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Examiners' report

GCSE

COMBINED SCIENCE A (GATEWAY SCIENCE)

OCR Level 1/Level 2 GCSE (9-1) in Combined Science A (Gateway Science)

J250

For first teaching in 2016

J250/12 Summer 2025 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 responses 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 Teach Cambridge.

Paper 12 series overview

J250/12 is one of six Higher tier papers for the GCSE (9-1) Combined Science A (Gateway Science)

qualification. It is the second of the two physics papers covering topics P4 Waves and radioactivity, P5 Energy, P6 Global challenges and CS7 Practical skills. There is assumed knowledge of P1 – P3 and this paper includes synoptic assessment.

To achieve well in this paper candidates, need to apply their knowledge and understanding to new situations and be familiar with a range of practical activities. In this paper the practical activities included:

- measuring the speed of trolleys moved by a compressed spring (Question 12)
- the relationship between speed, wavelength and frequency of water waves in a ripple tank including how the change in the water depth demonstrated the effect of changing speed on wavelength (Question 13).

To be successful candidates need to understand the command words used in the paper and know what is expected as a response for each different command word. The command words 'calculate' and 'describe' were well understood but other words such as 'explain' and 'suggest' were less well understood.

The candidates performed better on questions involving calculations, including questions that required the candidate to calculate means, convert answers to two significant figures and into MW.

Candidates performed less well on the interpretation of waves including both graphical interpretation and in a ripple tank (Questions 9, 13 (b), and 13 (c)).

There was no evidence to suggest that candidates were short of time in answering the questions on this paper and the omit rate was low.

Questions 1, 2 and 11 are overlap questions with the Foundation paper, J250/06.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• recalled and applied that a ray refracts towards the normal as the wave slows down as it moves across a boundary (Question 9) • recalled how crumple zones increase the time of a collision to reduce risk of injury (Question 8) • converted recalled and units, where required • explained that increasing voltage reduced energy dissipation in the national grid but still did not explain that the current is reduced (Question 11 (b) (iii)) • applied the assumed knowledge of velocity-time graphs to make a quantitative comparison of how initial speed and reaction time affected these (Question 14) • used precise language to suggest how factors affected thinking, braking and stopping distances (Question 14) • rearranged, substituted and evaluated correctly across several questions • recalled that the electron absorbs UV in an atom and that electrons are gained or lost during ionisation (Question 15) • compared accurately isotopes of iodine in terms of both proton number and neutron number (Question 16 (a)) • used initial and final activity and half-life to determine the time taken for a sample activity to decay to a given value (Question 16 (b) (ii)).	• left multiple-choice answers blank or tried to overwrite in an unclear way, especially with B and D as choices • when asked for explanations gave descriptions instead • used poorly matched descriptors such as faster time (Question 14) or shorter frequency (Question 15 (c)) • substituted correctly into given equations (Question 11 (b)) but not able to convert to 2 significant figures and MW) • correctly identified a directly proportional relationship in a line graph (Question 3) • were unfamiliar with the difference between alternating and direct voltage (Question 11(a)) • could not describe the role of the neutral wire (Question 11 (c)) • calculated mean time from readings but misunderstood how to calculate average speed (Questions 12 (a) (i) and (ii)) • could not recognise the limitations in methods to measure speed and hence could only suggested changing the investigator or carry out more repeats (Question 12 (a) (iv)) • correctly used a decay curve to show half-life (Question 16 (b) (i)) • explained how gloves can reduce contamination by a radioactive tracer (Question 16 (b) (iii)).

Section A overview

Section A consists of ten multiple-choice questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

Nearly all candidates attempted all the questions.

Some candidates also wrote down their calculations for the numerical multiple-choice questions, especially if the equation needed to be rearranged to work out the final answer.

The most successful candidates worked through the distractors methodically, e.g. by eliminating those they believed to be the most obviously incorrect responses (doing so by crossing through those eliminated choices).

The two overlap Questions 1 and 2 proved to present the same level challenge as the remainder of the questions in Section A.

Two questions were particularly challenging across the whole mark range, and both came from the Waves topic.

Question 7 (involving both rearrangement of equation and a unit conversion from THz) emphasised the importance of showing and using working in accessing this multistep question.

In Question 9, very few candidates scored in this question which appeared unfamiliar as a wave represented as a displacement-time graph (refer to Misconceptions insert). This reinforces the importance of the apparatus and techniques in the specification.

Question 1

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]**

Most candidates correctly selected option C. Almost all discarded option D but a significant minority incorrectly chose A or B.

Question 2

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

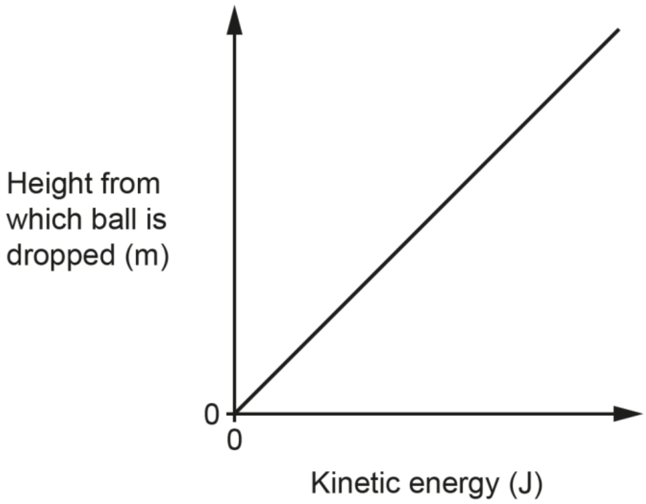
Your answer ☐ **[1]**

A significant majority of candidates correctly applied the proportional relationship between mass and kinetic energy

