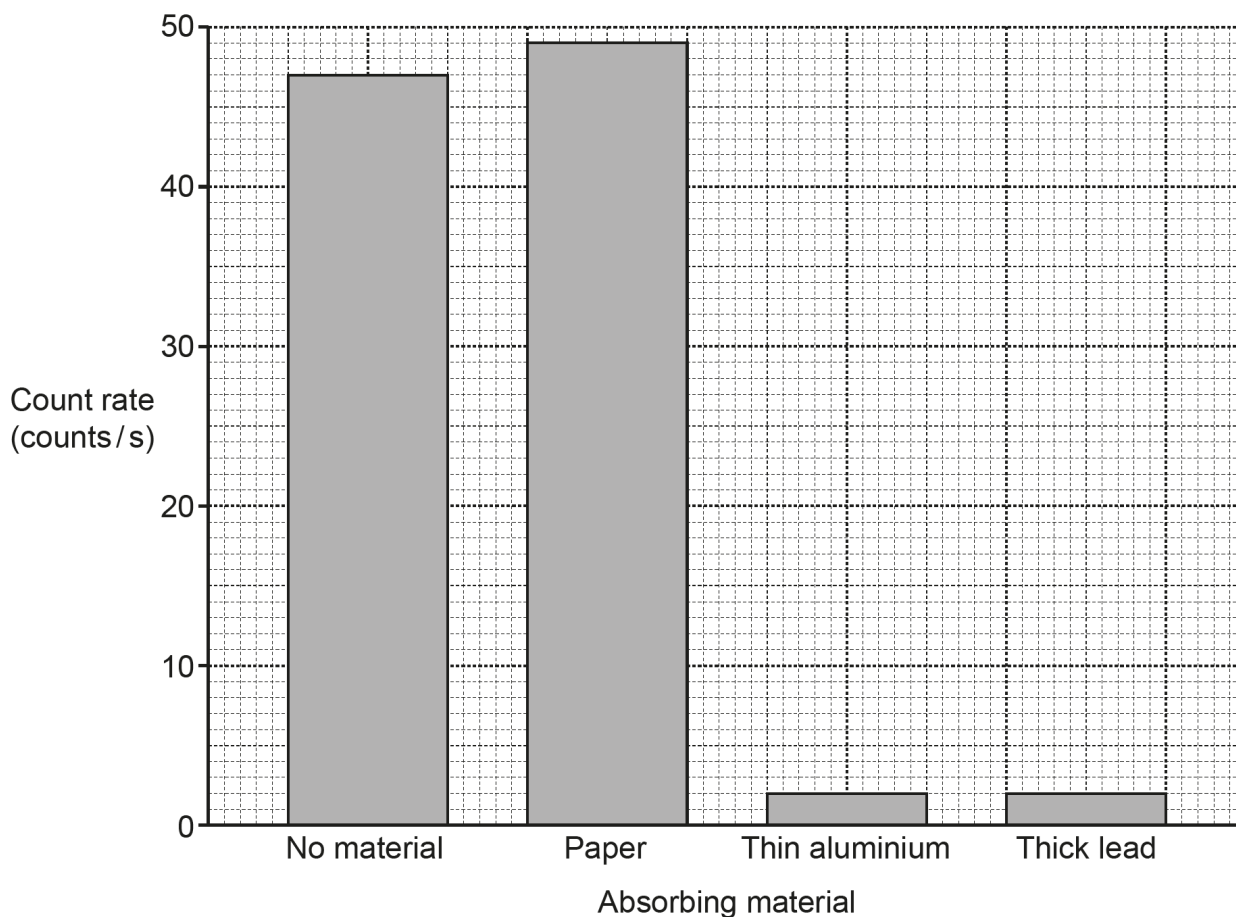
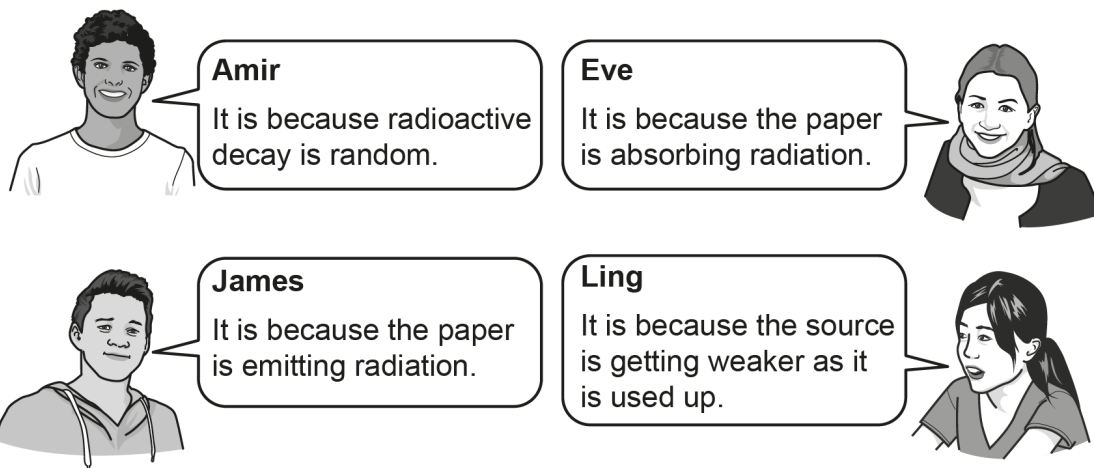


