OCR
Oxford Cambridge and RSA

F

Thursday 9 June 2022 – Afternoon

GCSE (9–1) in Combined Science B (Twenty First Century Science)

J260/03 Physics (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Physics) B (inside this document)

You can use:
- an HB pencil
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number ☐☐☐☐☐   Candidate number ☐☐☐☐

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **32** pages.

ADVICE
- Read each question carefully before you start your answer.

Turn over

Answer **all** the questions.

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]

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

Put a ⟨ring⟩ around each correct option.

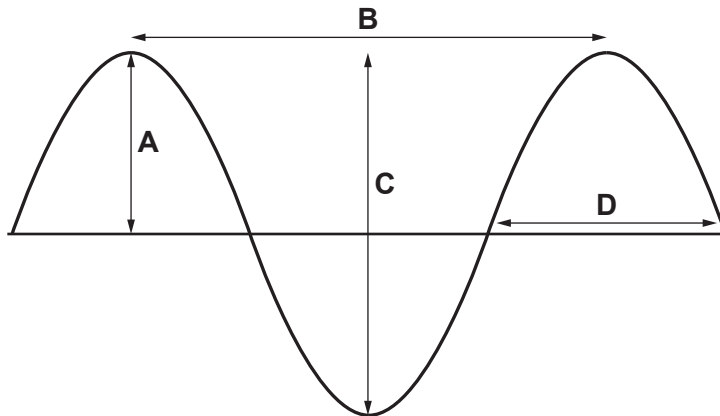An example of an electromagnetic wave is **electricity / light / sound**.

Electromagnetic waves are emitted by all objects and the wavelengths emitted depend

on the **mass / size / temperature** of the object.

[2]

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

.... **[1]**

(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]**

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

(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 × wavelength

Wave speed = ... m/s **[2]**

2 Jamal uses a microwave oven.

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

Energy transferred
by the microwaves = 750 J

Energy transferred
electrically = 1250 J

Energy transferred
to the surroundings = ... J
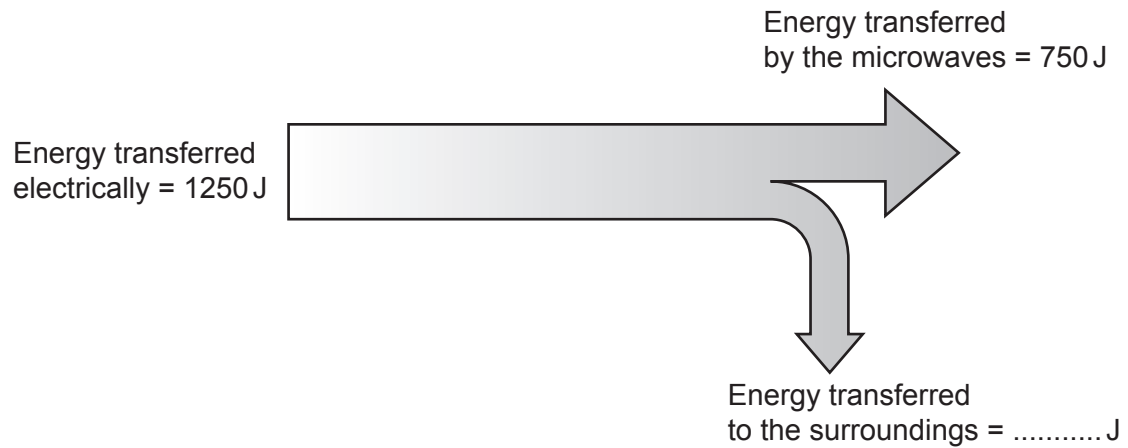
(a) Complete the diagram to show the energy transferred to the surroundings. **[1]**

(b) Calculate the efficiency of the microwave oven.

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

Give your answer as a percentage.