Question 3

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

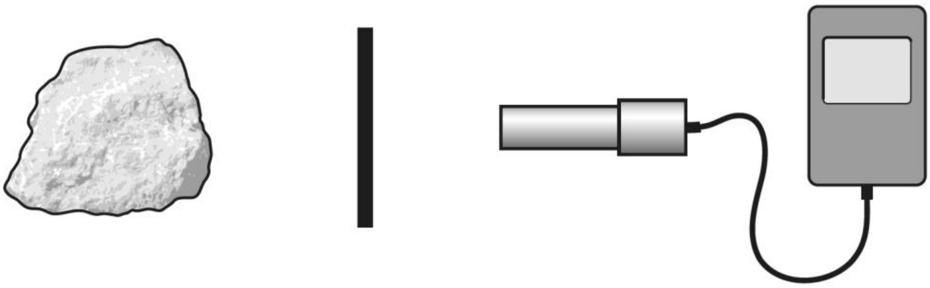
D Zero correlation

Your answer ☐ **[1]**

Almost all candidates recognised a directly proportional relationship presented as a graph.

Question 4

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]**

The majority of candidates correctly recalled and applied knowledge of the penetration of beta particles. Those that did not usually chose B or D.

Question 5

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]**

Most candidates correctly identified that increasing temperature would increase rather than decrease unwanted energy transfers. The most common incorrect response was B which may have been due to unfamiliarity with this example especially with candidates who scored less well overall.

Question 6

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]**

This question required the recall of typical speeds encountered in everyday experience. Although answered well by most candidates, a significant minority chose option A after eliminating the other choices C and D. There was very little evidence of attempts to convert from m/s to km/h which may have made the choice more obvious and provided a confirmation (5.4 km versus 10.8 km covered in an hour).

Question 7

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]**

Most candidates found this challenging. A majority selected option C by substituting incorrectly into the unrearranged equation (with speed in the place of wavelength) and not converting from THz to HZ. Successful candidates showed their working: rearrangement, conversion from THz, substitution into the rearranged equation and expressed their answer in standard form.

Assessment for learning

In numerical questions that require extended processing and interconversion of units, students need to experience and practice the following:

- write down the equation (using the Equation sheet where applicable)
- rearrange the equation (if required)
- substitute the data
- (if necessary) convert the prefixes of quantities to base units
- evaluate
- consider the whether the answer looks right
- give answers in units with the required prefix. Consider whether units are consistent and convert using appropriate prefix for powers of 10
- check that the answer is expressed to the required number of significant figures.

Teachers may wish to refer to section 2.4 of the ASE publication [The Language of Mathematics in Science].

It will help candidates if they underline the key quantities given, including what they represent, e.g. 10 kg (mass), and the prefix of any units.

Question 8

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.

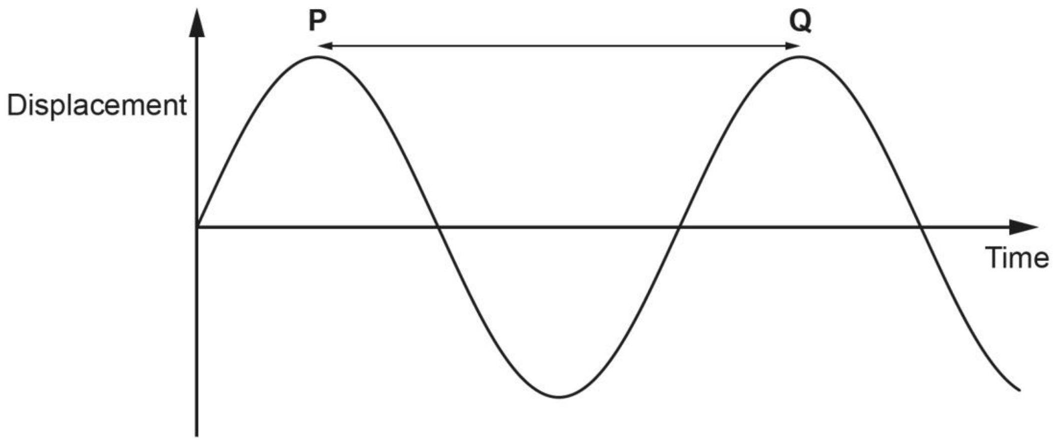
D They increase the time of the collision.

Your answer ☐ **[1]**

Few candidates selected option D, that crumple zones increase the time of the collision (the same point was made in the report on this component in 2024). The most common incorrect answers given were A and B.

Question 9

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]

Very few candidates correctly chose period as the distance on a displacement-time graph between two maxima. The vast majority chose incorrectly D wavelength.