Fig. 9.2

- (a) When paper is placed between the radioactive source and the radiation detector the count rate is higher than when no material is used.

Some students try to explain this difference.



Which student's explanation is correct?

..... [1]

Very few candidates realise that radioactive decay is random in nature. Students should know that radioactive decay is random and spontaneous. Most common errors Eve and James.

Question 9 (b)

(b) The table shows if the materials absorb alpha, beta or gamma radiation.

Absorbing material	Radiation absorbed		
	Alpha	Beta	Gamma
Paper	✓		
Thin aluminium	✓	✓	
Thick lead	✓	✓	✓

Suggest which type, or types of radiation the source emits.

Use the table and **Fig. 9.2** to explain your answer.

.....

.....

.....

.....

.....

..... [3]

Candidates demonstrated much confusion about interpreting the table and graph correctly. Many students merely described the absorption of alpha/beta/gamma particles which were provided on the table.

Question 9 (c)

(c) Carbon-14 is a radioactive source that can be used to find the age of some objects.

Fig. 9.3 shows the percentage of carbon-14 remaining in a sample, over time.

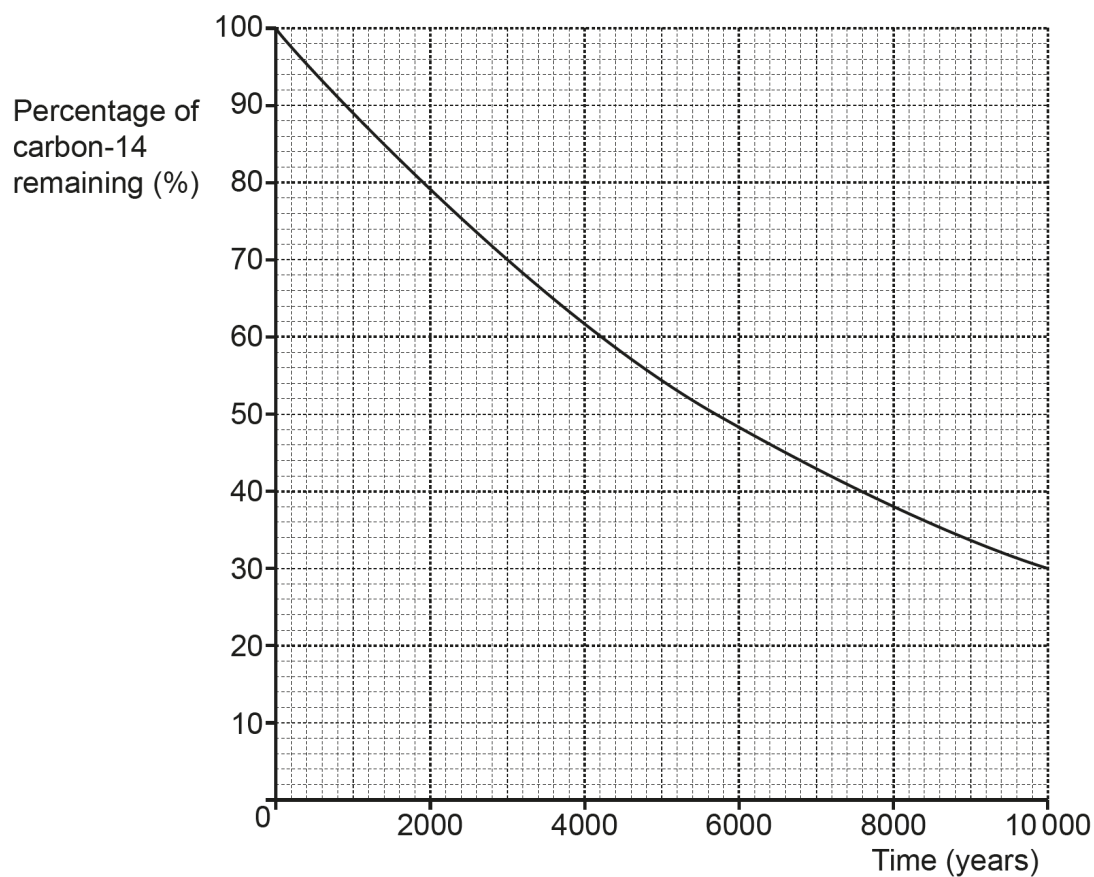


Fig. 9.3

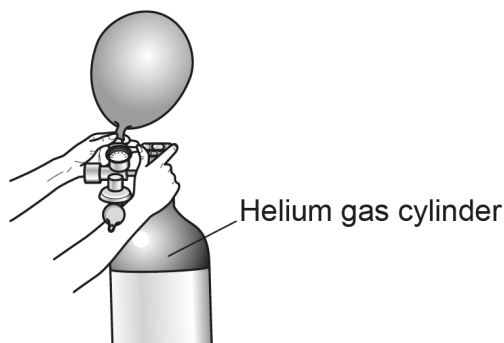
Use **Fig. 9.3** to find the half-life of carbon-14.

Half-life = years [1]

Most candidates had the right idea here, but many did not read the scales on the graph carefully.

Question 10 (a)

10 Helium gas cylinders are used to fill helium balloons with gas.



The table shows the density and states of some materials at room temperature.

Material	Density (kg/m^3)	Solid	Liquid	Gas
Helium	about 0.1			✓
Hydrogen	about 0.1			✓
Alcohol	about 1000		✓	
