OCR
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Thursday 23 June 2022 – Morning

GCSE (9–1) Combined Science (Physics) A (Gateway Science)

J250/12 Paper 12 (Higher Tier)

Time allowed: 1 hour 10 minutes

8997303794

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

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

J250122

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 **60**.
- 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 **20** pages.

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

SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

1 A remote control can be used to operate a television.

Remote control

Television

Which row in the table describes how energy is transferred?

	Remote control	Television
A	3 V a.c. from batteries	230 V d.c. from domestic mains supply
B	3 V d.c. from batteries	230 V a.c. from domestic mains supply
C	230 V a.c. from domestic mains supply	3 V d.c. from batteries
D	230 V d.c. from domestic mains supply	3 V a.c. from batteries

Your answer ☐ **[1]**

2 What is a typical acceleration of a car driving along a road?

A $3\,m/s^2$

B $10\,m/s^2$

C $60\,m/s^2$

D $80\,m/s^2$

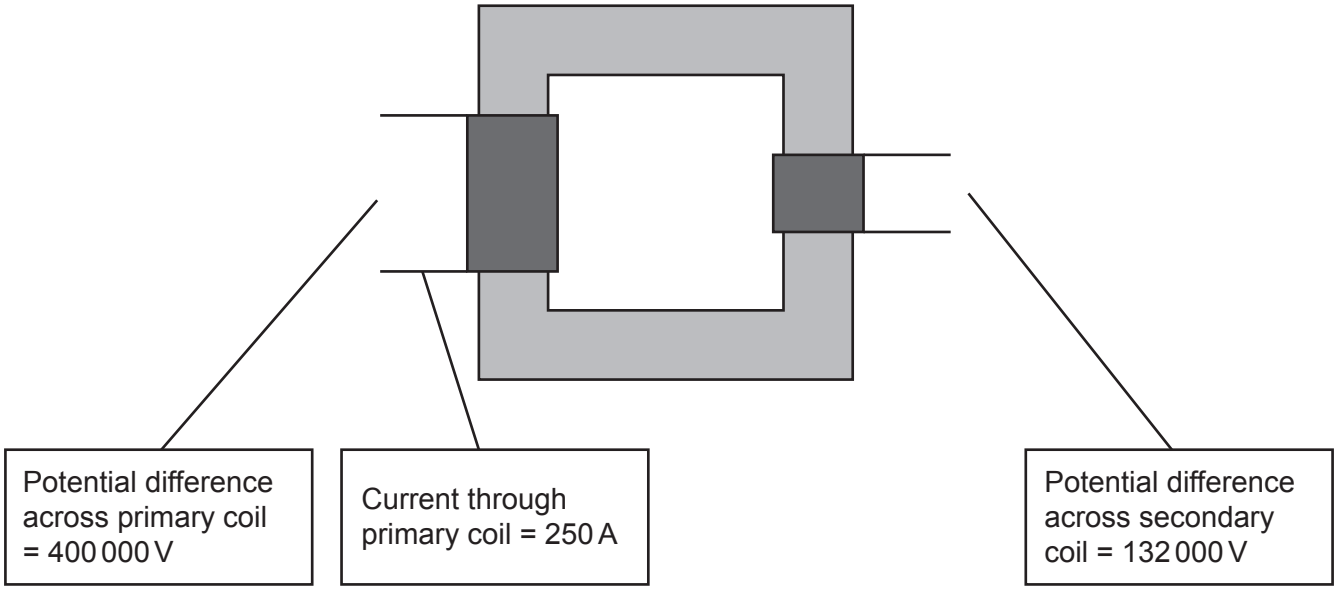
Your answer ☐ **[1]**

3 What is the **difference** between alternating voltage and direct voltage?

	Alternating voltage	Direct voltage
A	changes direction	changes direction
B	changes direction	does not change direction
C	does not change direction	changes direction
D	does not change direction	does not change direction

Your answer ☐ **[1]**

4 This is a diagram of a transformer:



What is the current through the secondary coil?

Use the Data Sheet.

A 0.00132A

B 125A

C 211A

D 758A

Your answer ☐ **[1]**

5 A filament lamp has a resistance of 1000 Ω and a current of 0.25 A.

What is the power of the filament lamp?

