Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2017

J250/12 Summer 2018 series

Version 1

www.ocr.org.uk/science

Contents

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. 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 can be downloaded from OCR.

3-3 grade

Like all exam boards, we have awarded a 'safety net' grade of 3-3 for higher tier GCSE Combined Science candidates in 2018 where appropriate so that they are not disadvantaged by being the first to sit a new GCSE. To help teachers making difficult decisions about higher versus foundation tiers in 2019, OCR will be providing further guidance and extra webinars during the Autumn term.

Paper J250/12 series overview

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

This is the first examination series for J250.

Section A overview

This section consists of 10 multiple choice questions testing AO1 and AO2.

Candidate performance

Questions answered well by candidates:

- Question 1 about calculating the kinetic energy of a car.
- Question 3 about the description of a renewable energy source.
- Question 5 about converting mph to m/s.
- Question 8 about how radio waves are produced.

Questions answered less well by candidates:

- Question 2 about the electron movement that emits radiation with the highest energy.
- Question 7 about the energy in a thermal store.
- Question 9 about the corresponding distance-time graph for the given velocity-time graph.
- Question 10 about relative thermal conductivity, thickness of insulation and the rate of cooling.

Candidates who used calculations where needed performed well e.g. Q1 when calculating kinetic energy (see Exemplar 1). Candidates who used notes next to the different graphs for Q9 also performed well (see Exemplar 2).

Question 1

Exemplar 1

1 A car travels at 10 m/s. The mass of the car is 800 kg.

Use the equation: Kinetic energy = 0.5 × Mass × Speed^2

Calculate the kinetic energy of the car.

$0.5 \times 800 \times (10^2) = 40,000$

A 4000 J ✗

B 8000 J ✗

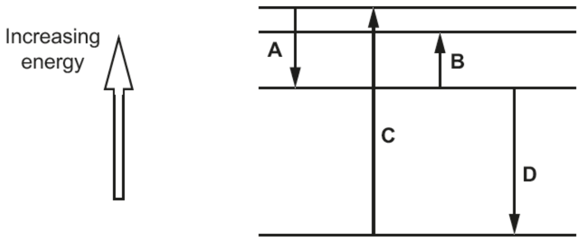
C 40 000 J ✓

D 80 000 J ✗

Your answer C **[1]**

Question 2

2 This is a model of energy levels inside an atom.



The arrows shown as ↓ and ↑ are electrons moving between energy levels.

Which electron movement **emits** radiation with the **highest** energy?

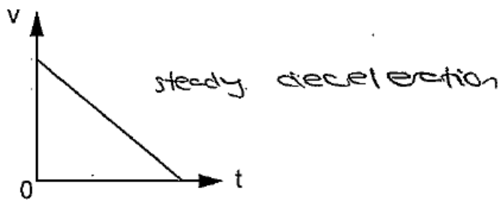
Your answer [ ] **[1]**

This was the most challenging question in Section A and fewer than 10% of candidates got it right. This question assessed P4.2h and an energy level diagram is the conventional model for showing this information graphically. Candidates found it difficult to interpret the energy level diagram.