Cooking oil	about 1000		✓	
Copper	about 10 000	✓		
Iron	about 10 000	✓		

(a) Compare the density of the materials in the table.

Use ideas about states of matter and data from the table in your answer.

.....

.....

.....

..... [2]

Generally well answered, however, some candidates misread the question. In some cases, detailed answer for 10(a) appeared in 10(b) rather than in 10(a) and lost mark for both as (a) was comparing the densities and (b) was explaining the difference.

Question 10 (b)

- (b) Explain the differences between the densities of solids, liquids and gases.

Use ideas about particles in your answer.

.....

.....

.....

.....

.....

..... [3]

Some candidates described the motion of particles rather than distance between the particles. The description of solid particles was usually correct (tightly packed/compact/grouped together) but liquid and gas particles were described in term of motion (example, gas particles moving freely). Not enough mention of particles in liquid are further apart than in solid and particles in gases are further apart than in liquids or solids.

Question 10 (c)

- (c) On a hot day the temperature of the gas in the helium gas cylinder increases, but the volume of the cylinder does not change.

Complete the table to show what happens to the helium gas.

Tick (✓) one box in each row.

	Decreases	Increases	Stays the same
Mass of the helium gas			
Pressure of the helium gas			
Average speed of the helium gas particles			

[3]

Most of the candidates got the pressure correct, but they were confused about mass and average speed.

Question 11 (a)

11 (a) Which of these statements about the domestic electricity supply in the UK is true?

Tick (✓) **one** box.

