OCR
Oxford Cambridge and RSA

Friday 16 June 2023 – Morning

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

J250/12 Paper 12 (Higher Tier)

Time allowed: 1 hour 10 minutes

H

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

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

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 **24** pages.

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

Section A

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

Write your answer to each question in the box provided.

1 Which sentence describes the **law of conservation of energy**?

A Energy can be created in a power station.

B Energy can be transferred into power.

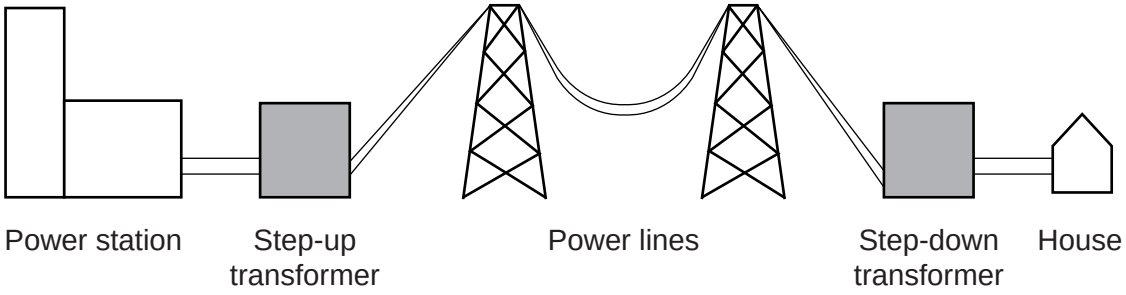
C Energy can only be transferred between stores.

D Energy can only be destroyed in the surroundings when it is wasted.

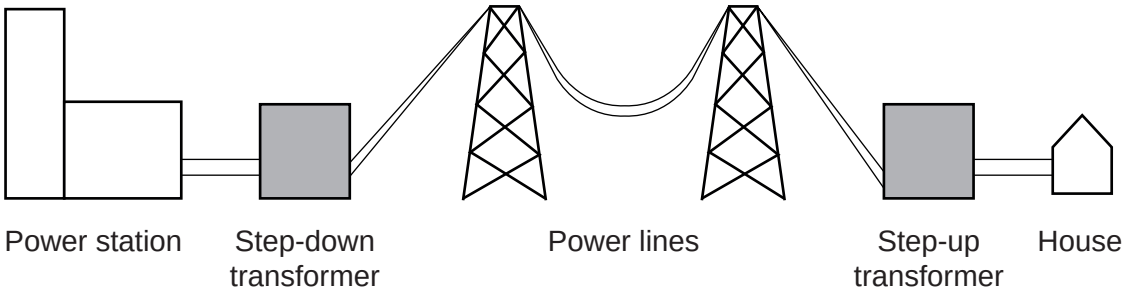
Your answer ☐ **[1]**

2 Which diagram shows how transformers are used in the national grid?

A



B



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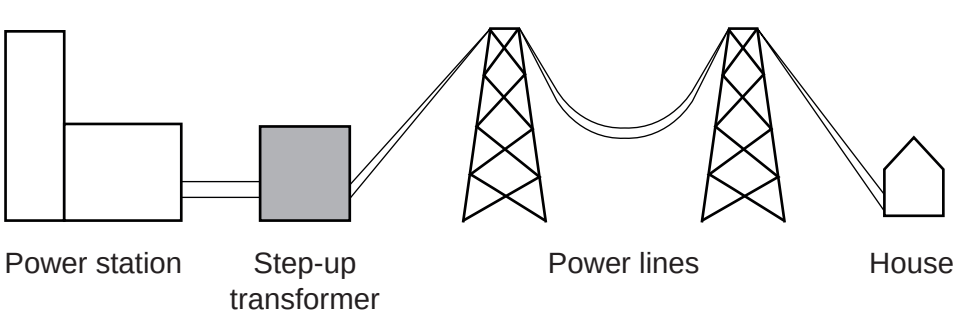