Efficiency = ... % **[3]**

(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]

3   This diagram shows a greyhound accelerating at the start of a race.
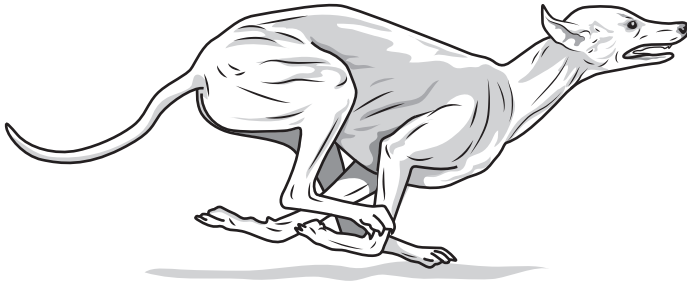
(a) A greyhound has a mass of $30\,kg$ and accelerates at $6.3\,m/s^2$.

Calculate the force the greyhound uses to accelerate.

Use the Data Sheet.

Force = ... N **[3]**

(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?

A Energy stores ⟶ Energy stores	B Energy stores ⟶ Energy stores
Chemical → *transferred to* → Kinetic and nuclear	Chemical → *transferred to* → Kinetic and thermal
C Energy stores ⟶ Energy stores	D Energy stores ⟶ Energy stores
Elastic → *transferred to* → Chemical and thermal	Elastic → *transferred to* → Kinetic and chemical
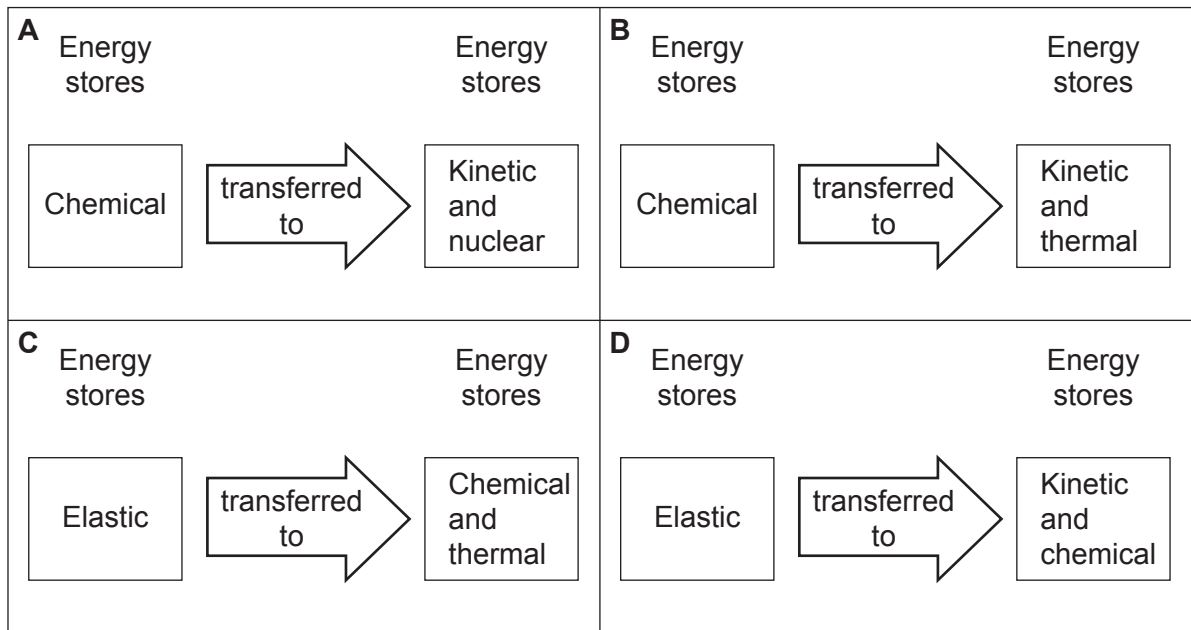
Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(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]**

Turn over

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]

(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]

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

....

....

....

.... **[2]**

(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.		
Visible light is generated when electrons in atoms lose energy.		
X-rays have enough energy to ionise some atoms.		
Radio waves are absorbed by oxygen in the atmosphere to produce ozone.		

[3]

5 Kai has a model crane that is powered by a battery. The model crane is used to lift a box.
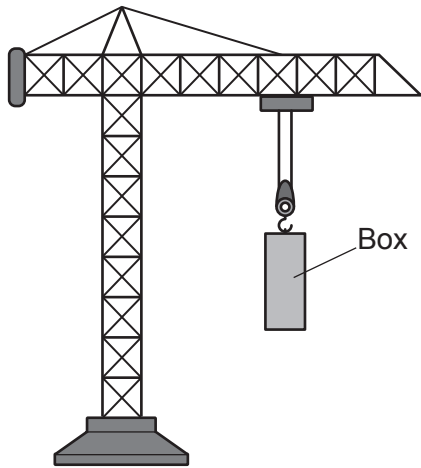
(a) A constant current of 1.1A flows through the battery when the crane is switched on.