Use the equation: power = $(\text{current})^2 \times \text{resistance}$

A 62.5 W

B 250 W

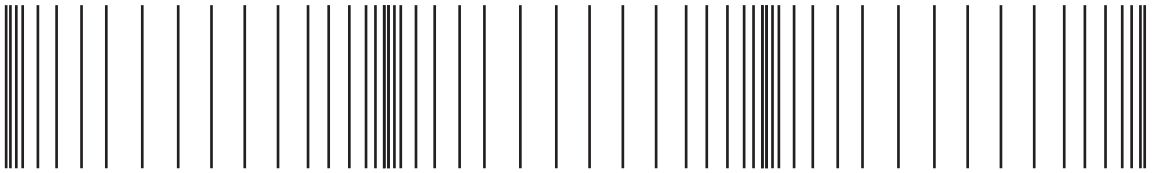
C 4000 W

D 250 000 W

Your answer ☐ **[1]**

6 This is a picture of a longitudinal wave.

The wave is drawn to scale.



What is the wavelength of the wave?

A 0.5 cm

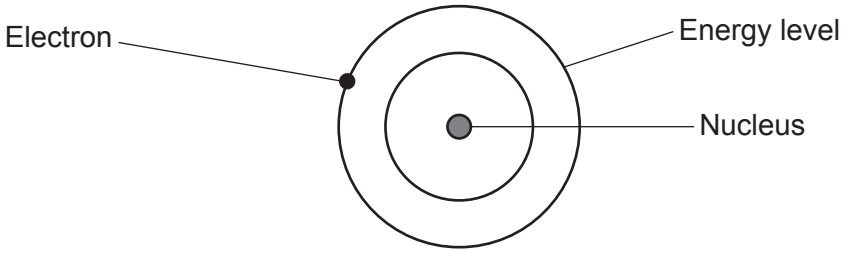
B 2.5 cm

C 5.0 cm

D 10 cm

Your answer ☐ **[1]**

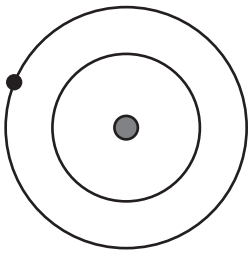
7 The diagram shows an electron in an atom.



When the electron moves between energy levels, the atom **emits** electromagnetic radiation.

Which diagram shows what happened to the electron?

A



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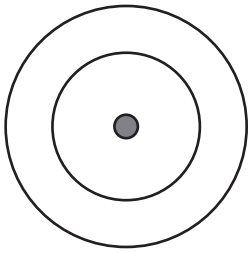
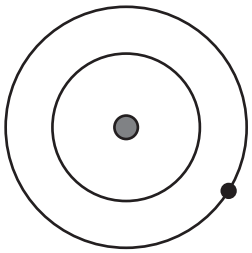
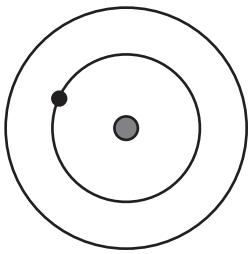


C



D



Your answer ☐ **[1]**

8 The table shows information about the number of protons, neutrons and electrons in different atoms.

Atom	Number of protons	Number of neutrons	Number of electrons
1	8	10	8
2	10	10	10
3	10	12	10
4	12	12	12

Which two atoms are isotopes?