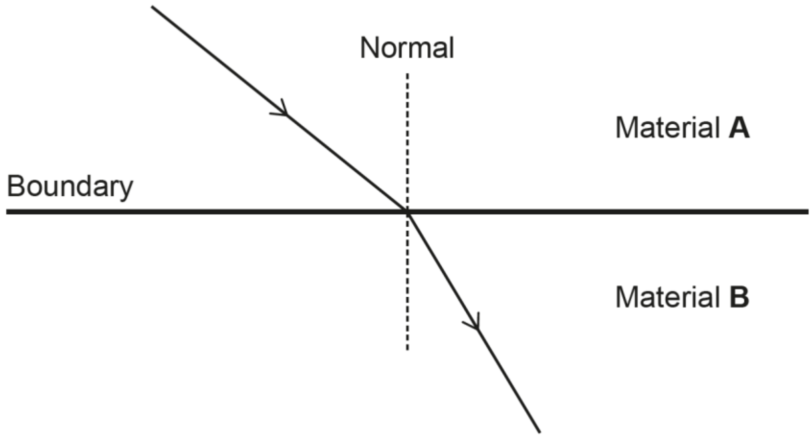
Misconception

Waves can be displayed graphically as displacement-distance (at a fixed point in time) or displacement-time (for a fixed point on a wave).

Almost all candidates identified the distance between two maxima on a displacement-time graph as wavelength rather than period. This could be shown in an oscilloscope, changing time base on the oscilloscope to show the importance of scale on the time axis.

Question 10

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]

The majority of candidates knew that a wave refracts towards the normal as it crosses a boundary between two media because the wave speed decreases. This was especially true of those candidates who achieved more strongly across the whole paper.

Section B overview

This section consists of six multiple part questions including short 1-mark questions, questions involving longer responses, some developed calculations and one Level of Response question (Question 14). This section tests AO1, AO2 and AO3.

To be successful in this section candidates should be encouraged to underline key information and data as they read a question.

Most candidates were able to attempt all of the questions.

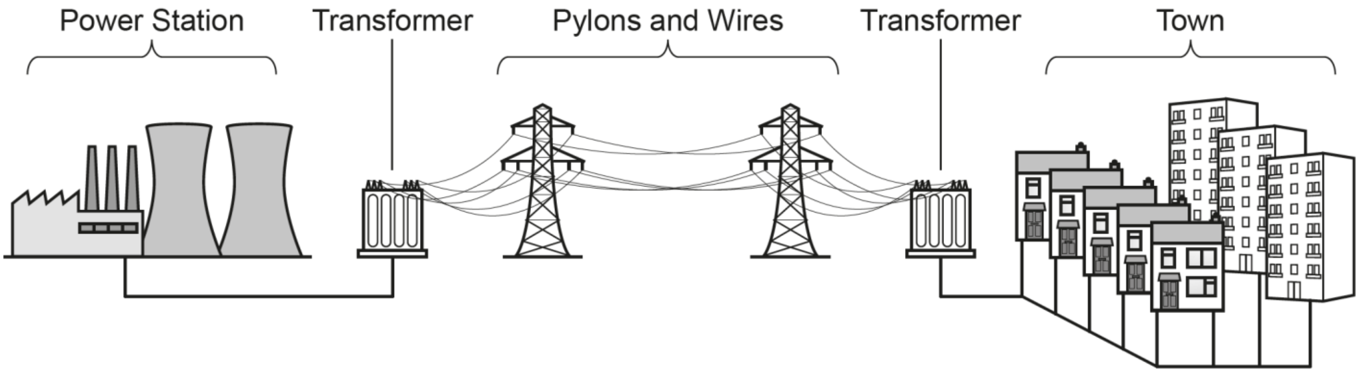
Candidates found explaining, making comparisons and suggestions with an open response to be the most challenging type of question. Candidates frequently gave correct but incomplete answers. This was particularly obvious in Questions 11 (a) and 14 where it would have been particularly helpful to underline and then check their response to make sure that the question had been answered fully.

The use of an incorrect descriptor or poorly matched one, such as shorter frequency or faster time hindered some candidates who clearly had knowledge but did not communicate this appropriately.

Candidates were more successful and familiar with transmission of energy in the national grid (Question 11), investigation into calculating mean time and determining average speeds (Question 12) and radioactive decay (Question 16). However, some parts of the specification such as the demonstration of wave phenomena in ripple tanks (Question 13) and absorption of UV, the electron and ionisation (Question 15) seemed far less familiar.

Question 11 (a)

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]**

Few candidates could explain the difference between alternating and direct voltage. There was a wide variety of incorrect explanations given including vague references to alternating voltage as having a range of values and alternating voltage going to many different places. Many candidates only commented on either alternating or direct but did not explain the difference. Only candidates who scored well on the whole paper answered this question consistently well.

Question 11 (b) (i)

(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]**

This was generally answered well. Most candidates scored at least 2 marks for selecting the correct current from the table, substituting accurately, and evaluating correctly.

Only higher scoring candidates achieved the marks for significant figures or conversion to MW. This was mainly due to either not responding to these demands or not being able to systematically show working to arrive at a response worthy of full marks.

Exemplar 1

Use the equation: power = current^2 × resistance

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

$P = I^2 \times r$ $730^2 \times 2 = 1065{,}800$

$\frac{1{,}065{,}800 \text{ watts}}{1000000}$

1.0658 MW

~~11,000~~

Power dissipated = ~~MW~~ 1.1 MW **[4]**

In this response key information is underlined, the equation is stated, data is then substituted into the equation and then evaluated.

The value is then methodically converted (by division by 1 000 000) to MW and finally the answer is presented to 2 significant figures. A very logical and complete step by step approach that gained full credit.

Question 11 (b) (ii)

(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]**

Most candidates scored at least one mark on this question. This was usually gained by dividing by the total energy input transfer. The question discriminated very well between candidates, with only those who achieved most highly on the paper correctly calculating the useful energy output transfer from the information given.