The domestic electricity supply in the UK is d.c.

☐

The energy transferred = current \times potential difference.

☐

The frequency of the supply is 230 Hz.

☐

Transmitting power at higher voltages is more efficient.

☐

[1]

The frequency of the supply is 230Hz proved a very strong distractor here. Probably because the candidates did not look at the units and read it as 230V.

Question 11 (b)

(b) Sundip installs panels made of material with low thermal conductivity to the walls of a house.

Describe how this will help to keep the house warm when it is cold outside.

.....

..... [1]

Very few candidates gave any indication that it was the rate of flow of energy that alters. Most common incorrect response was 'walls trapped heat.'

Question 11 (c)

(c) Sundip buys electricity from a company that uses energy from renewable energy resources.

What is the difference between a renewable and non-renewable energy resource?

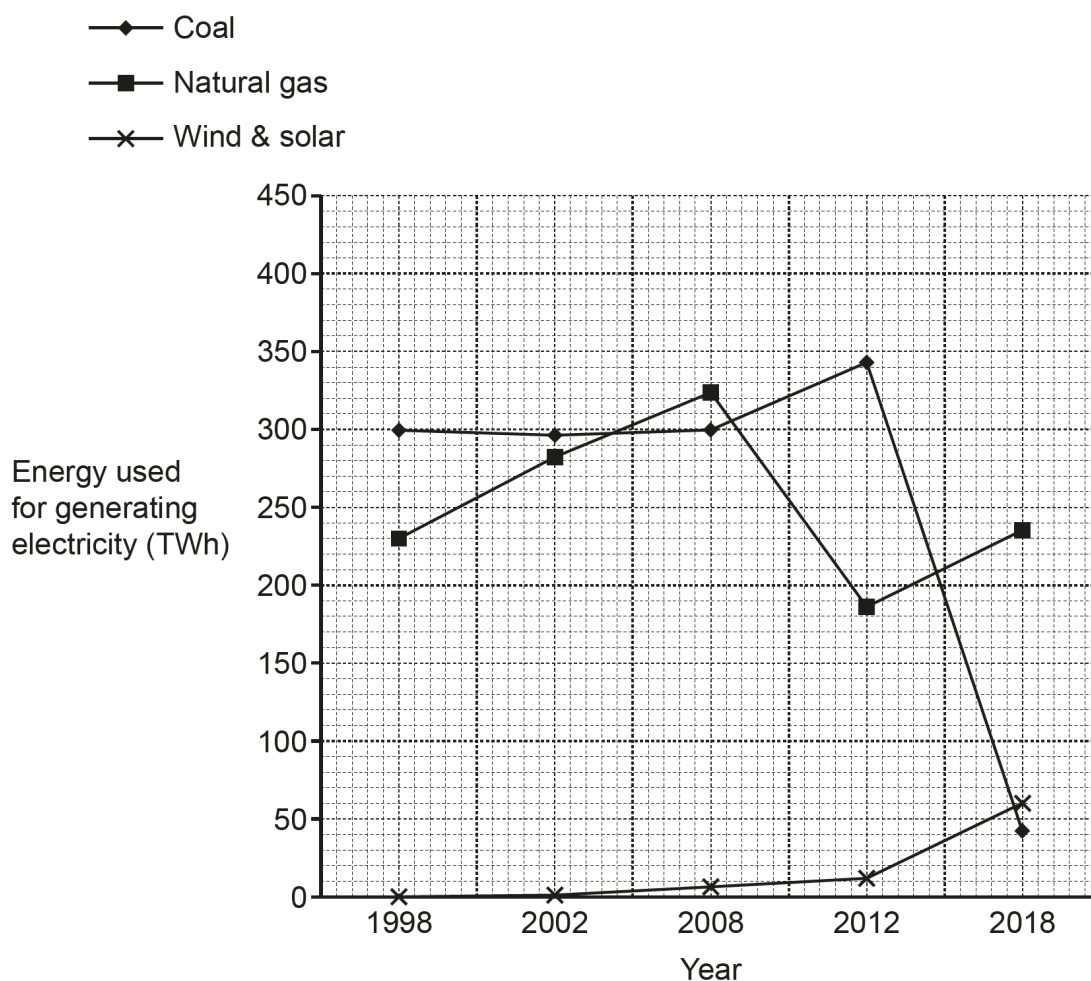
.....