A **1** and **2**

B **1** and **3**

C **2** and **3**

D **3** and **4**

Your answer ☐ **[1]**

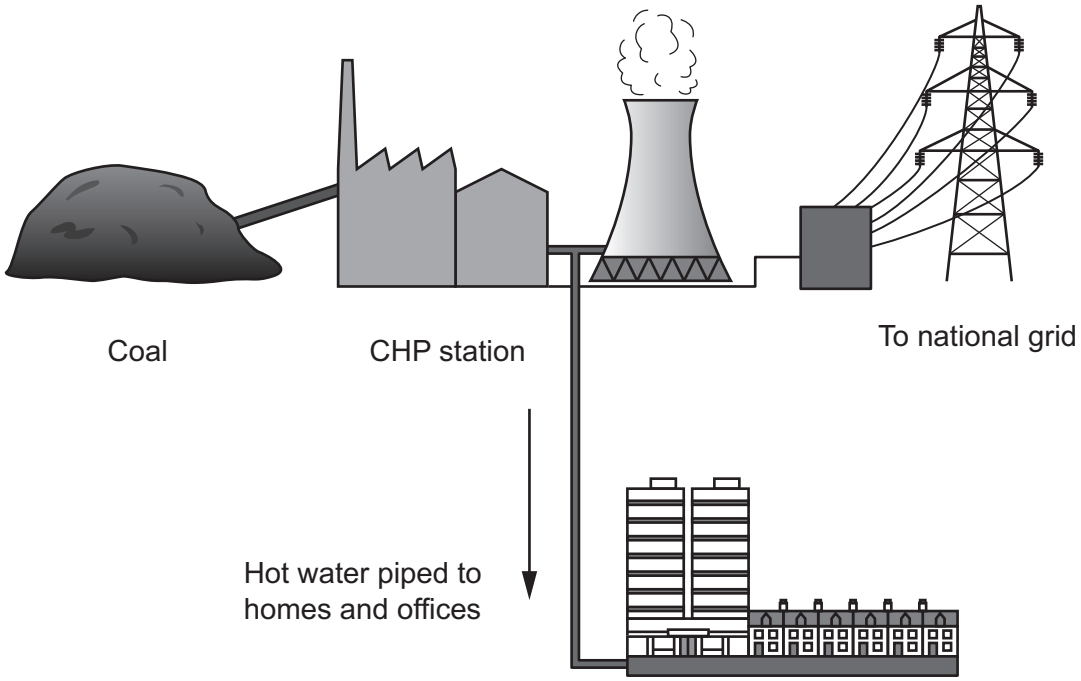
9 The thinking distance of a car at 20 mph is 6 m.
The braking distance of a car at 20 mph is 6 m.

What is the thinking distance and braking distance of the car at 40 mph?

	Thinking distance (m)	Braking distance (m)
A	6	12
B	12	12
C	12	24
D	24	24

Your answer ☐ **[1]**

10 The diagram shows a power station called a 'combined heat and power' (CHP) station.



Why is a CHP station is more efficient than a coal fired power station?

A Less energy is wasted in a CHP station.

B A CHP station produces renewable energy.

C The homes and offices contain insulation.

D There is more input of chemical energy in a CHP station.

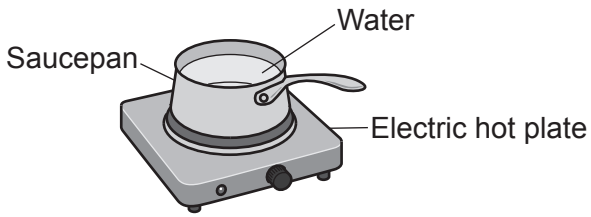
Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

11 (a) Student **A** uses the electric hot plate in **Fig. 11.1** to increase the temperature of water in a saucepan.

Fig. 11.1



(i) Student **A** wants to calculate the thermal energy transferred to the saucepan of water.

These are the steps in their method:

1 Measure the volume of water with a balance.
2 Measure the starting temperature of the water with a thermometer.
3 Use the equation:

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

Student **A**'s method is **incorrect**.

Identify the **two** mistakes the student has made and write down the correction for each mistake.

Mistake **1** .....

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Correction **1** .....

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Mistake **2** .....

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Correction **2** .....

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[3]

(ii) Student **A** suggests wrapping insulation around the saucepan in **Fig. 11.1**.

Suggest **another** way student **A** can improve their experiment.