Question 11 (b) (iii)

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

....

....

....

.... **[3]**

Most candidates recalled that the national grid reduced energy loss during power transmission. Only the highest scoring candidates could explain that this was a consequence of the current being reduced as the voltage was increased (for the same power supplied). The question discriminated very well.

Question 11 (c)

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

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

....

.... **[1]**

The role of the neutral wire was not well known across the whole mark range. The most frequent incorrect responses were that the neutral wire does not carry current (linked to a misconception about potential difference in a.c. circuits) or that it is for safety and to prevent overloading (confusing with the earth wire). Both misconceptions can lead to significant risk for the safety of mains electricity users.

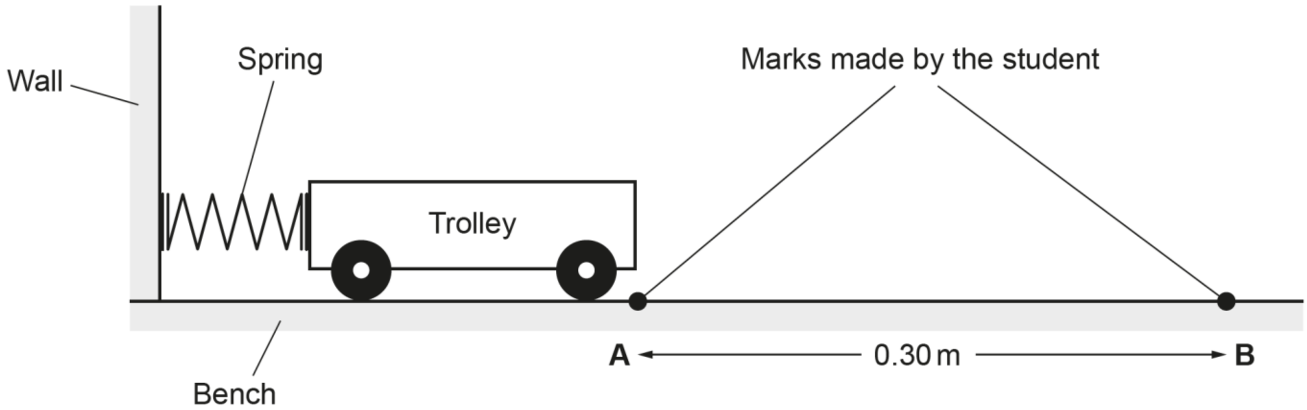
Question 12 (a) (i)

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]**

Almost all candidates accurately calculated the mean time.

Question 12 (a) (ii)

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

Use the Equation Sheet.

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

The vast majority of candidates correctly calculated average speed from by dividing the distance travelled by the mean time. Some students did not score as they did not state the appropriate equation and then gave the mean of the calculated values of distance divided by time for each repeat (the mean of the speeds rather than the average speed).

Question 12 (a) (iii)

(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]

Very few candidates did not score on this question (usually for reaction time) but only about a fifth of candidates achieved full marks and could identify a random error. The most frequent incorrect answer was systematic error.

Question 12 (a) (iv)

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

....

.... **[1]**

The most common response to this question was repeat with another student with faster reactions. Only a minority of students scored, usually for the selection of light gates and less frequently for increasing the length of the runway (and thereby increasing the total time taken).

Question 12 (b) (i)

(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]**

Most candidates were able to rearrange the equation, convert from standard form, substitute and evaluate correctly. Candidates who achieved less well overall found this question very challenging due to the level of mathematical demands. One common mistake was to fail to square the change in length of the spring.

Question 12 (b) (ii)

(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]**

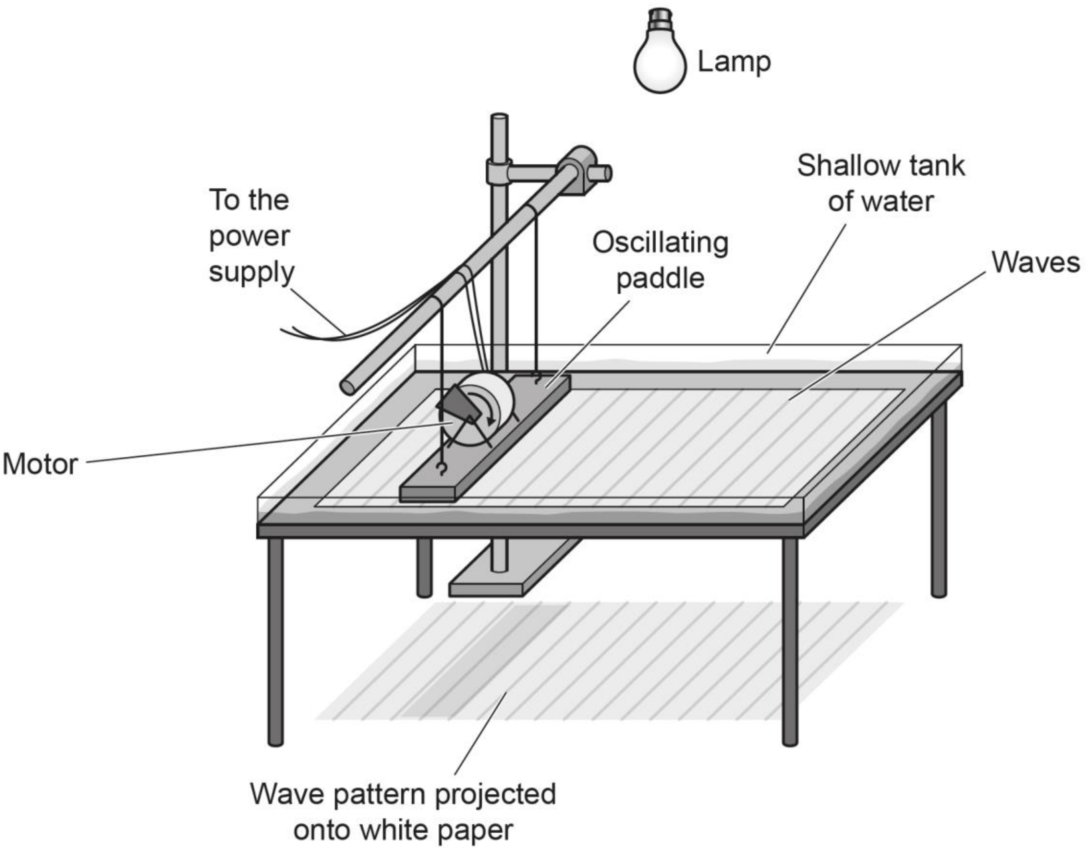
This question proved challenging. Where a mark was achieved it was usually due to a guess about the increase in the spring constant or a comment about energy dissipated to surroundings. Most candidates thought that the spring constant would decrease and gave ideas related to the trolley being harder to push.