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

Use the equation: charge = current × time

Charge = ... C **[3]**

(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 × gravitational field strength × height

Gravitational field strength = 10 N/kg

Gravitational potential energy = ... J **[2]**

(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]**

Turn over

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/s^2 **[3]**

(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]

(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.

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

[1]

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]

(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 × distance

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

Work done = ... J **[3]**

Turn over

7 Beth makes the circuit shown in the diagram using component **X**.
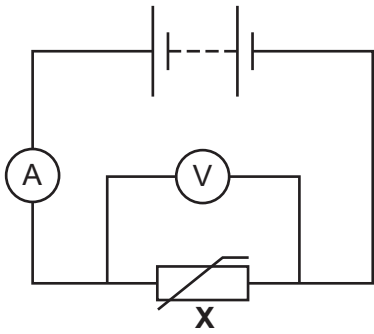
(a) What is component **X**?

Tick (✓) **one** box.

Diode ☐

Light dependent resistor ☐

Thermistor ☐

Variable resistor ☐

[1]

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

....

.... **[1]**

(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]**

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]**

(b) Ben places the chocolate in a fridge.
The graph shows how the temperature of the chocolate changes as it cools.
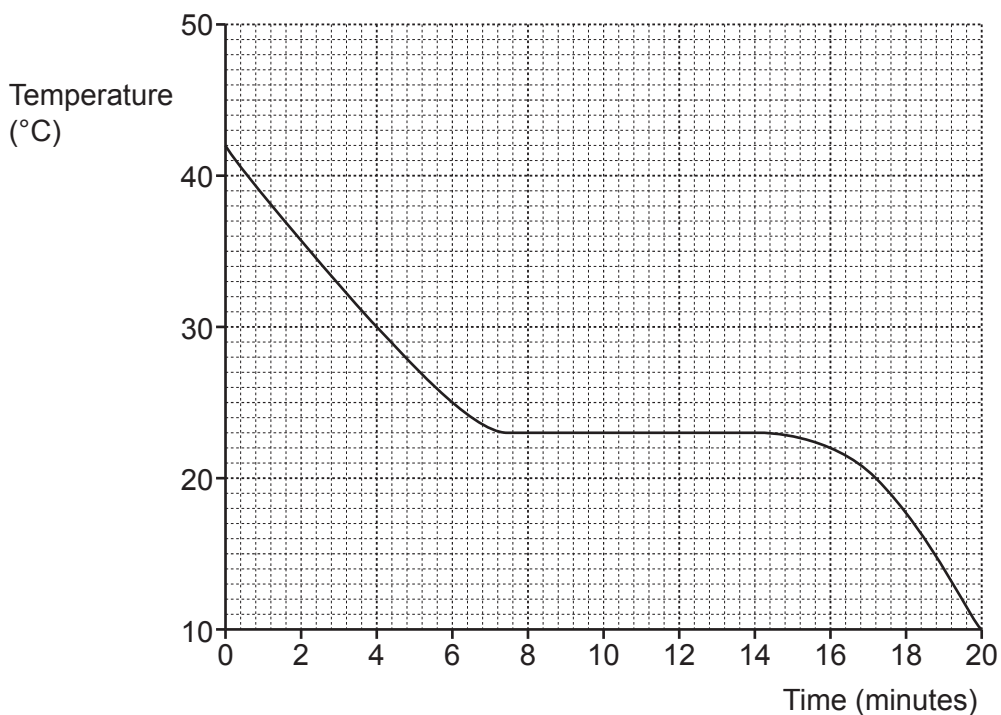
(i) What happens to the chocolate at 23 °C?

.... **[1]**

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

Change in temperature = ... °C **[2]**

(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]**

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.