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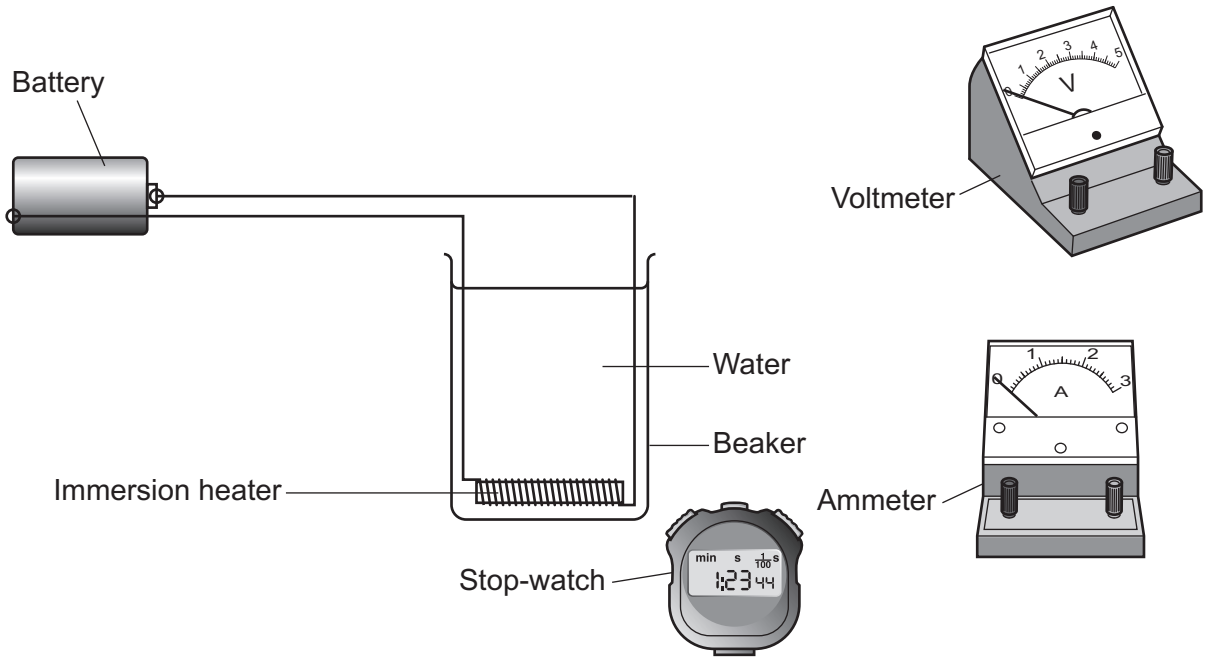
..... **[1]**

(b) Student **B** uses the immersion heater in **Fig. 11.2** to increase the temperature of water in a beaker.

Fig. 11.2



Describe an experiment to measure the **energy** transferred to the immersion heater, using the equipment in **Fig. 11.2**.

In your answer include:
- a method
- a circuit diagram
- an equation from the Data Sheet
- the symbol for a resistor to represent the immersion heater in your circuit.

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..... **[4]**

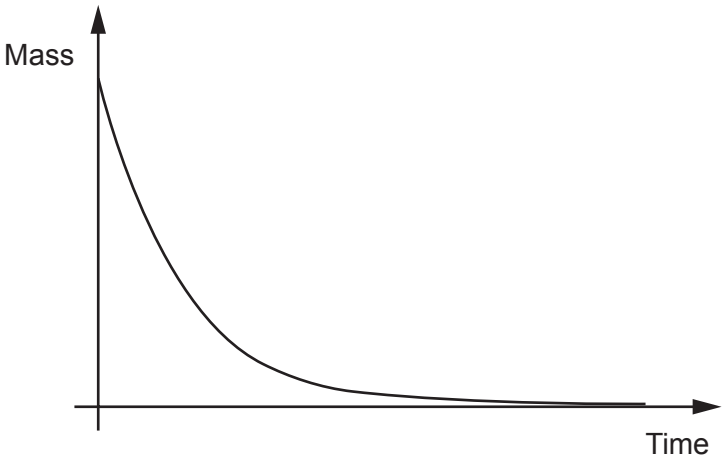
12 This question is about radioactivity.

(a) Which statements about the nucleus of an atom are correct?
Tick (✓) **two** boxes.

In radioactive atoms, the nucleus is stable.	☐
Most of the nucleus contains empty space.	☐
Scientists can say exactly when a nucleus will emit radiation.	☐
The diameter of a nucleus is approximately 1 nm.	☐
The mass of a nucleus is much less than the mass of an atom.	☐
The nucleus contains protons and electrons.	☐
The nucleus contains protons and neutrons.	☐
The nucleus has a positive charge.	☐

[2]

(b) The graph shows how the mass of a radioactive element changes with time.



Describe the trend shown by the graph.

