Oxford Cambridge and RSA

Monday 16 June 2025 – Morning

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

J250/12 Physics (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.

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Section A

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

Write your answer to each question in the box provided.

1 A student calculates that the energy used to make steel for a car is 1 260 000 000 J.

Which of these is equal to 1 260 000 000 J?

A 1260 GJ

B 1260 kJ

C 1260 MJ

D 1260 nJ

Your answer ☐ **[1]**

2 Object **X** and object **Y** move at the same speed.

Object **X** has 10 J of kinetic energy.
Object **Y** has twice the mass of object **X**.

What is the kinetic energy of object **Y**?

A 5 J

B 10 J

C 20 J

D 100 J

Your answer ☐ **[1]**

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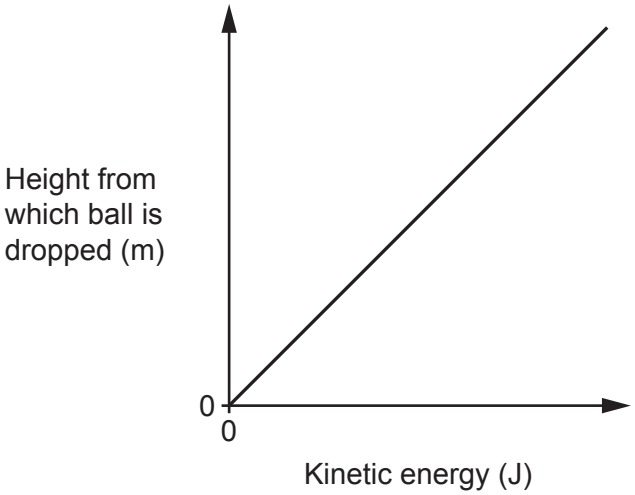
3 A student drops a ball.

The graph shows the relationship between the kinetic energy of the ball just before it hits the ground and the height from which the ball is dropped.



Which phrase describes this relationship?

A Directly proportional

B Negative correlation

C Non-linear

D Zero correlation

Your answer ☐

[1]

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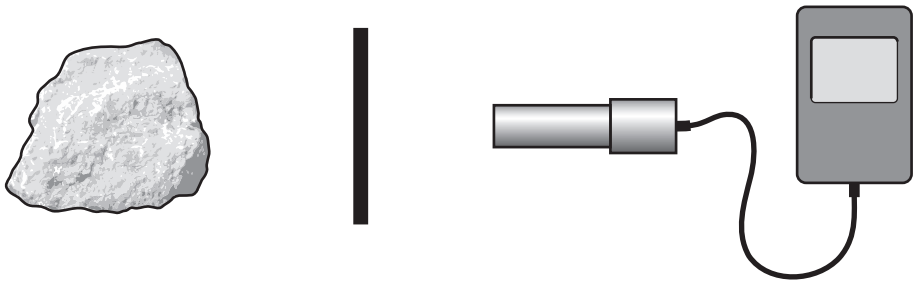
4 A geologist places different materials between a rock and a radiation detector to determine if the rock emits beta particles.



The counter records if radiation from the rock is detected when each material is used.

Which row shows the geologist's results if the rock emits beta particles?

Key
✓ radiation from the rock is detected

✗ radiation from the rock is not detected

	Material placed between the rock and the detector		
	1 cm of air	**5 sheets of paper**	**10 mm of aluminium**
A	✗	✗	✗
B	✓	✗	✗
C	✓	✓	✗
D	✓	✓	✓

Your answer ☐

[1]

5 Which of these would **not** reduce unwanted energy transfers?

A Filling gaps around doors and window frames

B Lubricating a bicycle chain

C Increasing the temperature of your home

D Insulating a mug that contains a hot drink

Your answer ☐

[1]

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6 What is a good estimate of the speed of a person running?