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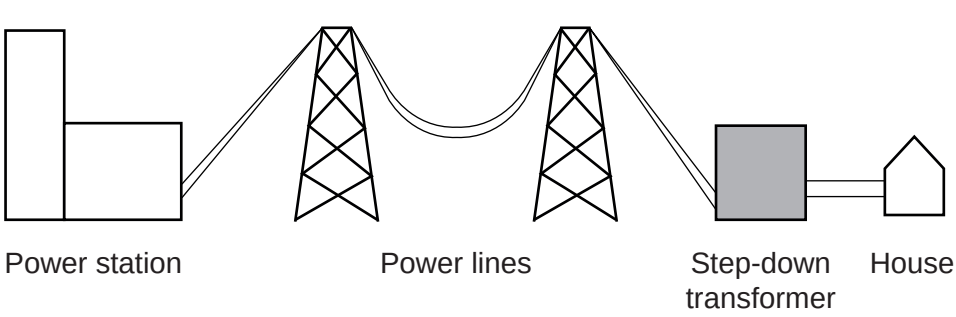


Your answer ☐ **[1]**

3 An electric plug contains a live wire, a neutral wire and an earth wire.

Which statement is correct?

A The neutral wire completes the circuit.

B The neutral wire only carries a current if there is a fault.

C The potential difference between the earth wire and the neutral wire is 230 V.

D The potential difference between the live wire and the neutral wire is 400 000 V.

Your answer ☐ **[1]**

4 This is the nuclear equation for an alpha particle hitting a beryllium nucleus.

$^{4}_{2}\text{He} + {}^{9}_{4}\text{Be} \longrightarrow {}^{12}_{6}\text{C} + \mathbf{X}$

What is **X**?

A $^{1}_{0}\text{n}$

B $^{0}_{-1}\text{e}$

C $^{4}_{2}\text{He}$

D $^{0}_{0}\gamma$

Your answer ☐ **[1]**

5 A driver drives a car along a road.
The driver presses the brakes to stop.

Energy is transferred between stores.

Kinetic store of car ⟹ Thermal store of surroundings

How is the energy transferred between these stores?

A By heating only

B Electrically and by heating

C Work done by forces and by heating

D Work done by forces only

Your answer ☐ **[1]**

6 A 6 V battery provides a current of 0.4 A in a circuit for 20 seconds.

How much energy is transferred by the battery?

Use the equations: charge flow = current × time

energy transferred = charge × potential difference

A 0.12 J

B 0.75 J

C 15 J

D 48 J

Your answer ☐ **[1]**

7 The table shows how braking distance changes with the speed of a car.

Speed (mph)	Braking distance (m)
20	6
30	14
40	24
60	56

What is the braking distance at 80 mph?

A 48 m

B 96 m

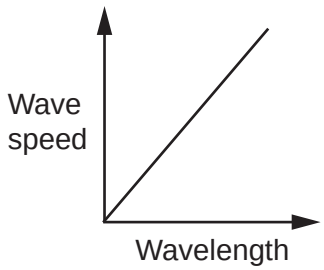
C 110 m

D 216 m

Your answer ☐ **[1]**

8 Which graph shows how wave speed varies with wavelength for electromagnetic waves in space?

A



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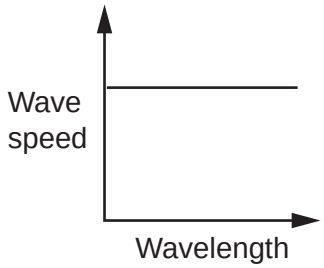

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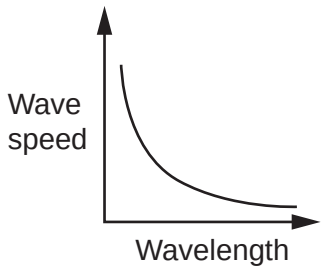

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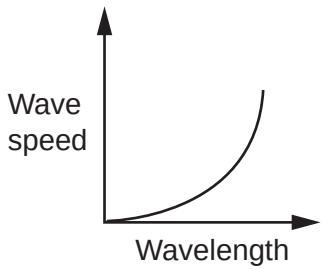


Your answer ☐ **[1]**

9 A 0.5 kg mass is placed on the end of a vertical spring with spring constant 125 N / m.
The extension of the spring is 0.04 m.

What happens to the energy stored in the spring when a 1.0 kg mass is placed on the end instead?

Assume the spring obeys Hooke's Law.

Use the Equation Sheet.