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

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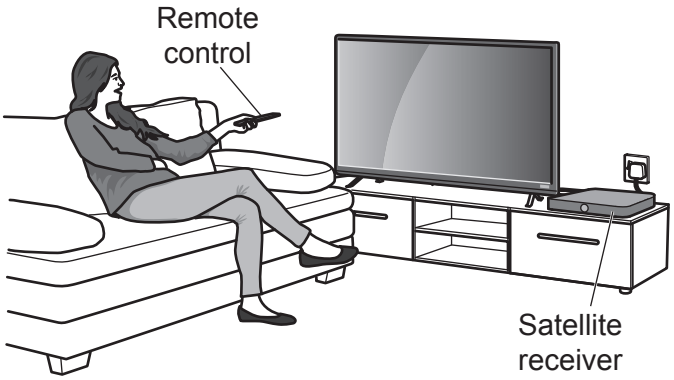
13 A satellite receiver can be used to watch television channels. It works using a remote control.



(a) Channel 4 uses a wave with a frequency of 1.0714×10^{10} Hz.

The speed of the wave is 3.0×10^{8} m/s.

Calculate the wavelength of the wave.

Use the equation: wave speed = frequency × wavelength
Give your answer to **3** decimal places.

Wavelength = ... m **[4]**

(b) The remote control emits infra-red or radio waves when a button is pressed.

The remote control also contains a light which flashes when a button is pressed.

Explain why the light is needed to show when a button is being pressed.

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

(c) A student uses a smart meter to check their energy use at home.

The student thinks they can save energy by unplugging their satellite receiver from the mains supply for 8 hours at night.

	Power of satellite receiver (W)
Receiver switched on	25
Receiver switched off	15
Receiver unplugged	0

(i) Calculate the amount of energy saved by unplugging the receiver compared to switching the receiver off for 8 hours at night. Use the Data Sheet.

Give your answer in kWh.

Energy saved = ... kWh **[4]**

(ii) The government wants all homes to have a smart meter by 2024.

Describe how smart meters may change the way energy resources are used.
Use your answer to **(c)(i)**.

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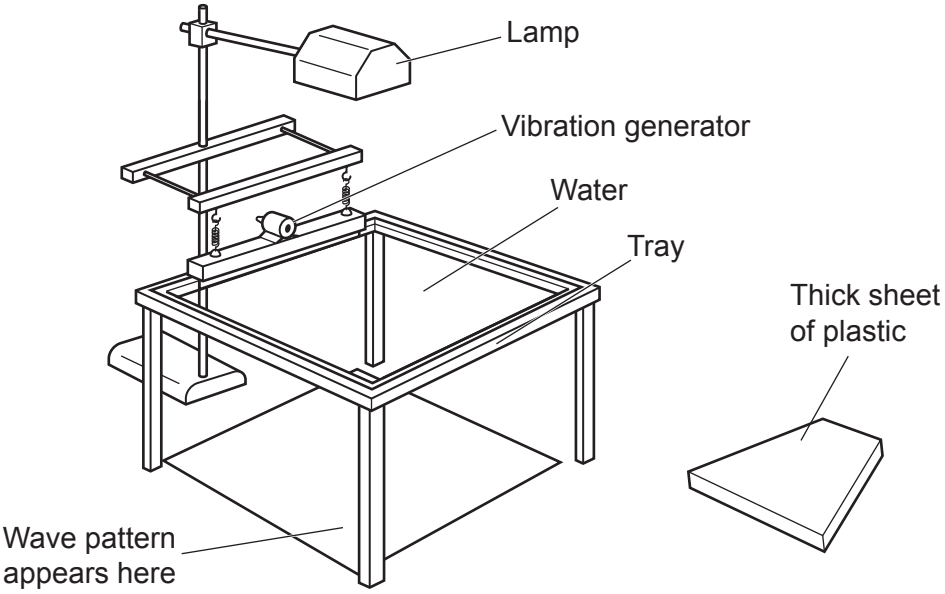
..... **[2]**

14 A teacher uses a ripple tank to show refraction of water waves.
Fig. 14.1 shows a ripple tank.

Fig. 14.1



(a) Explain how the ripple tank and a thick sheet of plastic can be used to show refraction of water waves.