A 1.5 m/s

B 3.0 m/s

C 15 m/s

D 24 m/s

Your answer ☐ **[1]**

7 A remote control uses infra-red waves to send signals to a television.

The infra-red waves have a frequency of 320 THz and a speed of 3.0×10^8 m/s.

What is the wavelength of the infra-red waves?

Use the equation: wave speed = frequency × wavelength

A 9.4×10^{-7} m

B 1.1×10^{-6} m

C 9.4×10^{5} m

D 1.1×10^{6} m

Your answer ☐ **[1]**

8 Crumple zones reduce the risk of injury to car passengers in collisions.

How do crumple zones reduce the forces exerted in a collision?

A They decrease the time of the collision.

B They decrease the speed of the collision.

C They increase the acceleration during the collision.

D They increase the time of the collision.

Your answer ☐ **[1]**

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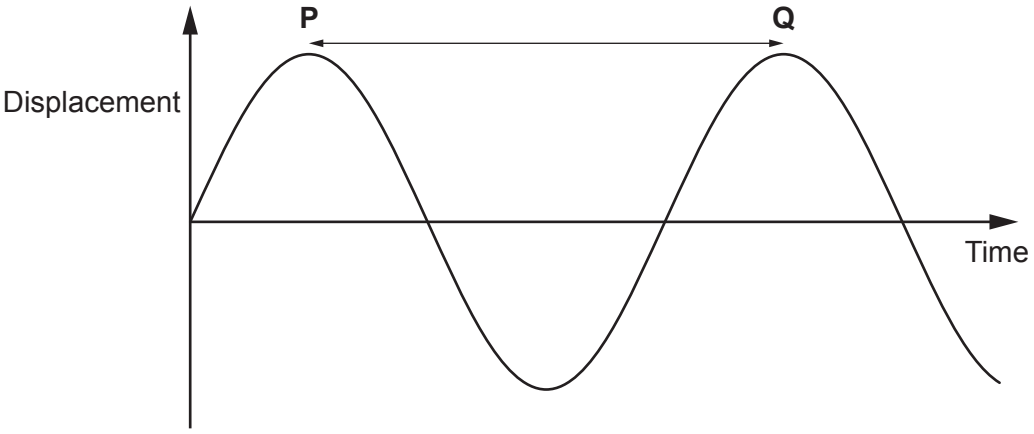
9 The displacement-time graph is shown for a wave passing a point.



Which quantity is indicated by the arrow **PQ**?

A Amplitude

B Frequency

C Period

D Wavelength

Your answer ☐

[1]

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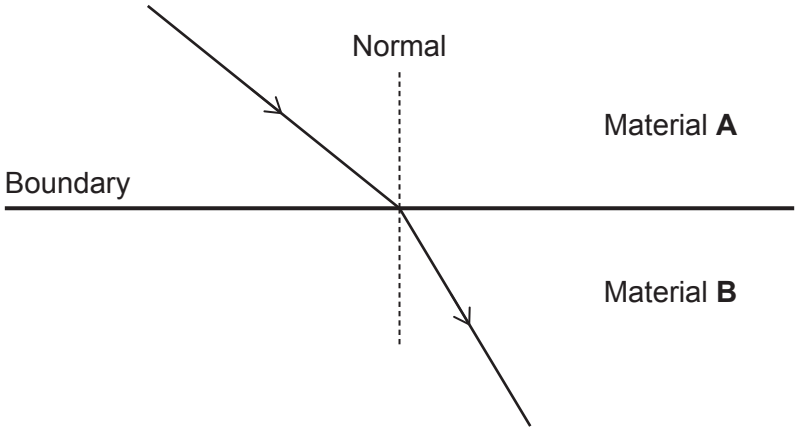
10 The diagram shows the refraction of a light wave as it passes from material **A** to material **B**.



Which statement is correct?

A The frequency of the wave increases as it passes from material **A** to material **B**.

B The period of the wave decreases as it passes from material **A** to material **B**.

C The speed of the wave decreases as it passes from material **A** to material **B**.