A Doubles

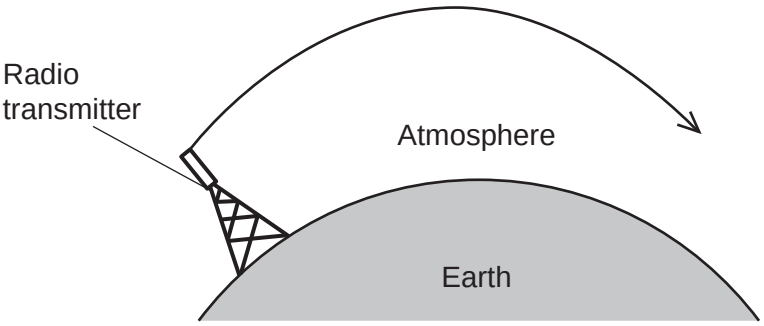
B Halves

C Quadruples

D Stays the same

Your answer ☐ **[1]**

10 In summer, a layer of warm air forms above a layer of dense cool air in the atmosphere.
This causes radio waves to bend instead of travelling in straight lines.



Which statement explains why the radio waves bend?

A The frequency of the wave changes.

B The speed of the wave changes.

C The wave is absorbed by the cool air.

D The wave spreads out.

Your answer ☐ **[1]**

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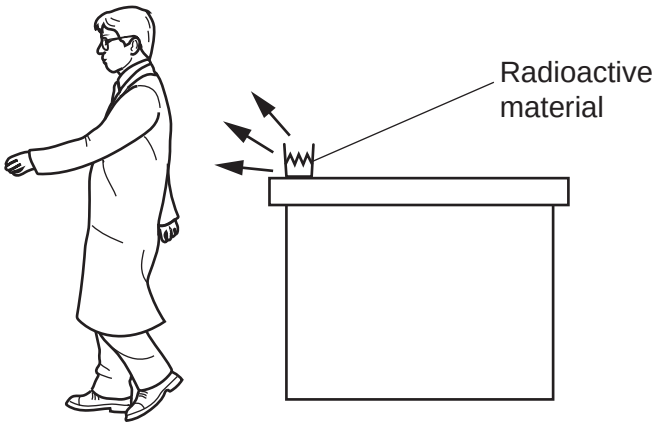
Section B

11 A scientist is working with a radioactive material.
The radioactive material emits **beta** radiation.

(a) **Fig. 11.1** shows the scientist walking very close to the radioactive material.

Fig. 11.1



Describe the effect of the radioactive material on the scientist as they walk past.

Tick (✓) **one** box.

They have been irradiated only. ☐

They have been contaminated only. ☐

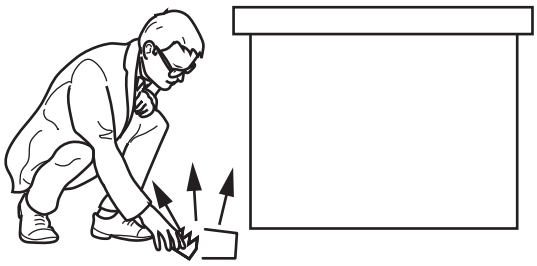
They have been irradiated and contaminated. ☐

They have **not** been irradiated or contaminated. ☐

[1]

(b) In **Fig. 11.2**, the scientist knocks the radioactive material onto the floor.
They pick up the radioactive material with their bare hands.

Fig. 11.2



Describe the effect of the radioactive material on the scientist as they pick it up.

Tick (✓) **one** box.

They have been irradiated only. ☐

They have been contaminated only. ☐

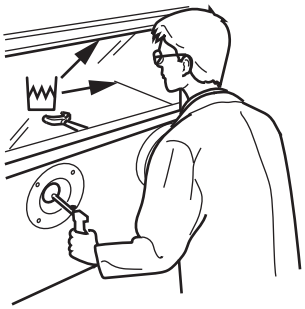
They have been irradiated and contaminated. ☐

They have **not** been irradiated or contaminated. ☐

[1]

(c) **Fig. 11.3** shows the scientist standing behind a lead screen and a lead-glass window.
They use a robotic arm to handle the radioactive material.

Fig. 11.3



Describe the effect of the radioactive material on the scientist when they are behind the lead screen.