Question 13 (a)

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]

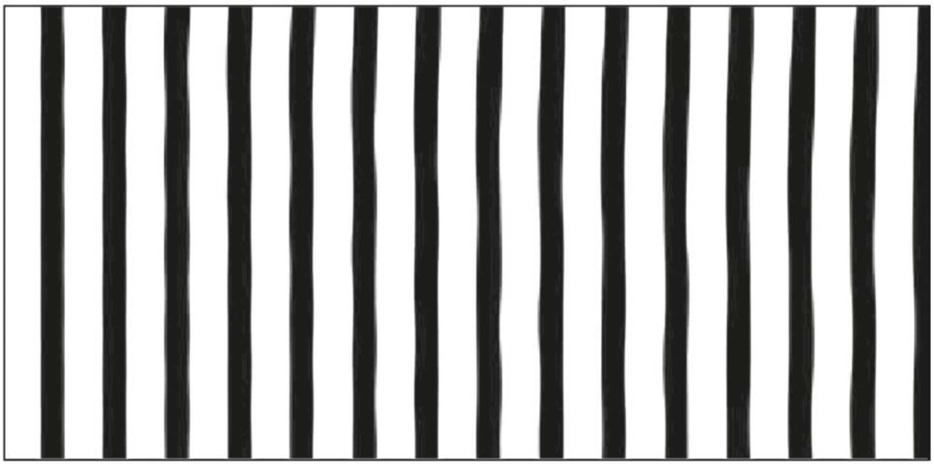
Almost all candidates scored at least one mark and the majority scored full marks. Where candidates did not gain full credit it was due to giving symbols instead of units, an incorrect or omitted choice for frequency or for a wavelength or speed prefix not suitable for this context, e.g. nm or km / h respectively.

Question 13 (b)

(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]**

Most candidates found this question challenging. Frequently candidates misconceived wavelength as the width of a white gap (rather than the distance between the start of one bright and the next) or wanted to time the number of waves passing each second and wave speed (even though they had been asked to use the photograph).

Question 13 (c)

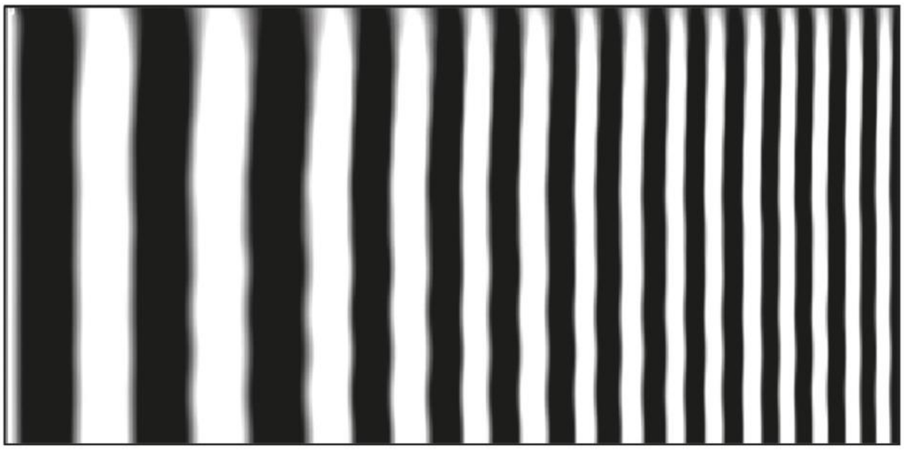
(c) The student lifts the ripple tank at one end so that the water is deeper at one end of the ripple tank than at the other end.