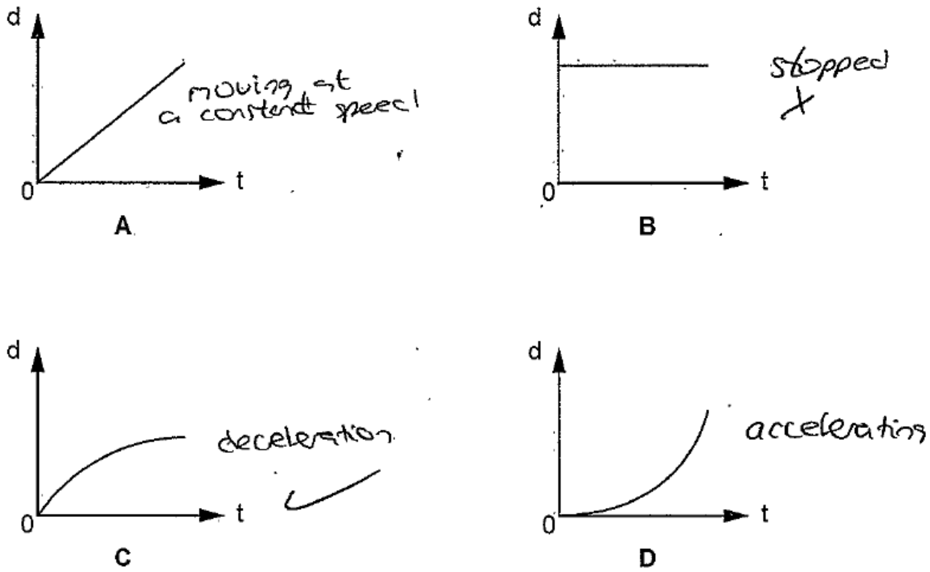
Question 9

Exemplar 2

9 Look at the velocity-time graph for a car.



Which graph shows the correct distance-time graph for this car?



Your answer C **[1]**

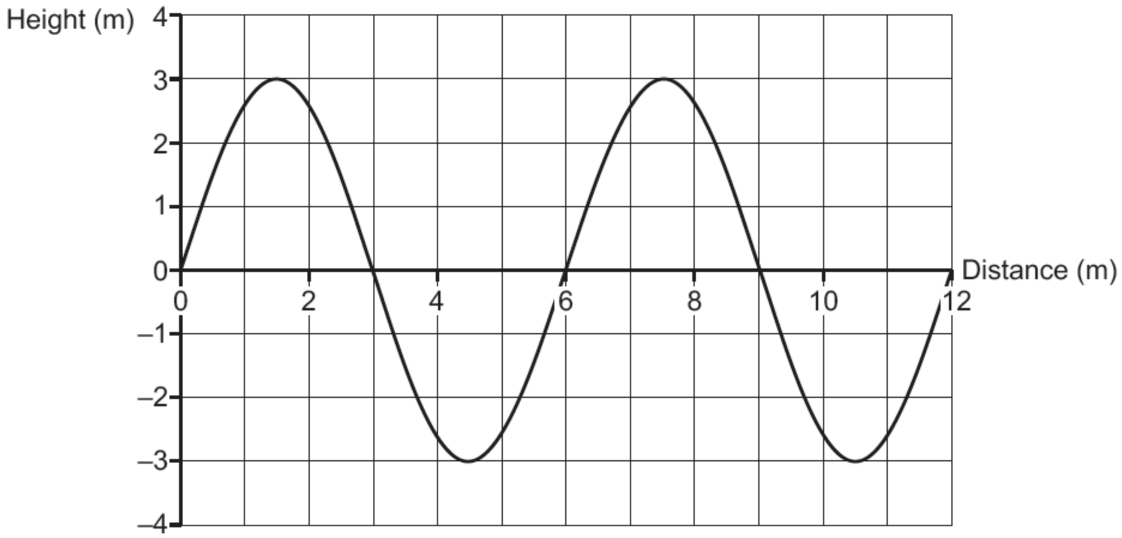
Section B overview

This section consists of six questions testing AO1, AO2 and AO3.

Candidates who were able to manipulate equations and apply them to different situations performed well on this section. All candidates should have experienced a practical activity which made observations of waves in a fluid (PAG P4) and those who had experienced the demonstration of the ripple tank were able to answer this question well and explained how to make the measurements needed. Other candidates were unable to understand what was being demonstrated and had clearly not experienced the use of a ripple tank. Candidates that had performed investigations to calculate the specific heat capacity of water (PAG P5) tended to understand the experimental procedures, and the interpretation of these results. Many candidates were unfamiliar with how to apply their experience of practical activities in new contexts and so were unable to suggest how to ensure their results were accurate, demonstrate an understanding of random errors or how to evaluate and deal with anomalous observations.

Question 11 (a)

11 The graph shows how the height of a water wave changes with distance.



(a) The water wave has a wavelength of 6 m.

Describe how the graph shows this.

....