Tick (✓) **one** box.

They have been irradiated only. ☐

They have been contaminated only. ☐

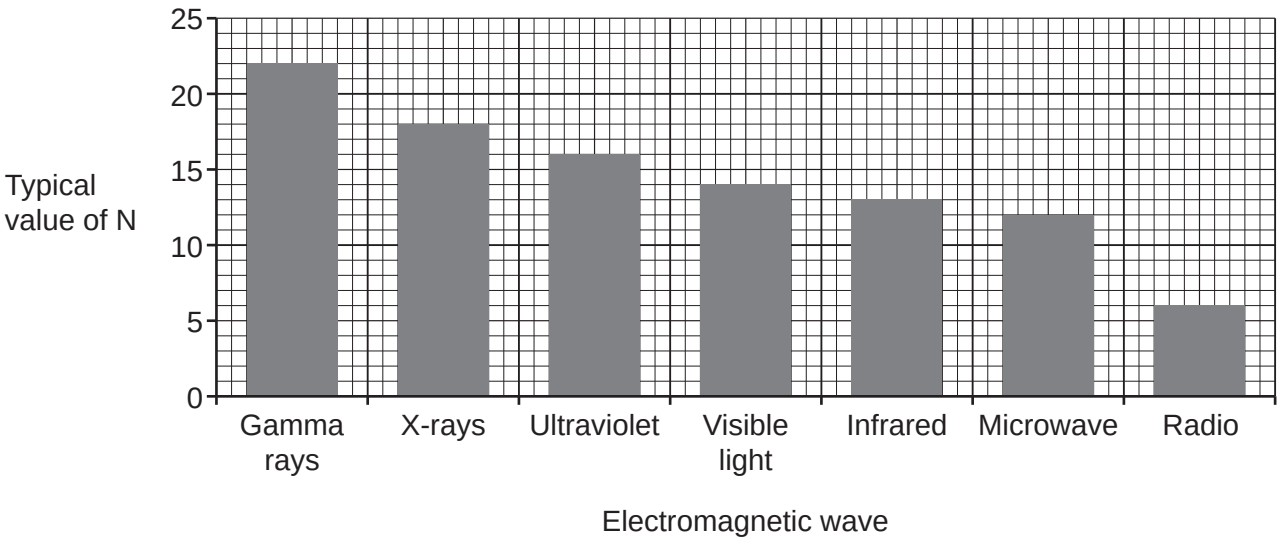
They have been irradiated and contaminated. ☐

They have **not** been irradiated or contaminated. ☐

[1]

12 The frequency of electromagnetic waves can be written as 1×10^{N} Hz.
N is an integer (a whole number).

The graph shows the typical values of N for different electromagnetic waves.



(a) Which electromagnetic wave has the **highest** frequency?

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

(b) Which electromagnetic wave is the **most** dangerous?

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

(c) Ultraviolet waves have a greater frequency than visible waves.

How many times greater?

Put a (ring) around the correct answer.

10^{2} 10^{3} 10^{13} 10^{14} 10^{16}

[1]

(d) What is the frequency of a typical radio wave on the graph?

Write your answer as an ordinary number without standard form.

Frequency = ... Hz **[2]**

(e) Which sentence is true about electromagnetic waves?

Tick (✓) **one** box.

Infrared waves do not have any harmful effects on human body tissue. ☐

Only microwaves transfer energy. ☐

Our eyes can detect all electromagnetic waves. ☐

They are transverse waves. ☐

[1]