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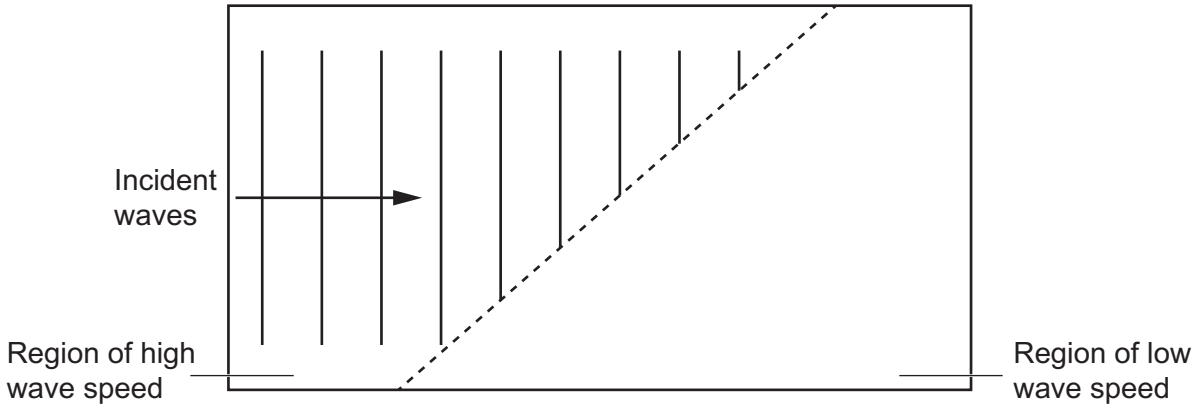
..... **[2]**

(b) Complete **Fig. 14.2** to show the wave pattern when the incident waves enter the region of low wave speed.

Fig. 14.2



[2]

15 In 1986, a nuclear power station exploded in Chernobyl.

The radioactive isotopes caesium-137 (Cs-137) and iodine-131 (I-131) were released.

(a) An old unit of activity is the Curie (Ci).

- The activity of Cs-137 released in the explosion was 2 300 000 Ci.
- 1 Ci = 37 000 000 000 Bq

Calculate the activity of Cs-137 released in Bq.
Give your answer in standard form.

Activity = ... Bq **[2]**

(b) Cs-137 emits beta radiation. The table shows some information about this decay.

Element	Symbol	Charge on nucleus	Mass of nucleus
Caesium	Cs	+55	137
Barium	Ba	+56	137

Use the table to complete the balanced nuclear equation for Cs-137 decay.

$$\text{.....}^{\text{.....}}\text{Cs} \longrightarrow \text{.....}^{\text{.....}}\text{Ba} + \text{.....}^{\text{.....}}\beta$$

[3]

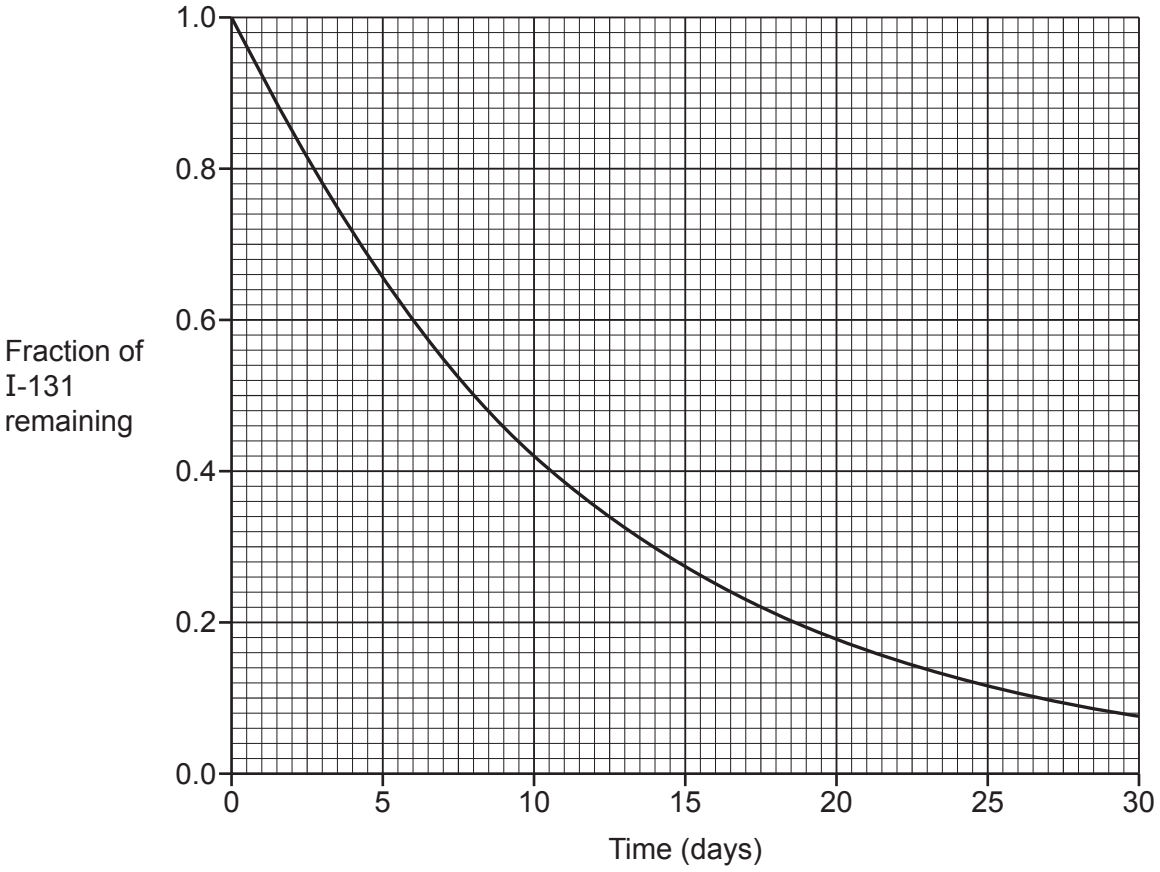
***(c)** The isotopes I-131 and Cs-137 from Chernobyl contaminated sheep.