..... [1]

This should be straightforward for candidates however less than 50% of candidates answered it correctly. By far the most common error was to suggest renewable energy could be re-used, which is simply not true.

Question 11 (d)*

(d)* The graph shows how some energy resources were used to generate electricity in the UK over 20 years.



Explain how the use of these **three** energy resources changed between 1998 and 2018.

.....

.....

.....

.....

.....

.....

.....

[6]

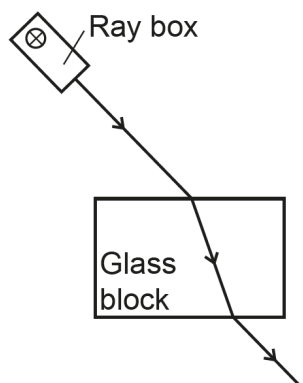
Exemplar 2

The use of coal stayed constant from 1998 to 2008 however it then increased by 50 TWh ^{more} ~~and~~ until 2012 and decreased very quickly by 2018 with only 50 TWh. Natural gas ~~been~~ ~~gained~~ ~~to~~ increase until 2008 but then decreased by 150 TWh and increased again until 2018 by 50 TWh. Lastly wind and solar ~~at~~ began ~~at~~ with 0 usage of energy and ~~it~~ increased by ~~at~~ 60 ~~TWh~~ by 2018.

Very few candidates had read the question carefully, with the majority just describing the changes shown in the graph. No matter how detailed and accurate the description it cannot progress beyond Level 1 without some attempt at explanation as shown in this response.

Question 12 (a)

- 12 Alex is investigating the refraction of light in a rectangular glass block, using the equipment shown in the diagram.



- (a) This is Alex's method.
The sentences are **not** in the correct order.

- A. Repeat the experiment for different angles of incidence.
- B. Shine a ray of light into the block.
- C. Place the glass block on some paper.
- D. Measure the angle of incidence and angle of refraction.
- E. Mark the path of the rays on the paper with a pencil.
- F. Draw a line to show the path of the ray inside the glass block.
- G. Remove the glass block and ray box.

Write the letters in the boxes to show the correct order of the method.

The first one has been done for you.

C						
---	--	--	--	--	--	--

[3]

Most candidates gained 1 or 2 mark(s) for showing the correct order of method. 'Removing the glass block and ray box' came before 'draw a line to show the path of the ray inside the glass block' were the most often confused; G/F, not the other way around.

Question 12 (b)

- (b) Suggest **two** ways in which Alex could improve his method to get more accurate measurements of the angles.

1

.....

2

.....

[2]

The less successful answers here suggested that candidates may not have performed the experiment themselves. Repeat the experiment multiple times and use better/good devices were some of the unsatisfactory answers.

Question 12 (c) (i)

- (c) Alex records his results in the table.

Angle of incidence (°)	Angle of refraction (°)
20	13
30	19
40	25
50	41
60	35
70	39

- (i) Plot the results from the table on the graph. One point has already been plotted.

[2]

Most candidates plotted the points correctly. The most common error was to use only 1 small square = 1 degree on the angle of refraction scale, rather than 2 small squares = 1 degree.

Question 12 (c) (ii)

- (ii) Put a ring around the outlier on the graph.