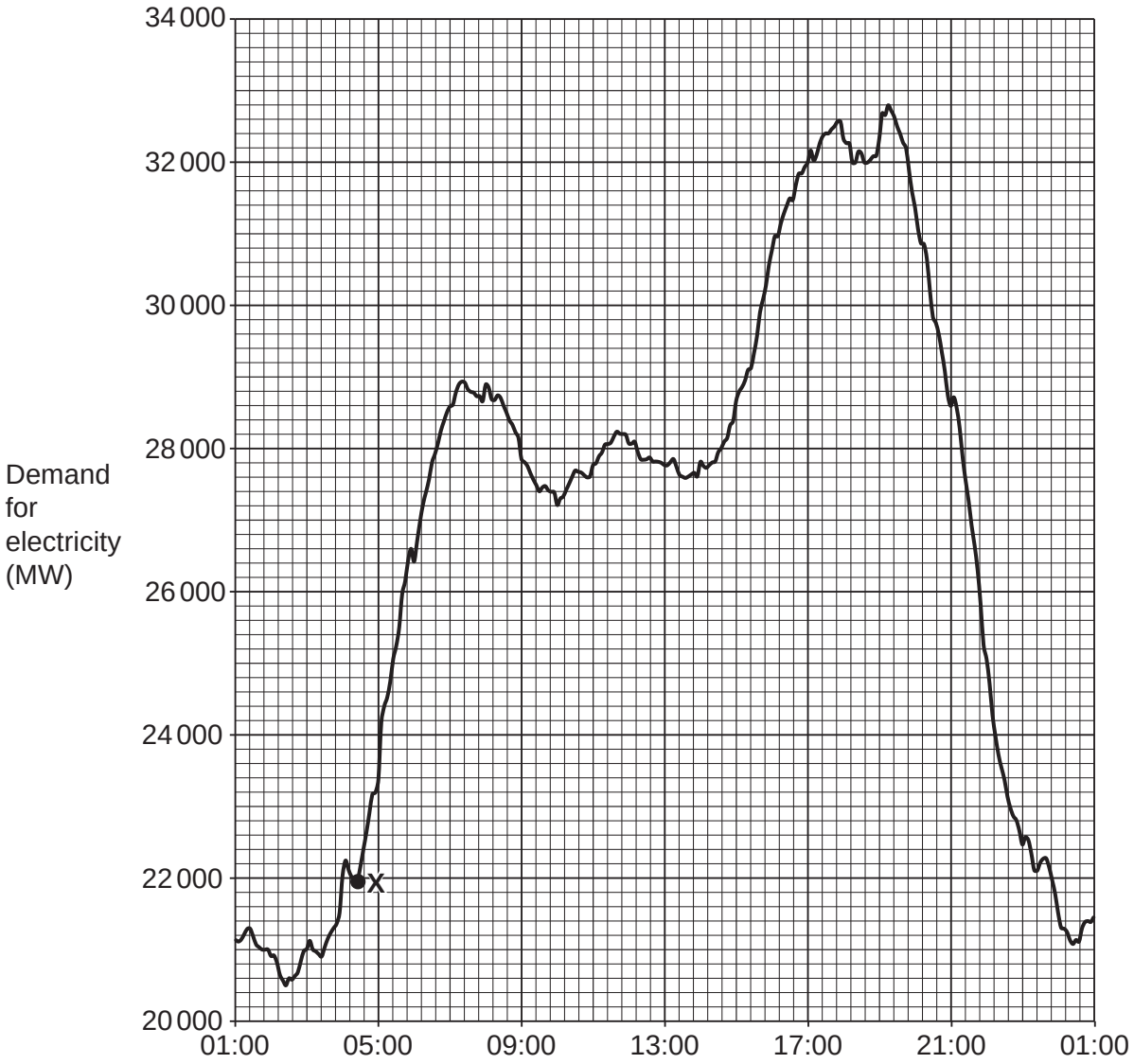
(f) A 0.8 kW microwave oven is used to cook food.
The microwave oven transfers 0.56 kWh when it is used to cook food.

Calculate the time the microwave oven is used for.

Use the equation: energy transferred = power × time

Time = ... h **[3]**

13 The graph shows how demand for electricity changes during a typical day in the UK.



Different energy sources can be used by the national grid at different times.

(a) Describe how the demand for electricity changes from 14:00 to 23:00.

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

(b) Explain why a gas fired power station is started at **X**.

.....

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.....

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

(c) The baseload demand is the minimum demand for electricity during the day.