The government stopped the movement of contaminated sheep for 26 years.

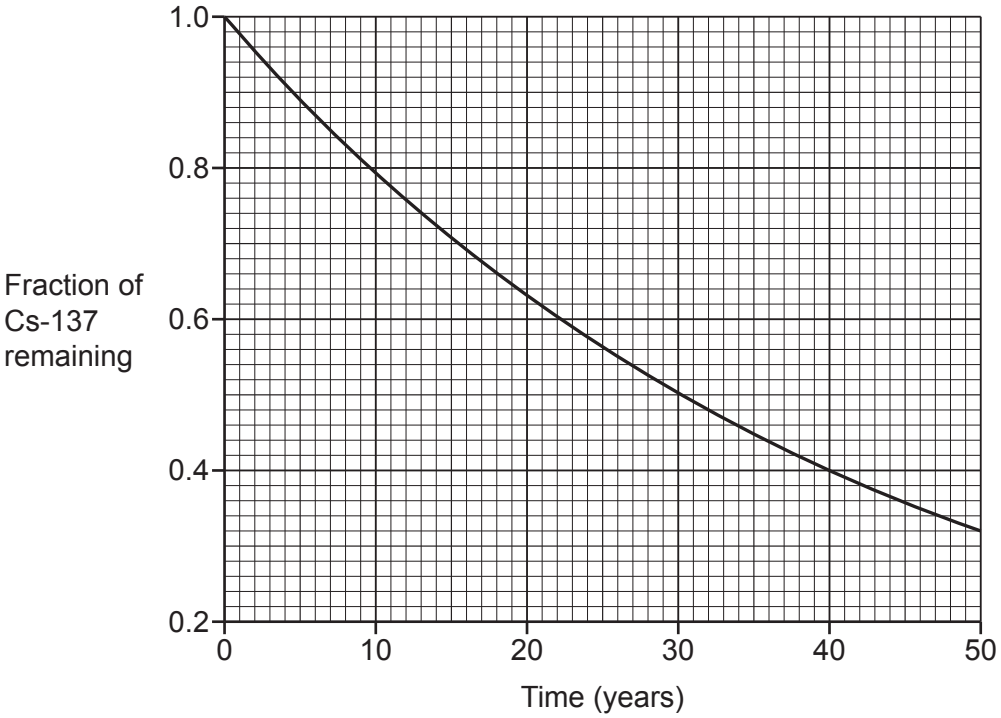
- If the activity per kilogram of sheep was greater than 1000 Bq / kg, the sheep were **contaminated**.
- In 1986, the activity per kg of some sheep was greater than 1600 Bq / kg.
- I-131 emits beta radiation.
- Cs-137 emits beta **and** gamma radiation.

The graphs show how the amount of I-131 and Cs-137 change with time:

Graph for I-131



Graph for Cs-137



Use the graphs to explain why the government stopped the movement of contaminated sheep for 26 years.

Use ideas about half-life and half-life calculations.