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]**

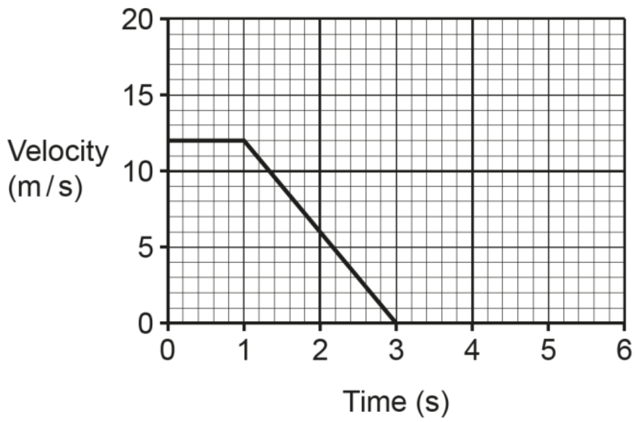
Most candidates gained one mark for correctly using the photograph to deduce that the wavelength decreased into the shallow end. However, very few candidates realised that the frequency of the waves from the source was invariant. Therefore, few identified that wavelength was proportional to wave speed without at the same time contradicting the mark by stating that frequency increased as well.

Question 14*

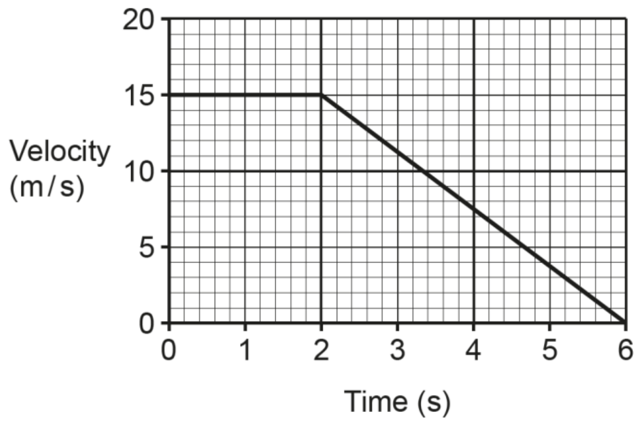
14* The drivers of two cars, **A** and **B**, see the same hazard on the road in front of them at the same time. Both drivers press the brakes and come to a stop.

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.

Car **A**



Car **B**



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.

....

....

....

....

....

.... **[6]**

This question discriminated well between candidates. Most candidates showed a good level of knowledge and understanding of thinking and braking distance including the factors that affect each of them.

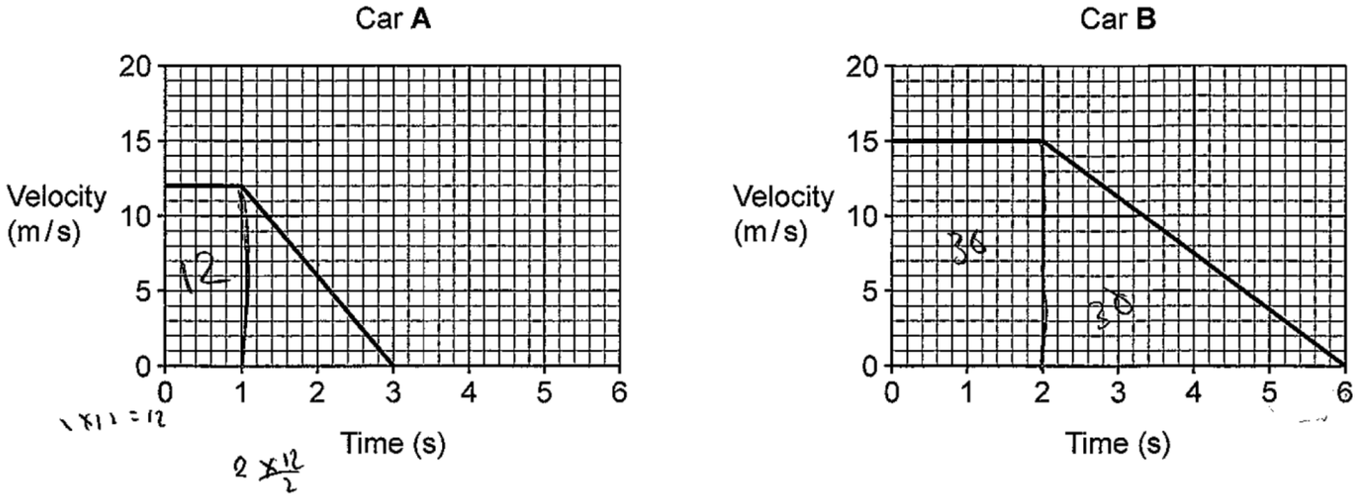
The most common mark scored was Level 2 for a comparison of thinking and braking distance and reasons for the difference (with frequent reference to age and alcohol for thinking distance, and condition of brakes or tyres for braking distance). Poorly matched descriptors for time and distance frequently limited the Level 2 mark awarded to 3 rather than 4.

The most successful candidates completed detailed and quantitative processing of the velocity-time graphs to calculate braking and thinking distance of each car by applying key prior learning.

Candidates who achieved Level 1 often did so by completing a comparison of the two cars OR by suggesting factors that affect thinking or braking distance.

Very few candidates were unable to score or attempt this question and almost all seemed very familiar with this area of the specification.

Exemplar 2



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

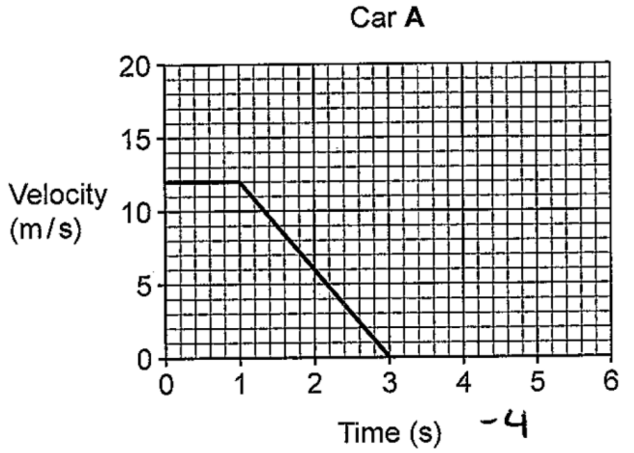
Suggest reasons for the differences in the thinking distance and braking distance of each car.