.... **[1]**

The quality of candidate descriptions of wavelength were varied. Good descriptions included the distance from peak to peak or from trough to trough. Many candidates also drew on the graph to indicate the start and end of one complete wave. Some lower ability candidates had difficulty describing wavelength and gave responses such as 'the distance for each wave to fully finish' and 'the distance of one wave'. Incorrect responses invariably described the amplitude of the wave rather than the wavelength, with descriptions such as 'the peak of the wave is at 3m and trough is at -3m so difference is 6m'.

Question 11 (b)

(b) The frequency of the water wave is 0.5 Hz.

Calculate the speed of this water wave.

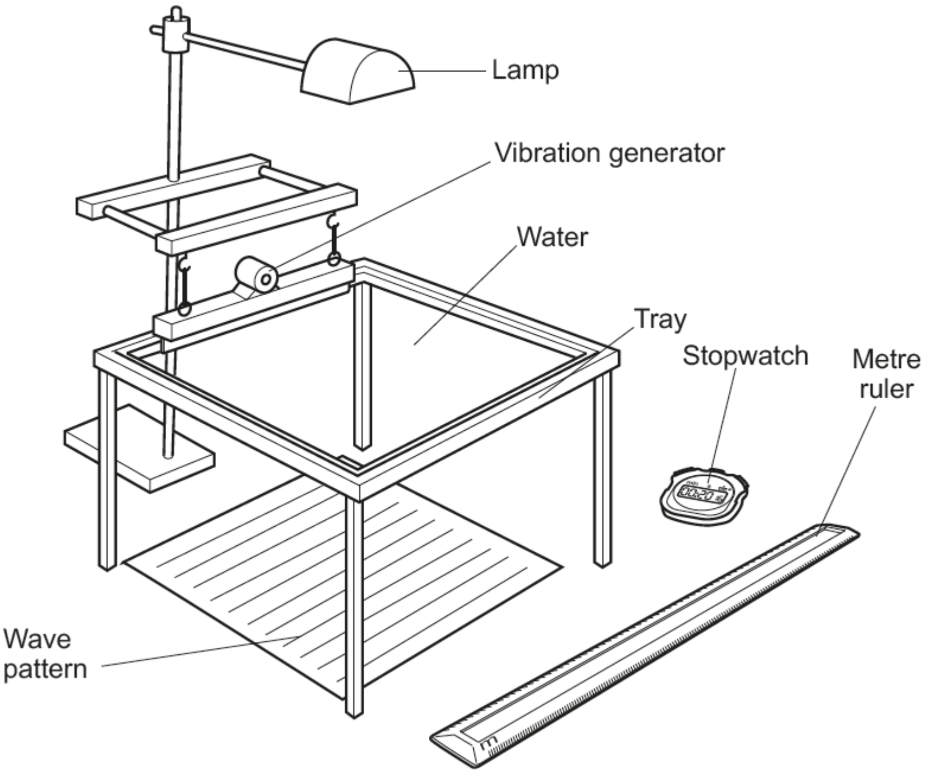
Answer = ... m/s **[3]**

Two thirds of candidates were able to perform this simple calculation and achieved full marks for this question. Most other candidates provided no workings and so only a handful of candidates achieved any compensatory marks for their workings. The most common incorrect response was '12' where the candidate used an incorrect version of the equation (i.e. $v = \lambda \div f$).

Question 11 (c)

(c) A group of students use a ripple tank, a metre ruler and a stopwatch.

They draw a diagram of this equipment.



Explain how this equipment is used to measure the frequency of water waves.

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....