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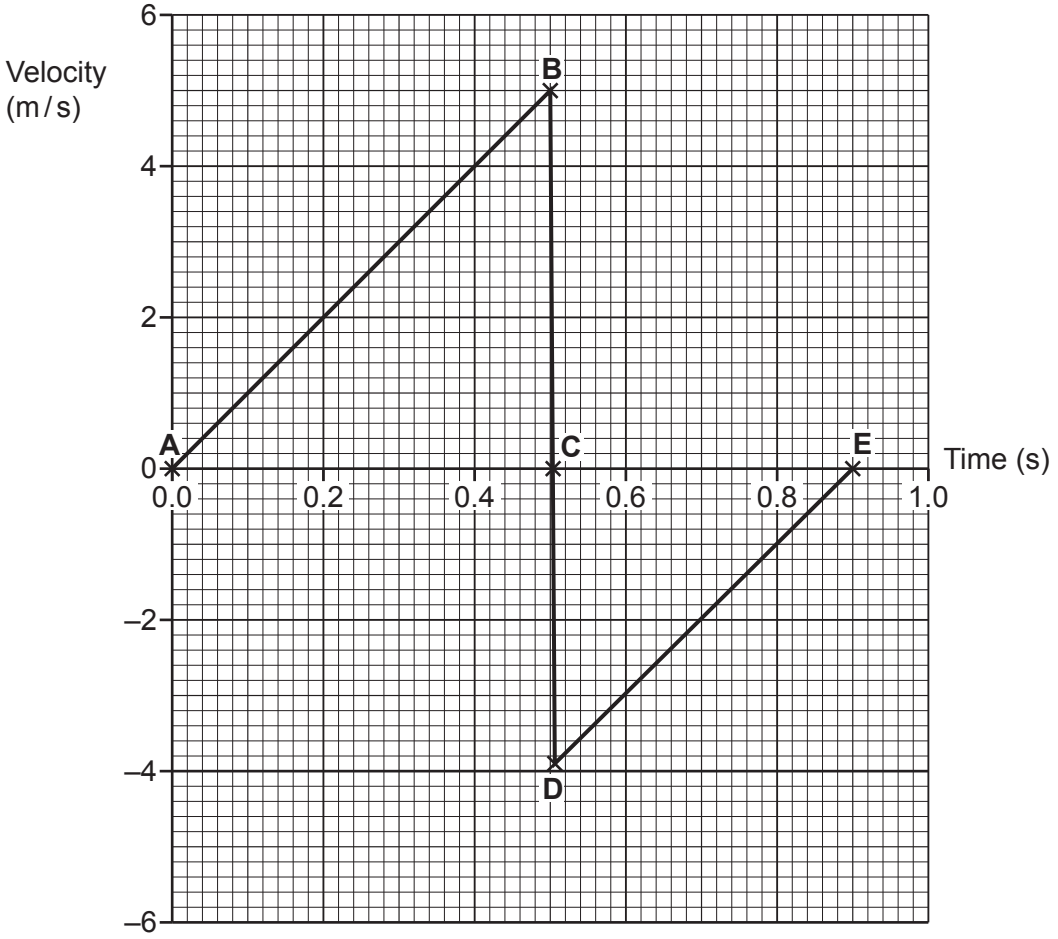
..... **[6]**

16 A student drops a ball onto a hard floor. The mass of the ball is 0.06 kg.

The ball bounces once and the student catches the ball.

The graph shows how the velocity of the ball changes after it is dropped.



(a) (i) State a point on the graph where the gravitational store of the ball has a minimum value.

Choose from **A**, **B**, **C**, **D** or **E**.

Answer = ... **[1]**

(ii) State the point on the graph where the kinetic store of the ball has a maximum value.

Choose from **A**, **B**, **C**, **D** or **E**.

Answer = ... **[1]**

(b) Calculate the kinetic energy of the ball at 0.4 seconds. Use the Data Sheet.

Kinetic energy = ... J **[3]**

(c) (i) Calculate the potential energy of the ball at **A**.

Use the graph and the equation:
potential energy = mass × height × gravitational field strength

Gravitational field strength = 10 N / kg.

Potential energy = ... J **[4]**

(ii) The potential energy of the ball at **E** is 0.45 J.

Calculate the efficiency of the ball bounce.
Use the Data Sheet and your answer to **(c)(i)**.

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

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).