Radioactive   Absorbing   Radiation detector
source   material
                                                        Count rate
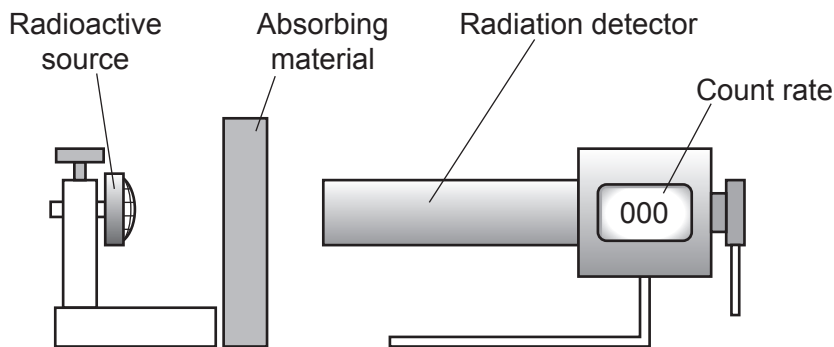
Fig. 9.1

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**.
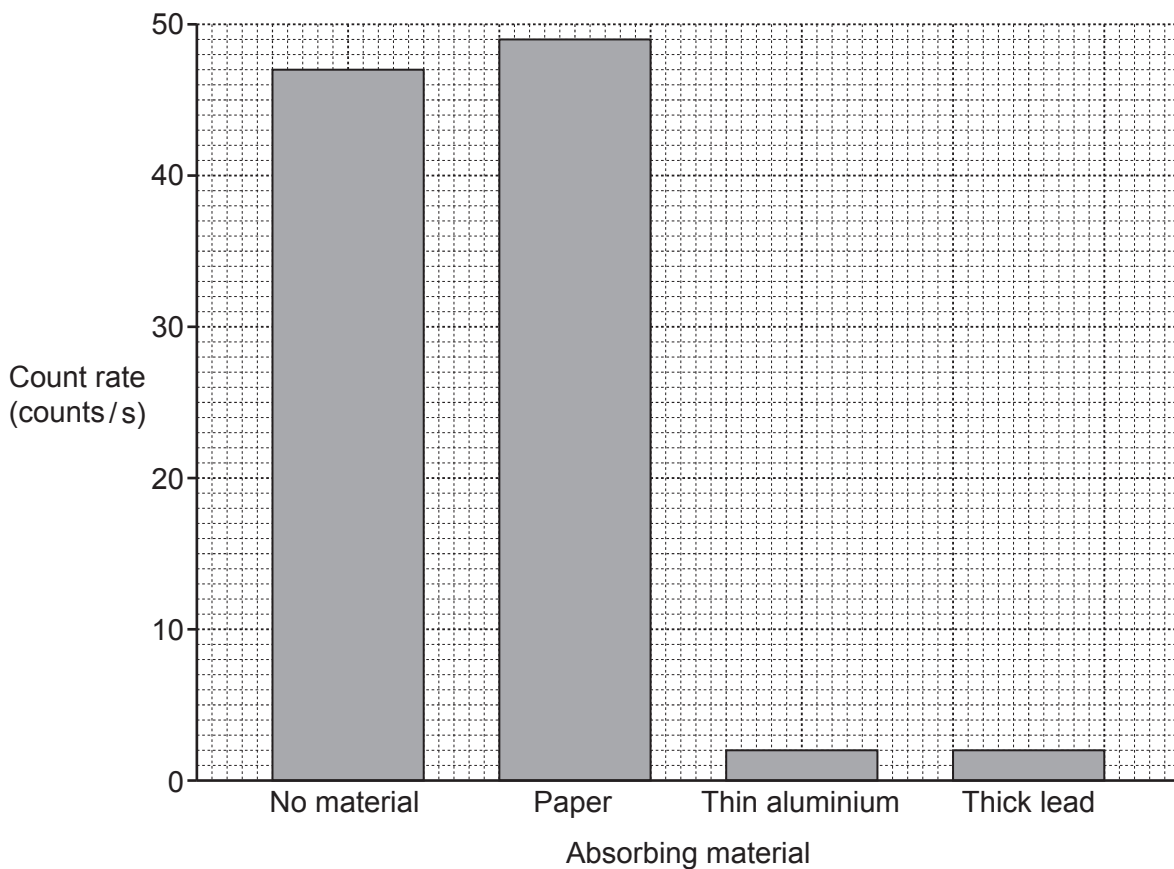
Fig. 9.2

(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.