D The wavelength of the wave increases as it passes from material **A** to material **B**.

Your answer ☐

[1]

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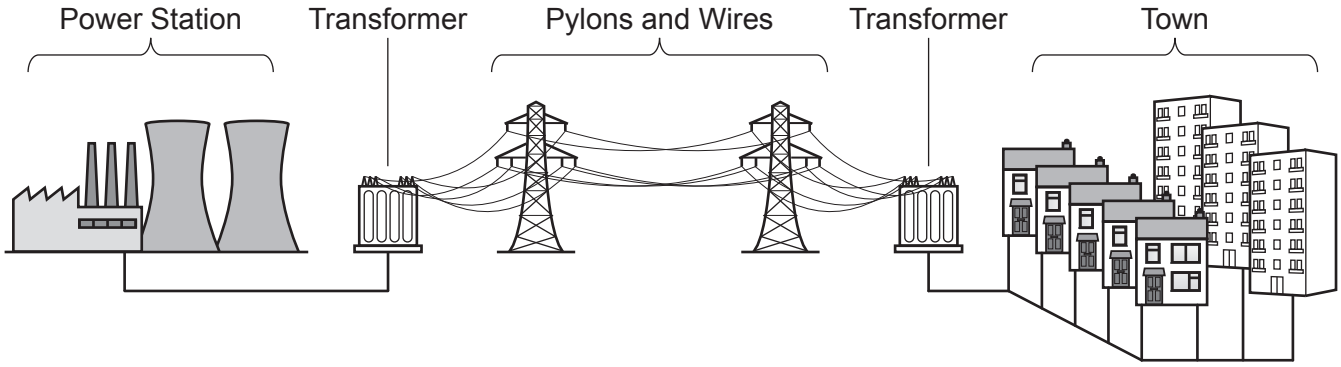
Section B

11 The diagram shows a power station connected to a town by the national grid.



(a) The national grid uses alternating voltage.

A simple circuit powered by a battery uses direct voltage.

Explain the difference between alternating voltage and direct voltage.

.....

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

(b) The table shows the current in one of the wires in the national grid at two different voltages.

Voltage across wire (V)	**Current in wire (A)**
11 000	730
400 000	20

(i) The wire has a resistance of 2.0 Ω.

Calculate how much power is dissipated from the wire at 11 000 V.

Use the equation: power = current^2 × resistance

Give your answer to **2** significant figures and in **MW**.

Power dissipated = ... MW **[4]**

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(ii) The national grid transfers 8 000 kJ of energy from the power station every second.

When the voltage across the wires is 400 000 V, the transformers and wires dissipate 160 kJ of this energy every second.

Calculate the efficiency of the energy transfer at 400 000 V.

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

efficiency = ... **[3]**

(iii) Explain how step-up transformers allow the national grid to transfer energy more efficiently.

.....

.....

.....

..... **[3]**

(c) A UK mains plug has 3 wires: live, neutral and earth.

Describe the function of the **neutral** wire.

.....