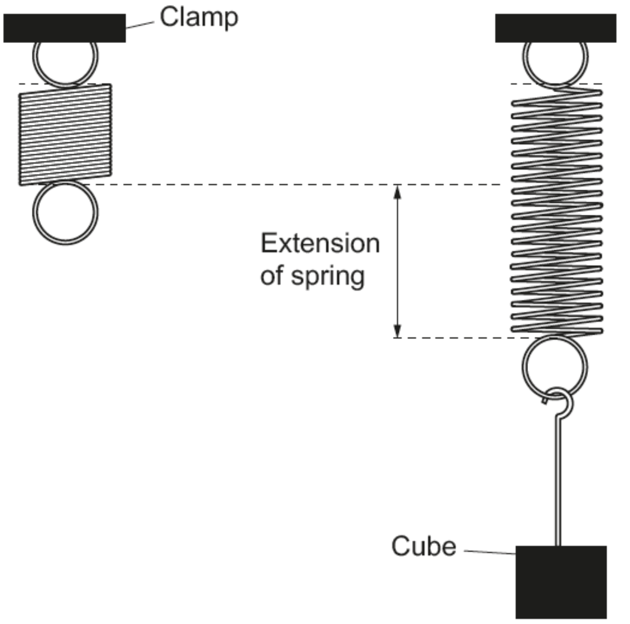
....

.... **[2]**

Higher ability candidates were able to describe how this equipment is used to measure the frequency of the waves with a common answer being to 'count the number of waves passing a point in a given time'. Lower ability candidates and those candidates who had not read the question carefully thought that the stopwatch was used to measure the frequency or speed of the wave and that the ruler was being used to measure the height of the waves.

Question 12 (a) (part one)

12 A student measures the extension of a spring when it is stretched.



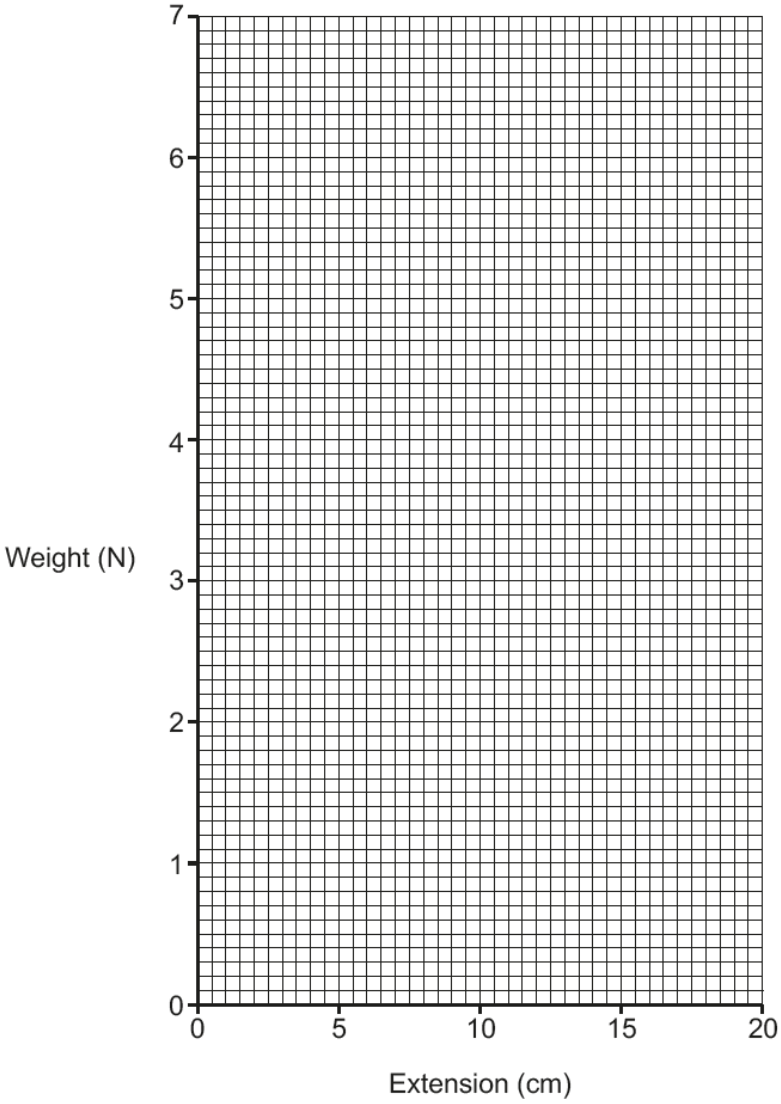
He hangs different cubes from the spring. He measures the extension of the spring for each cube.