Amir

It is because radioactive decay is random.

Eve

It is because the paper is absorbing radiation.

James

It is because the paper is emitting radiation.

Ling

It is because the source is getting weaker as it is used up.

Which student's explanation is correct?

.... **[1]**

(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]**

(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.

Percentage of carbon-14 remaining (%)
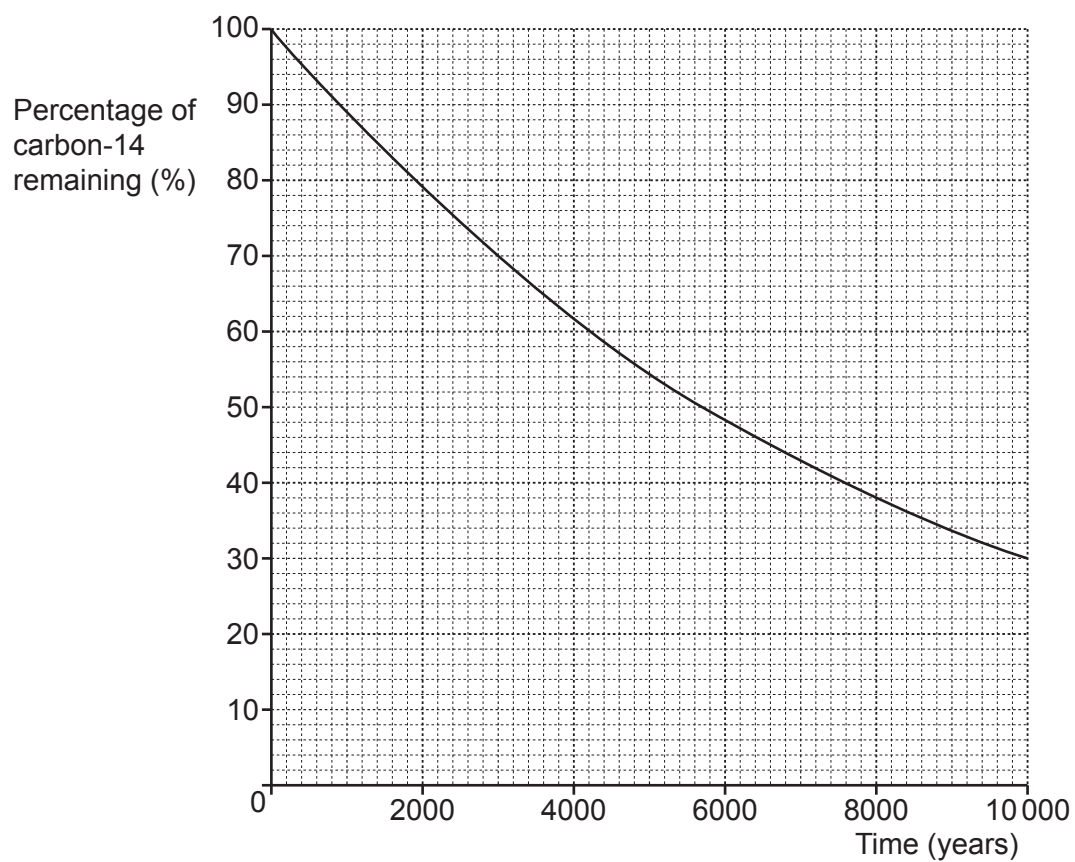
Fig. 9.3

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

Half-life = ... years **[1]**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Turn over

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

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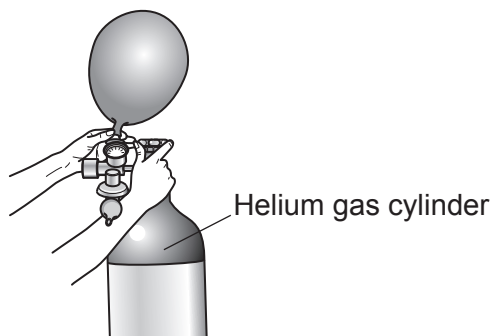
The table shows the density and states of some materials at room temperature.

Material	Density (kg/m³)	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]**

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

Use ideas about particles in your answer.