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

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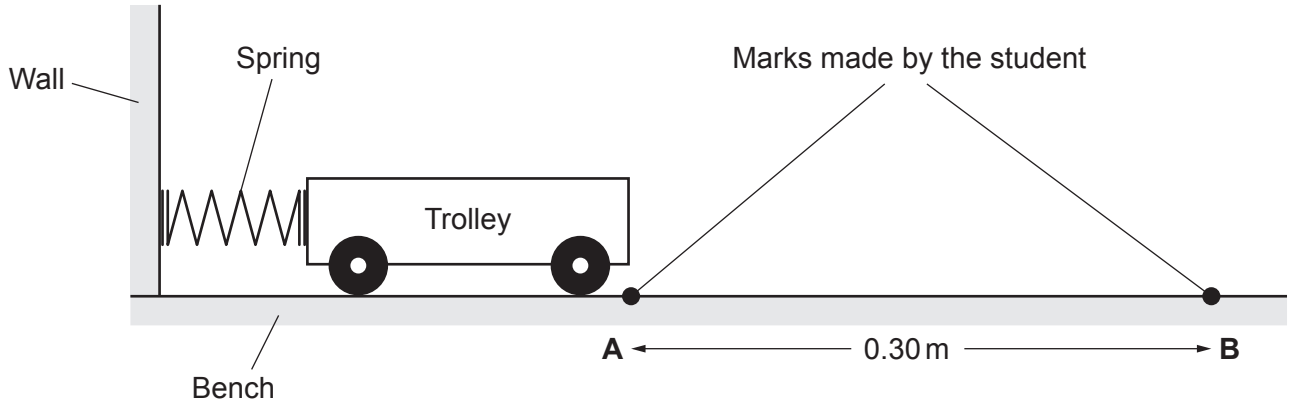
12 A student investigates the transfer of energy from a compressed spring to a trolley. They want to calculate the spring constant of the spring.

The diagram shows the position of the trolley and the spring **before** being compressed.

The student makes two marks, **A** and **B**, 0.30 m apart in front of the trolley.

The spring is **not** attached to the trolley.



(a) This is their method:

- Compress the spring by pushing the trolley towards the wall.
- Release the trolley from rest.
- Measure the time it takes for the trolley to travel 0.30 m from **A** to **B** using a stopwatch.
- Repeat the experiment 2 times.

The table shows the student's results.

Experiment Number	Time (s)
1	1.1
2	1.6
3	1.5

(i) Calculate the mean time it takes the trolley to travel from **A** to **B**.

Mean time = ... s **[2]**

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(ii) Calculate the average speed from **A** to **B**.

Use the Equation Sheet.

Average speed = ... m/s **[3]**

(iii) The **range** of results for the time it takes the trolley to travel from **A** to **B** is 0.5 s.

This range is large compared to the mean time it takes. It is due to errors when the student uses the stopwatch.

Complete the sentence to explain the large range of results.

Use words from the list.

accuracy	**random**	**reaction**	**systematic**

A large range of results is caused by a type of error know as a ..... error.

The ..... time of the student causes this type of error.

[2]

(iv) Suggest **one** way the student can improve the experiment to reduce the effect of the error in **(a)(iii)**.

.....

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

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(b)

(i) The student uses the speed calculated in **(a)(ii)** to determine the change in the kinetic energy store of the trolley.

The change in the kinetic energy store of the trolley is 1.9×10^{-2} J.

The spring is compressed by 0.02 m each time.

Calculate the spring constant of the spring.

Assume that all of the energy stored in the compressed spring is transferred to the kinetic energy store of the trolley.

Use the equation:

$$\text{energy stored in the compressed spring} = \frac{1}{2} \times \text{spring constant} \times (\text{change in length of spring})^2$$

Spring constant = ... N / m **[3]**

(ii) The value calculated for the spring constant in **(b)(i)** assumes that there is **no** friction between the wheels of the trolley and the bench.

What effect would friction have on the value calculated for the spring constant in **(b)(i)**?

Explain your answer.

Effect on spring constant .....

.....

Explanation .....

.....

[2]