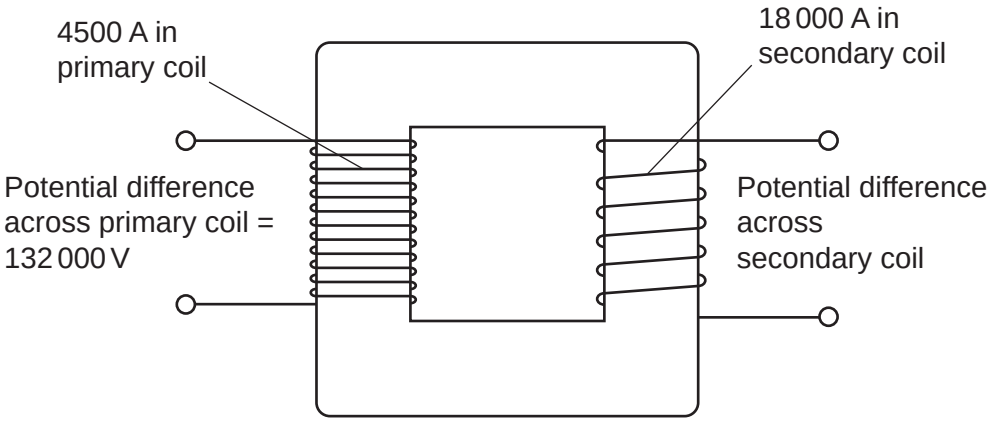
(i) Use the graph to calculate the baseload demand as a percentage of the maximum demand.

Percentage = ... % **[3]**

(ii) Suggest a type of power station which is suitable for supplying the baseload.

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

14 **(a)** The diagram shows a transformer.



Calculate the potential difference across the secondary coil of the transformer.

Use the Equation Sheet.

Potential difference across the secondary coil = ... V **[2]**

(b) The manufacturer says, 'The transformer is 98% efficient.'

Explain what this statement means.

.....

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

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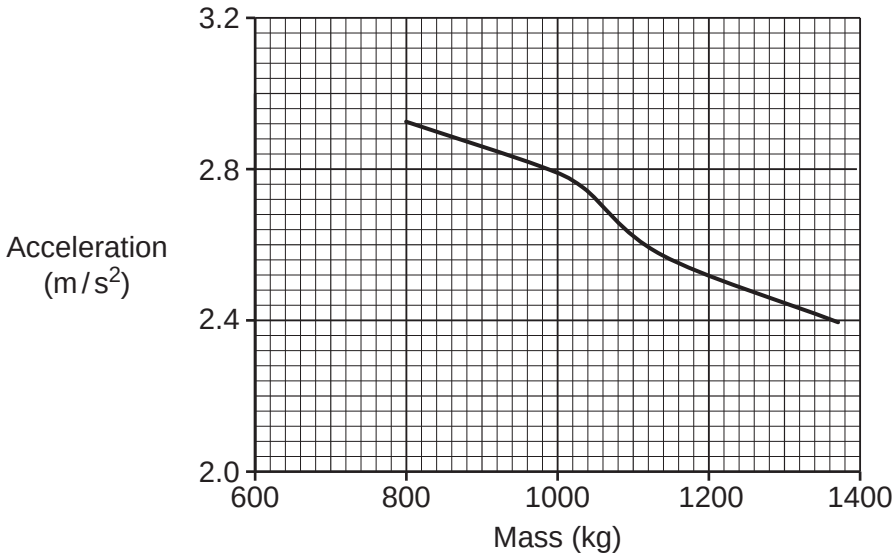
15 **(a)** The graph shows how acceleration changes with the mass of a car.



(i) Use the graph to determine the acceleration of a car with a mass of 1250 kg.

Acceleration = ... m/s² **[1]**

(ii) Use the graph to estimate the acceleration of a car with a mass of 700 kg.

Acceleration = ... m/s² **[2]**

(b) A car is travelling at 60 mph.

Which statement most likely describes what the car is doing?

Tick (✓) **one** box.