Look at his results.

Weight of cube (N)	**Extension of spring (cm)**
1.0	2.9
3.0	8.4
4.0	11.4
5.0	14.4
7.0	20.0

Question 12 (a) (part two)

(a) Plot a graph of the results on the grid.



[1]

This question was generally well answered, but a number of candidates did not plot all the points and some of the points were not accurately plotted (i.e. ± half a small square).

Question 12 (b)

(b) Use the results and the graph to show the spring constant is 35 N / m.

....

....

.... **[3]**

Candidates found this question very challenging and devised many different ways to try and calculate the answer of 35 N/m, many of which did not use the graph or the table of results. Many candidates used the correct force and extension to calculate the gradient in N/cm and then multiplied by 100 to get N/m. Higher ability candidates tended to perform the conversion first from 20 cm to 0.2 m and then divide 7 by 0.2 to give the correct answer of 35 N/m.Lower ability candidates incorrectly assumed because multiplying 7N by 5 gave the answer of 35 this was the approach needed. A number of candidates incorrectly chose to use the energy transferred in stretching equation to try and show the spring constant is 35 N/m.

Question 12 (c)

(c) The spring constant is 35 N / m.

Calculate the energy transferred to this spring when the extension is 0.2 m.

Answer = ... J **[2]**

The majority of candidates gained both marks for correctly using the energy transferred in stretching equation from the data sheet. A third of candidates did not receive any credit and often provided no written workings that could have been be awarded one mark. Lower ability candidates often forgot to square the extension in their calculation.