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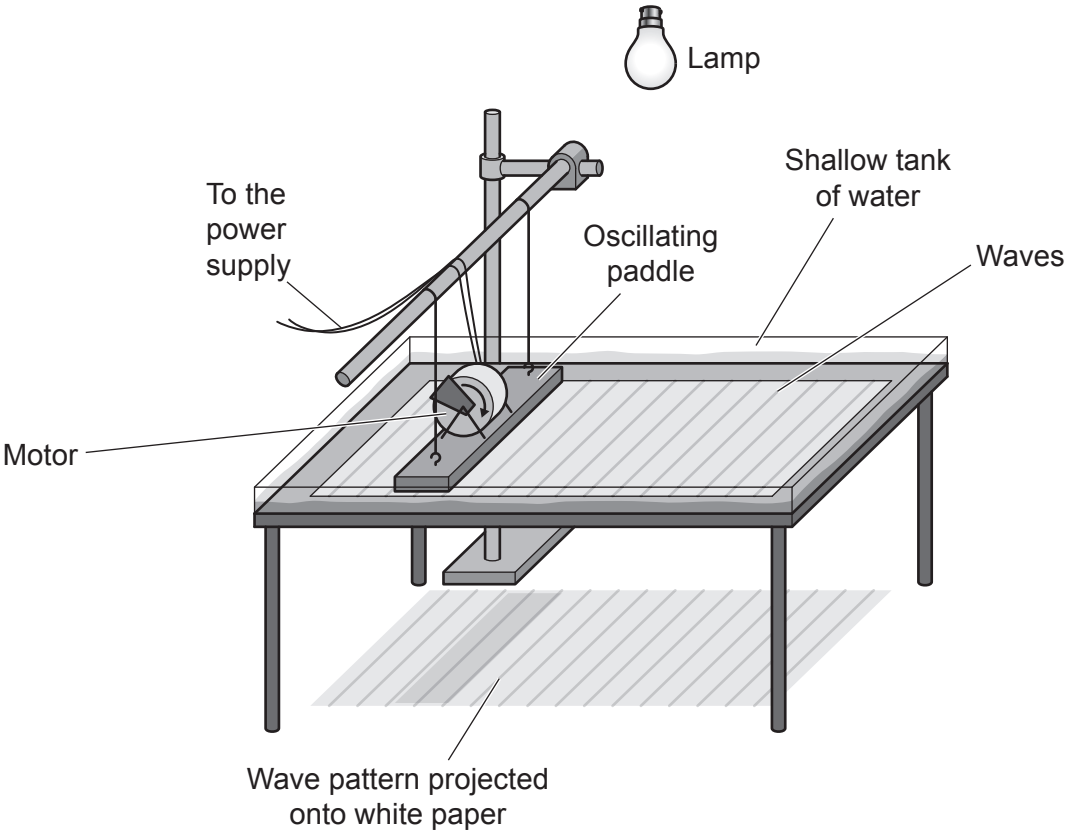
13 A student investigates if there is a relationship between the depth of water in a ripple tank and the speed of the waves on the surface of the water.

Fig. 13.1 shows the equipment the student uses.

Fig. 13.1



The motor causes the paddle to oscillate and produce waves in the ripple tank.

The lamp above the ripple tank projects the wave pattern onto white paper underneath the ripple tank.

(a) The frequency, wavelength and speed of the waves can be changed.

State the unit for each of the variables.

Frequency .....

Wavelength .....

Wave speed .....

[2]

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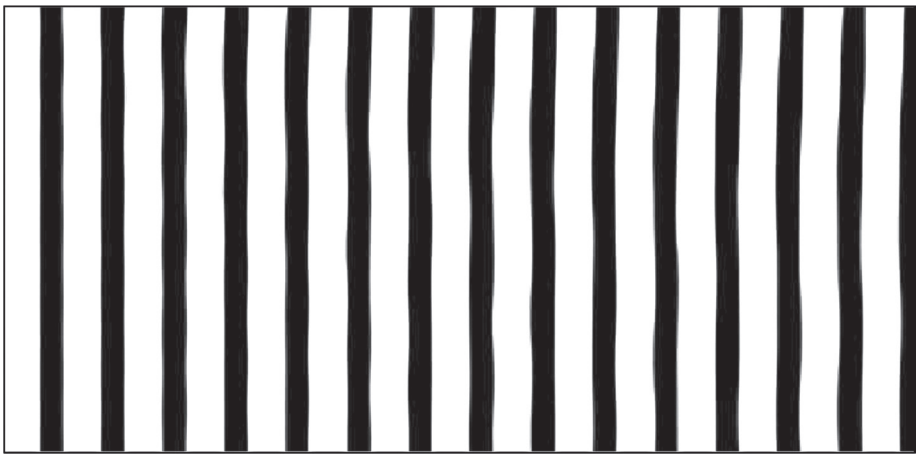
(b) The student takes a photograph of the wave pattern projected onto the white paper.