....

....

....

....

....

.... **[3]**

(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]

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 × potential difference. ☐

The frequency of the supply is 230 Hz. ☐

Transmitting power at higher voltages is more efficient. ☐

[1]

(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]**

(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]**

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

—◆— Coal

—■— Natural gas

—✕— Wind & solar

Energy used for generating electricity (TWh)
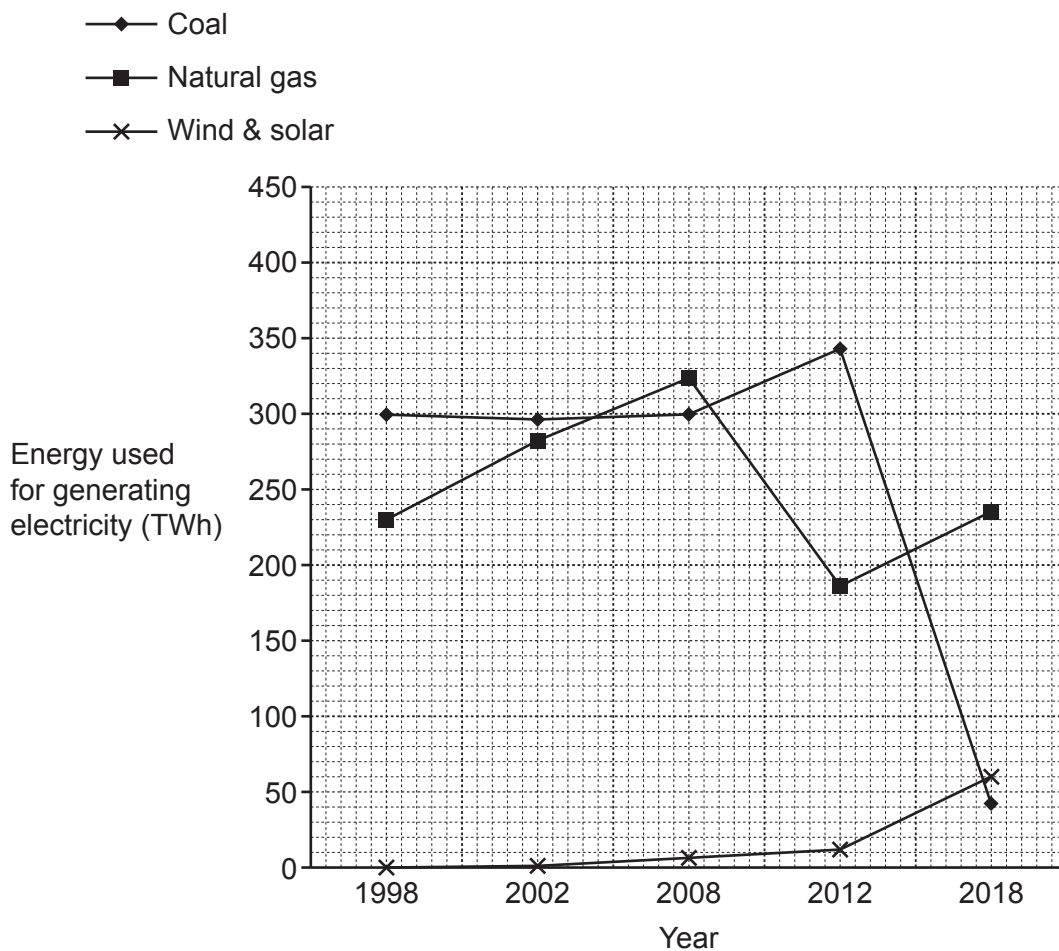
Explain how the use of these **three** energy resources changed between 1998 and 2018.

....

....

....

....

....

....

....

....

....

....

....

.... **[6]**
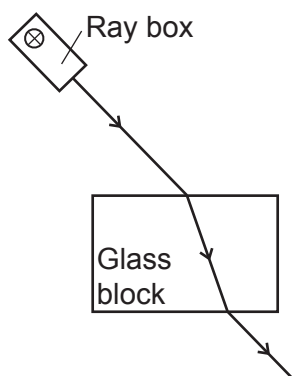
Turn over

26

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

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]

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

1 ....

....

2 ....

....