Reversing into a parking space ☐

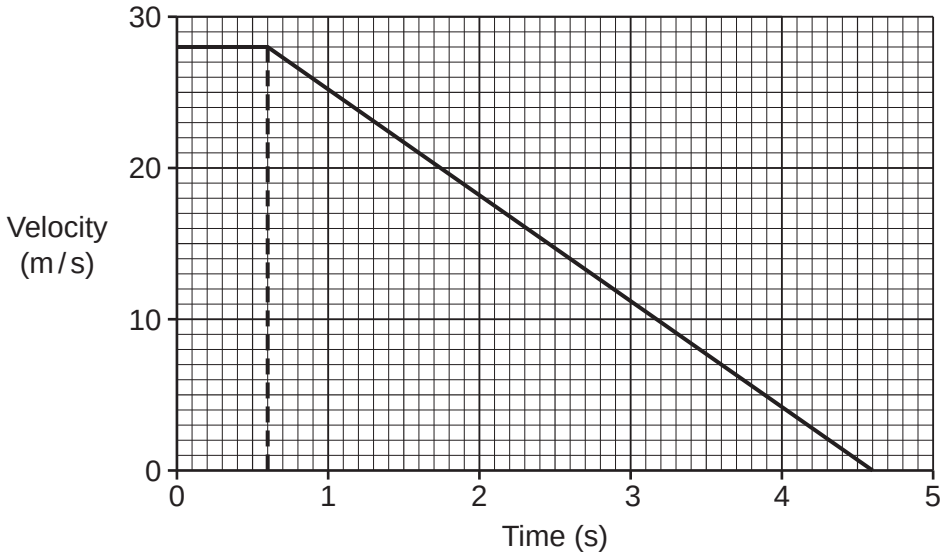
Travelling along a motorway ☐

Travelling along a road near a school ☐

Travelling in a town centre ☐

[1]

(c) This graph shows how the velocity of a car changes when driver **A** sees a hazard in the road at time = 0 seconds.



(i) Describe how the graph shows that the reaction time of driver **A** is 0.6 s.

.....

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

(ii) Calculate the braking distance on the graph.

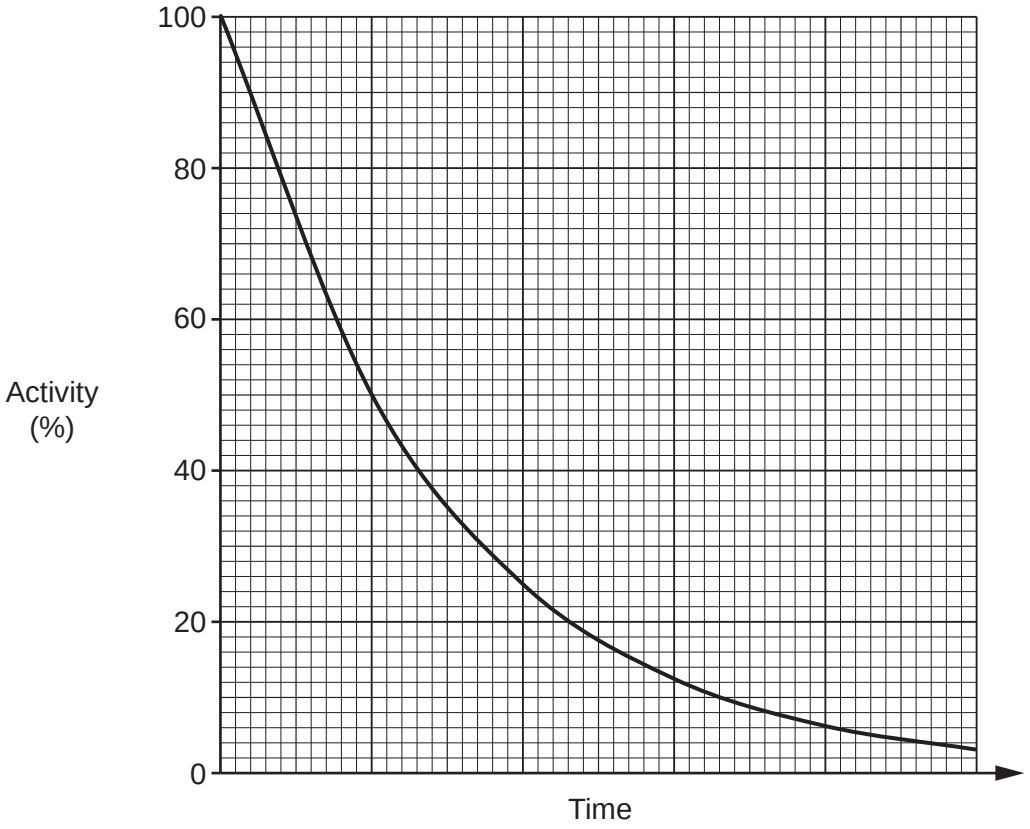
Braking distance = ... m **[2]**

(iii) Driver **B** then drives the same car with the same road conditions and sees the same hazard.