Fig. 13.2 shows a diagram of the photograph.

Fig. 13.2



Describe how the student uses **Fig. 13.2** to obtain an accurate value for the wavelength of the wave.

You can draw on **Fig. 13.2** to support your answer.

.....

.....

.....

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

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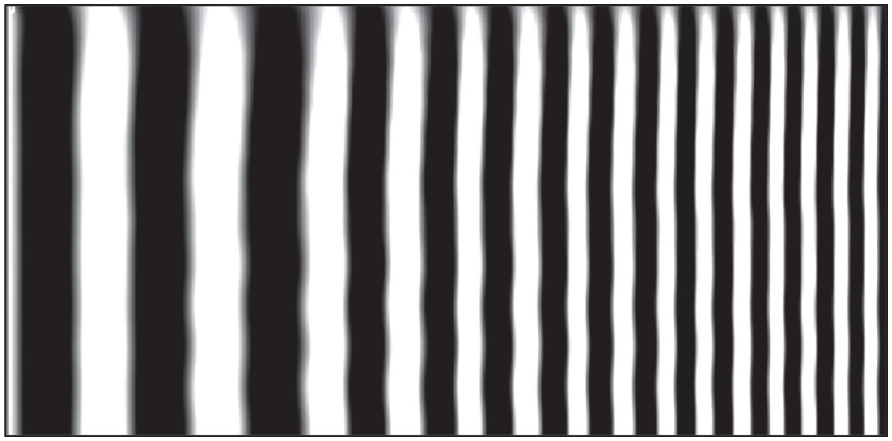
(c) The student lifts the ripple tank at one end so that the water is deeper at one end of the ripple tank than at the other end.

The student uses the motor and paddle to produce waves and takes a photograph of the wave pattern projected onto the white paper.

Fig. 13.3 shows a scale diagram of the photograph.

Fig. 13.3

Deep end



Shallow end

Describe and explain how the speed of the waves changes as the waves travel from the deep end of the ripple tank to the shallow end in **Fig. 13.3**.

Use the relationship between wave speed, frequency and wavelength in your explanation.

.....

.....

.....

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

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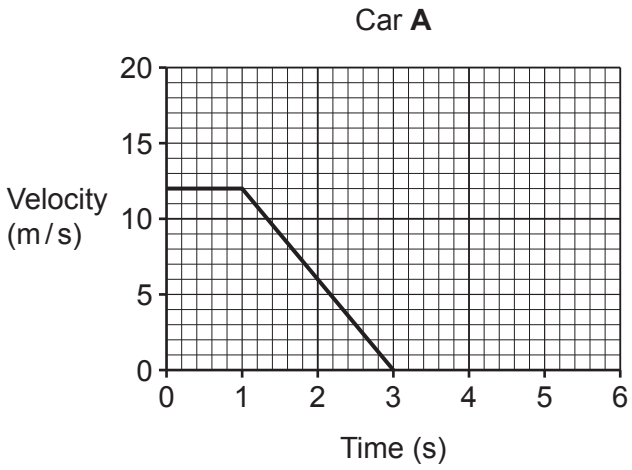
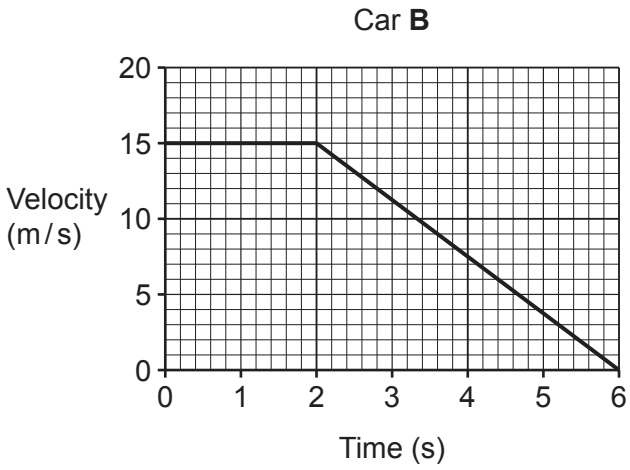
14* The drivers of two cars, **A** and **B**, see the same hazard on the road in front of them at the same time. Both drivers press the brakes and come to a stop.