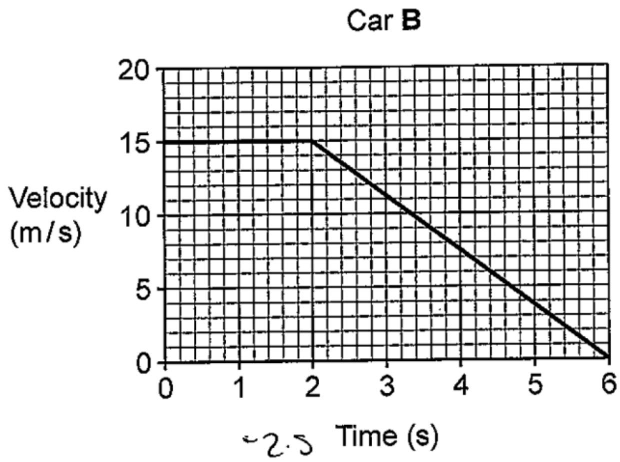
The thinking distance ~~of~~ is the distance travelled during reaction time. for car A the thinking distance is 12m (1 × 12) which is much lower than car B which has a thinring distance of 30m (2 × 15) The driver of car B may be older resulting in a greater thinking distance as it takes longer to react to the hazard/stimulus. The breaking distance of car A was $\frac{2 \times 12}{2}$ = 12m which is again much lower than car b which is 30m ($\frac{4 \times 15}{2}$). The reason for this could be the conditions of the road as it could be icy/slippery or pressure in the tyres being lower. The overall stopping distance of A is 24m < car B which is 60m. * breaking distance is the distance travelled while under a breaking force

Thinking distance of car A < car B breaking distance of A < car B **[6]**

This response shows an accurate and detailed quantitative comparison of the two cars (helpful annotation added to the graphs). It is supported by reasons suggested for factors that may have affected thinking and braking distance of each car. This achieves Level 3 6 marks.

Exemplar 3





Car A has a thinking distance of 1 second and a braking distance of 2 seconds. with a starting velocity of 12 m/s. Car B has a thinking distance of 2 seconds and a braking distance of 4 seconds from a velocity of 15 m/s. therefore, A had a faster reaction time ~~at~~, however, the reaction time for B could be due to the larger velocity which can increase both thinking distance and braking distance. Another reason why A may have had a ~~faster~~ lower thinking distance is because their reaction time wasn't impacted **[6]** by distractions or alchohol.

(continued on extra page)

14. car A may also have ~~had~~ a ~~fast~~ lower ~~ca~~ also stopped faster due to the good conditions of the brakes, applying maximum pressure. This may also be due to road conditions, ~~Ro~~ car B may've been on an icy road, meaning less traction and a higher possibility of sliding. Overall, the rate of deceleration for A was 50.4 m/s² and for B it was 2.5 m/s²

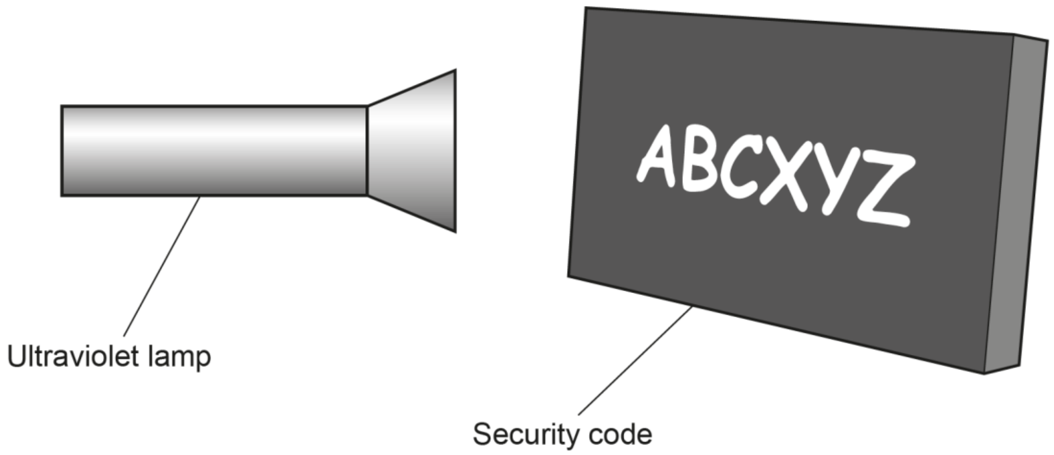
This response shows a simple quantitative comparison (without processing to calculate thinking or braking distance). Several reasons are suggested for the differences. This achieves Level 2 but is limited to 3 marks for communication – in this case mixing up time and distance.

Question 15 (a) (i)

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]**

Most candidates seemed found this area of the specification challenging.

Only half of the candidates knew that the electron absorbed and re-emitted electromagnetic radiation.

Question 15 (a) (ii)

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

....