Driver **B**:
- drives at the same speed as driver **A**
- has been drinking alcohol
- applies the brakes harder than driver **A**.

Draw another line on the graph to show how the velocity changes for driver **B**. **[2]**

16* The graph shows how the activity of a radioactive isotope changes with time. The graph can be used to determine the half-life of the isotope.



Explain what is meant by half-life.

Describe how the half-life of this radioactive isotope is measured using a radiation detector. Draw on the graph to support your answer.

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

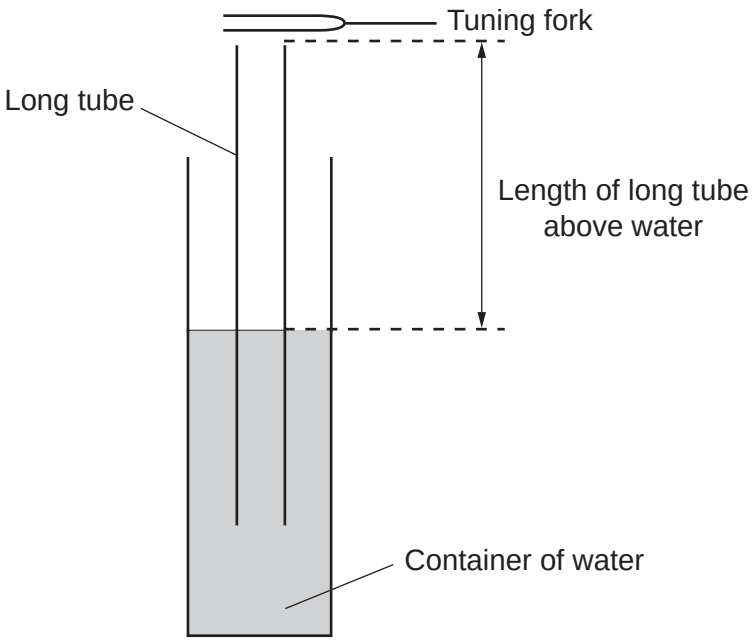
17 **(a)** Describe the motion of air particles in a sound wave.
You may include a labelled diagram.

.....

.....

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

(b) A group of students measure the speed of sound at a temperature of 20 °C using this equipment.



This is the method they follow:

- Place a long tube in a container of water.
- Hold a vibrating tuning fork over the top of the long tube.
- Pull the long tube out of the water slowly, until a loud sound is heard.
- Measure the length of the long tube above the water.

(i) **Table 17.1** shows the results for one student.

Table 17.1

Length of tube above the water	0.175 m
Frequency of tuning fork	480 Hz

The wavelength of the sound = 4 × the length of the tube above the water.

Calculate a value for the speed of sound using this student's results.

Use the Equation Sheet.

Speed of sound = ... m/s **[3]**

(ii) **Table 17.2** shows the results for the group of students.

Table 17.2

Student	Speed of sound (m/s)
1	314
2	320
3	330
4	315
5	321

The quality of these results can be judged using percentage uncertainty.

The percentage uncertainty in an experimental value is given by the equation.

$$\text{percentage uncertainty} = \left(0.5 \times \frac{\text{range}}{\text{mean value}}\right) \times 100\ \%$$

Calculate the percentage uncertainty in the students' results from **Table 17.2**.

Percentage uncertainty = ... % **[3]**

(iii) The speed of sound at 20 °C is 343 m / s.

Evaluate the **precision** and **accuracy** of the results in **Table 17.2**.

Precision .....

.....

Accuracy .....

.....

[2]

(iv) Which statement improves the **accuracy** of the results?

Tick (✓) **one** box.

Holding the tuning fork as close as possible to the end of the tube ☐

Measuring the volume of water in the container ☐

Using a tube with a shorter length ☐

Using a tuning fork with a higher frequency ☐

[1]

(v) Which statement describes a **systematic** error in the experiment?

Tick (✓) **one** box.

Background noise in the laboratory ☐

Changes in the temperature of the air ☐

Measuring the length of the tube below eye level ☐

Using a ruler with a zero error ☐

[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).