The velocity-time graphs show how the velocity of each car varies from when the driver sees the hazard at time t = 0 seconds to when the car comes to a stop.





Compare the thinking distance and braking distance of each car using both graphs.

Suggest reasons for the differences in the thinking distance and braking distance of each car.

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

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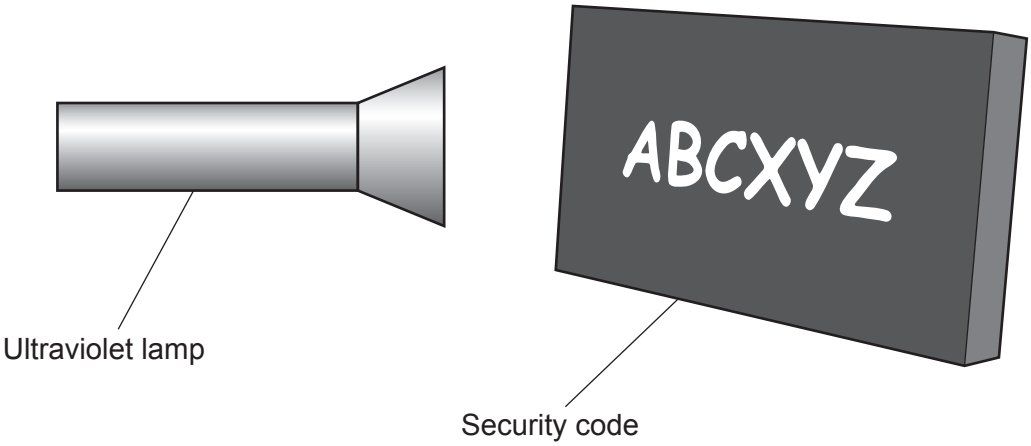
15

(a) Security markings can be written on items you own. These are written using a fluorescent ink which is only visible under an ultraviolet lamp.

The diagram shows a security code ABCXYZ written on a black surface.



Particles inside the atoms in the ink absorb energy from ultraviolet radiation.

The same particles inside the atoms in the ink re-emit the energy as waves in the visible light region of the electromagnetic spectrum.

(i) Which particles inside the atom absorb ultraviolet radiation and emit visible light?

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

(ii) Describe what happens to these particles when they absorb ultraviolet radiation.

.....

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

(iii) Electromagnetic waves with short wavelengths can cause **ionisation** when absorbed by these particles inside the atom.

Describe the effect ionisation has on the atom.

.....

.....

.....

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

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(b) Radio waves and microwaves are both electromagnetic waves.

(i) Describe the difference in frequency between radio waves and microwaves.

.....

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

(ii) Describe **one use** that radio waves and microwaves have in common.

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

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16 Two isotopes of iodine are $^{127}_{53}I$ (iodine-127) and $^{131}_{53}I$ (iodine-131).

(a) Describe **one similarity** and **one difference** between a nucleus of iodine-127 and a nucleus of iodine-131.