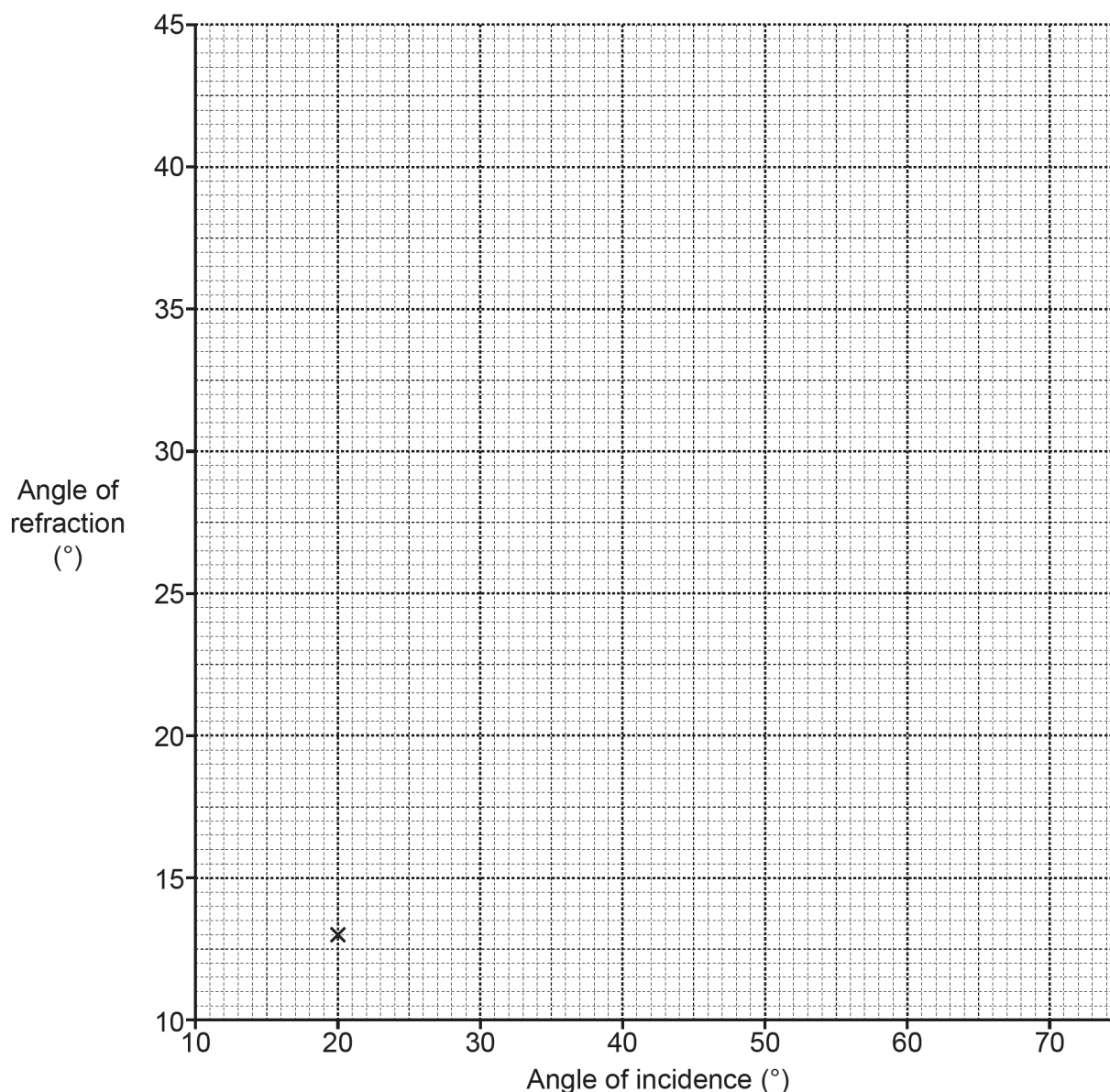
[1]

Nearly all candidates identified the outlier correctly.

Question 12 (c) (iii)

(iii) Draw a line of best fit.

[1]



This was a challenging question for many candidates. Almost all candidates drew a straight line rather than a curved one, as the question asks candidates to draw a line of best-fit. Candidates should know that a best-fit line is meant to mimic the trend of the data. The idea is to get a line with equal points on either side or draw a smooth curve that passes through as many points as possible and ignore any outlier. The curve does not need to join every data point together perfectly as some candidates did.

Question 12 (c) (iv)

- (iv) Describe the relationship between the angle of incidence and the angle of refraction for the rectangular glass block in Alex's investigation.

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

Many candidates described the relationship as 'as angle of incidence increases, angle of refraction increases' instead of a positive correlation. Even though it is correct, and candidates were given marks, candidates should know the technical terminology and use it effectively in their responses.

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