.... **[1]**

Few candidates were able to describe that (inner) electrons can become excited and rise to a higher energy level. Some candidates had a level of understanding but did not achieve a mark as they described the electrons as excited but then did not link to changing energy levels.

Question 15 (a) (iii)

(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]**

About half of candidates did not score in this question, with similar numbers gaining 1 or 2 marks. Many candidates did not attempt to answer the question and instead described the effect of ionisation on cells. A significant number also demonstrated the common misconception between ionisation (affecting electrons outside the nucleus) with beta decay (emission of electrons due to changes within the nucleus). A very small number correctly noted that short wavelength electromagnetic radiation transfers more energy.

Question 15 (b) (i)

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

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

....

.... **[1]**

Most candidates knew that radio waves have a lower frequency than microwaves. A number of candidates did not gain this mark by describing frequency as longer or faster.

Question 15 (b) (ii)

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

.... **[1]**

Most candidates successfully stated one common application, often TV or mobile phones.

Question 16 (a)

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

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

Similarity ....

Difference ....

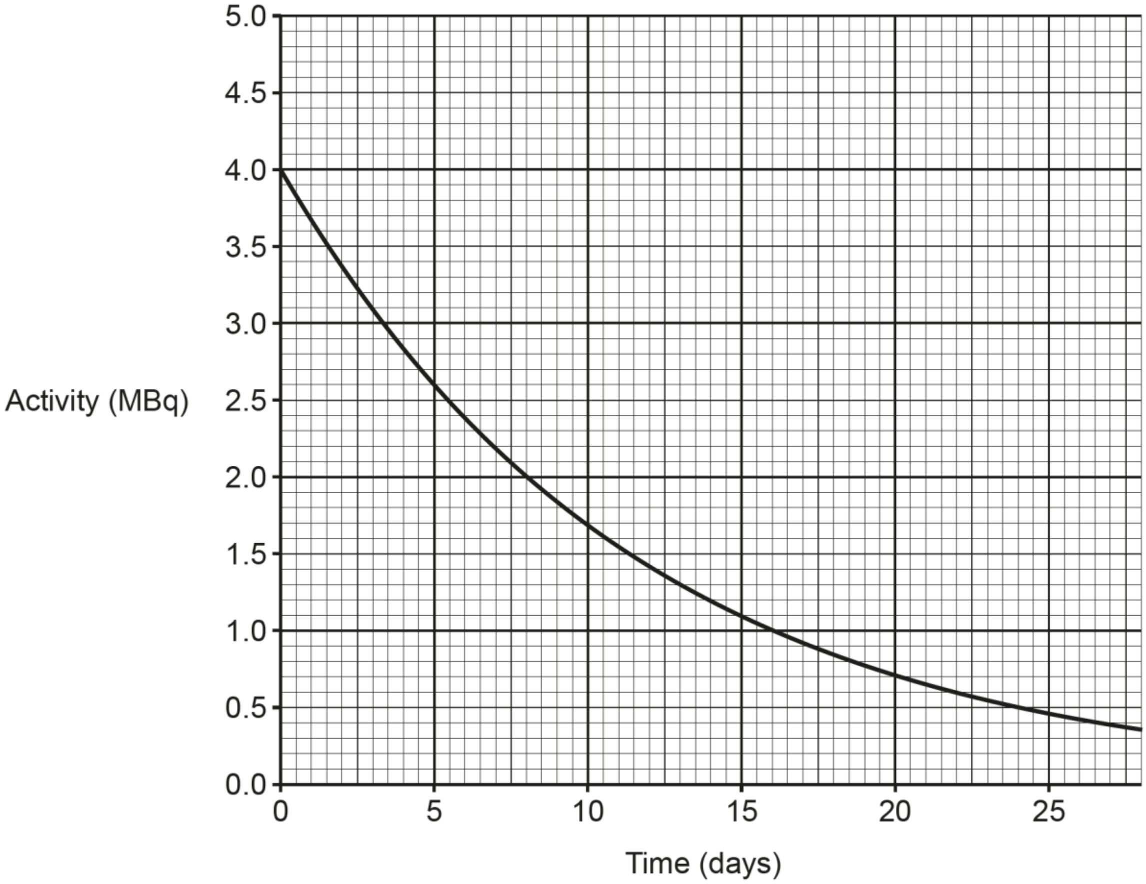
[2]

Most candidates achieved 1 mark on this question (for stating that the proton number is the same in isotopes of the same element) and few then went on to achieve a second mark for describing in detail the difference in neutron number of the two isotopes.

Question 16 (b) (i)

(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]**

The vast majority of candidates could use the decay curve to show a half-life.

Question 16 (b) (ii)

(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]**

Most candidates gained at least 1 mark on this question. The most successful responses methodically showed their working by halving 4 times (from 4.0 MBq to 0.25 MBq) and then multiplied by 8 days to reach the correct answer.

Question 16 (b) (iii)

(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]**

The vast majority of candidates achieved at least 1 mark on this question. This was usually for the sue of the gloves in reducing contamination. A range of misconceptions were evident (as set out below). Another common misconception was that the film badge acts as a shield against the radiation.

Assessment for learning

Contamination and irradiation effects need to be explicitly taught and made distinct from each other. Irradiation involves exposure to radiation (without making the object radioactive). Contamination happens when a radioactive substance comes into contact with an object (and transferring radioactive material). In this question the gloves were effective in preventing contamination and the film badge was effective in monitoring irradiation while both may be damaging to living tissue.

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