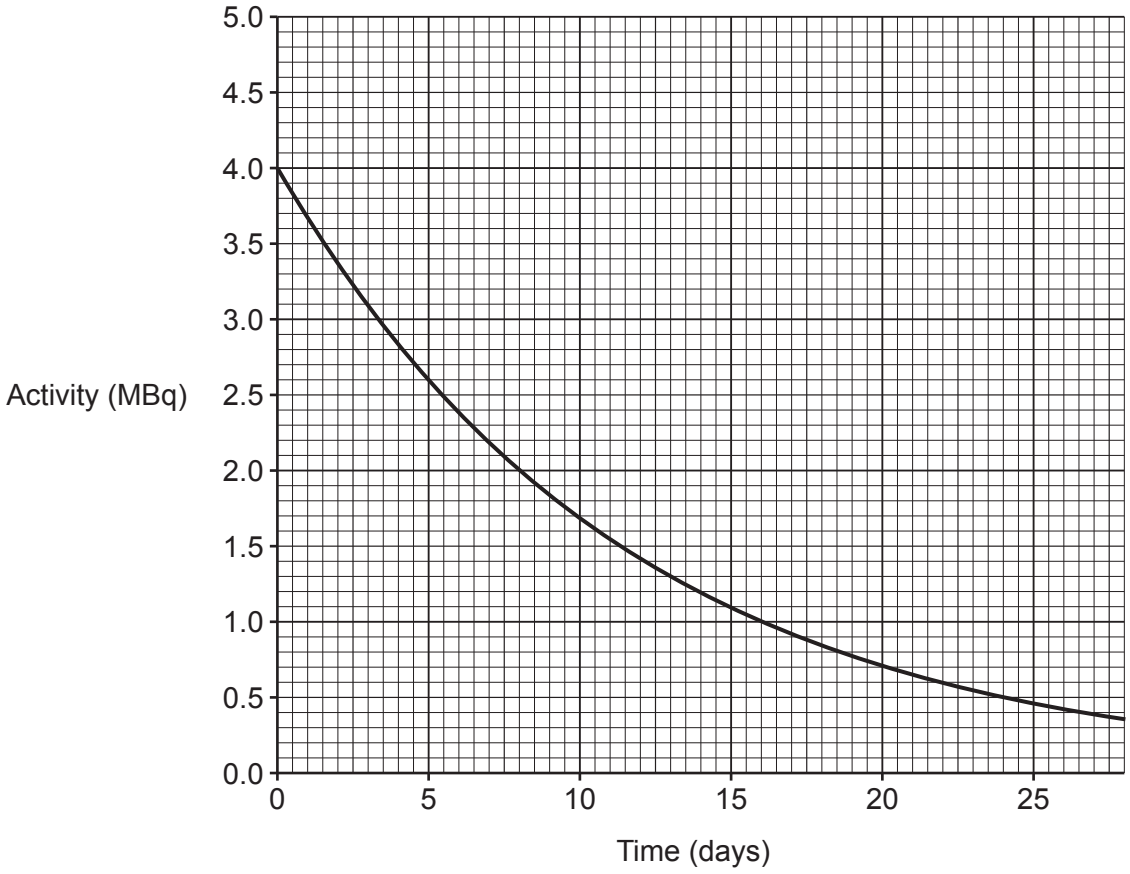
Similarity .....

Difference .....

[2]

(b) Iodine-131 is radioactive.

The graph shows how the activity of a sample of iodine-131 changes over time.



(i) Use the graph to show that the half-life of iodine-131 is approximately 8 days.

Show your working on the graph.

.....

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

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(ii) Iodine-131 is used as a medical tracer and for radiotherapy when treating cancer patients.

A radiologist injects a patient with a dose of iodine-131. The dose has an initial activity of 4.00 MBq.

Calculate the number of days it takes the activity to reduce to 0.25 MBq.

Number of days = ... days **[2]**

(iii) The radiologist wears gloves and a film badge while handling iodine-131.

The film badge contains photographic film which turns dark when exposed to ionising radiation.

Explain how using the gloves and the film badge reduces risks to the radiologist's health.

.....

.....

.....

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

END OF QUESTION PAPER

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EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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