[2]

(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]**

(ii) Put a ⬭ring⬭ around the outlier on the graph. **[1]**

(iii) Draw a line of best fit. **[1]**
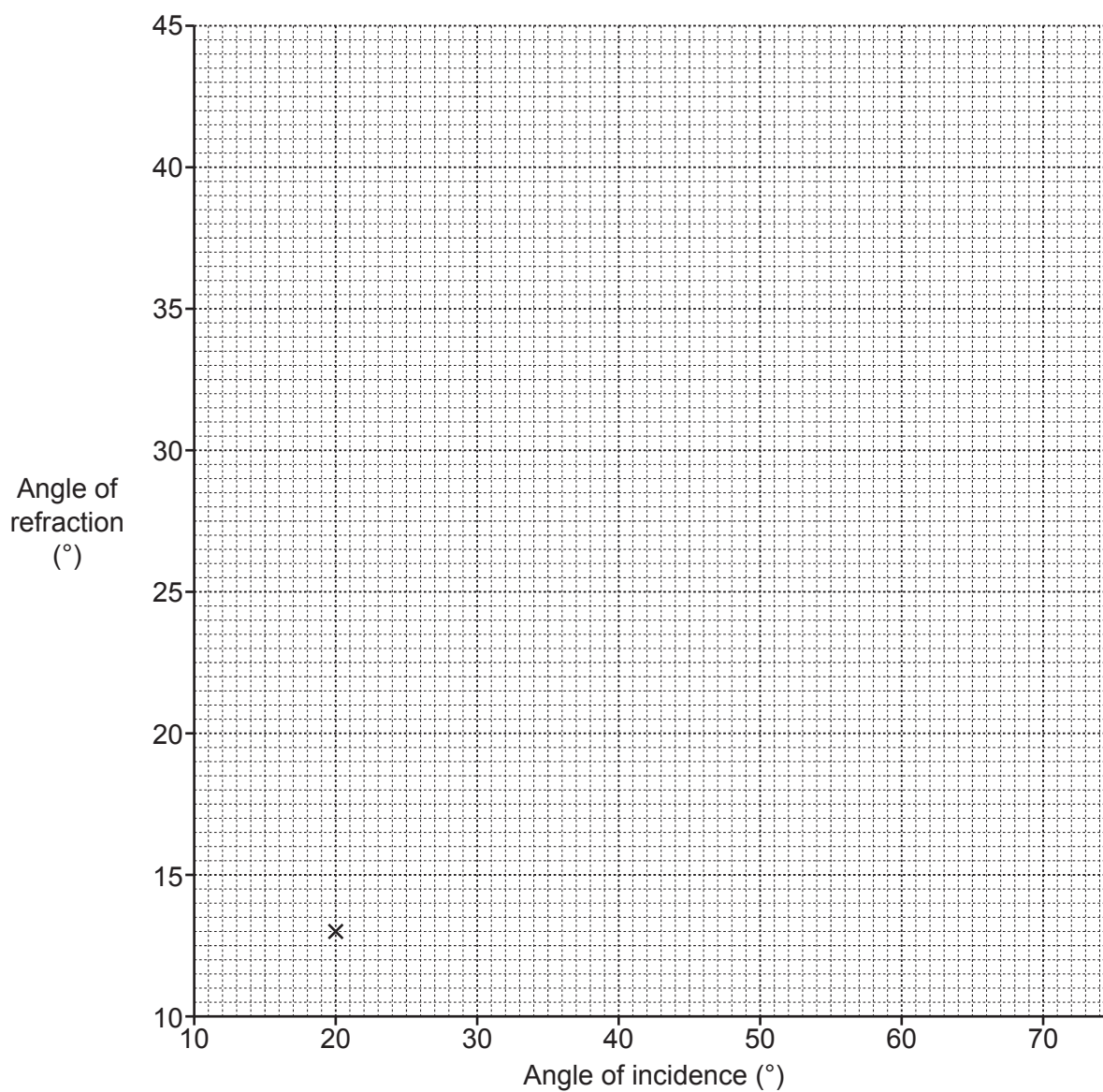
(iv) Describe the relationship between the angle of incidence and the angle of refraction for the rectangular glass block in Alex's investigation.

....

.... **[1]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....