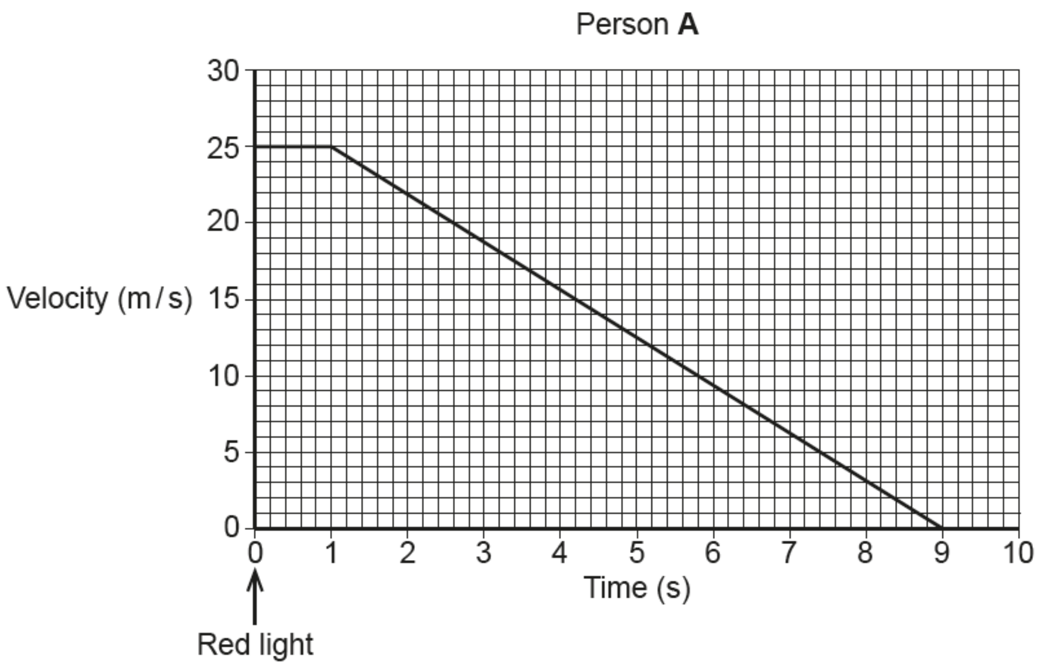
Question 13

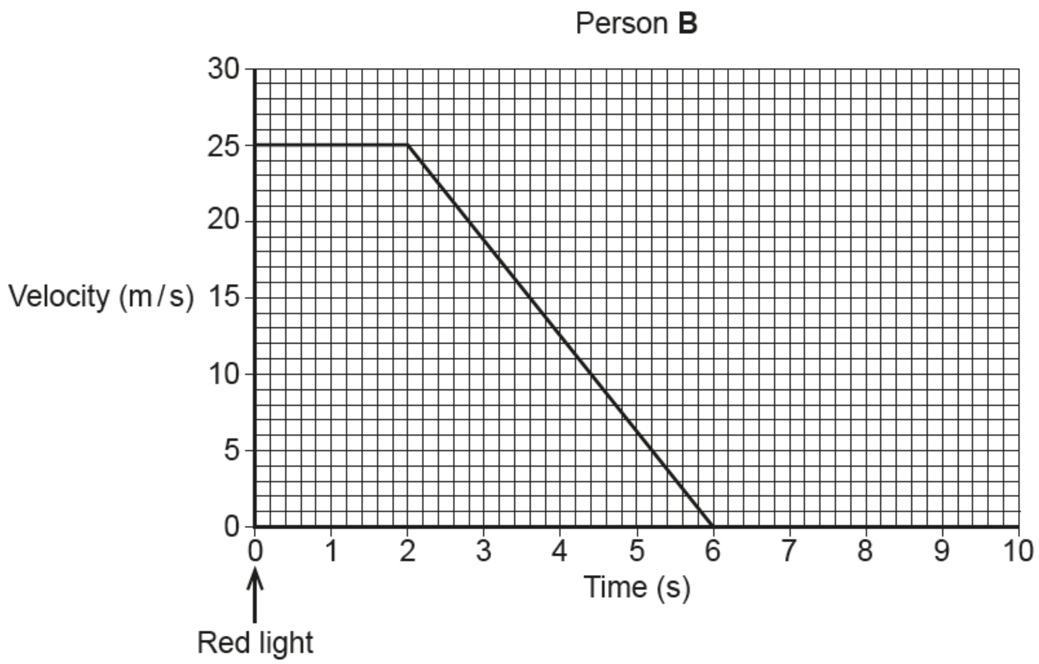
13* Person **A** and person **B** drive their cars along the same road on different days.

Both cars travel at 25 m/s. The traffic lights along the road change to red.

Person **A** and person **B** see the red light and press the brakes in their car.

The graphs show the velocity of each car **after** person **A** and person **B** see the red light.





The graphs are drawn using the same scale.

Explain what the graphs show you about how the cars stop.

Use values from the graphs and calculations in your answer.

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....

.... **[6]**

This Level of Response (LoR) question was answered well by candidates and the full range of the marks available were credited. Many candidates gained credit for recognising the differences in thinking time, braking time and stopping time between the two graphs. Many of these candidates also gave appropriate figures e.g. the stopping time for A is 9 seconds and for B it is 6 seconds. Higher ability candidates gained credit for analysing the graph and using the gradient to draw conclusions about the different decelerations. Many of these candidates also calculated the decelerations. Fewer candidates were able to analyse and interpret the graph in terms of thinking distance, braking distance and stopping distance by calculating the area under different sections of the graph. A significant number of candidates wrote in a confusing way and muddled technical terms and their associated units, for example. 'thinking distance is 1s' or 'thinking time is 25m'.

Exemplar 3

- ~~Person A's stopping distance was much~~ shorter ~~than~~ - Person A's velocity decreased faster than person B's by 1 second.

- This could mean Person ~~A~~ B may be more fatigue as their thinking distance was ~~longer~~ ~~Longer~~ shorter so their stopping distance was ~~shorter~~ longer than Person A's.

- ~~Person A~~ Person B's braking is deemed to ~~[scribbled out]~~ be more abrupt as the gradient is steeper than Person A's graph

- The steady decline in person A's graph would be as a result of having a faster reaction to the red lights ~~and a longer thinking distance~~ so they were more prepared to decelerate than person B **[6]**

velocity = $\frac{\text{distance}}{\text{time}}$

- 25 x 1 = 25 m
- 25 x 2 = 50 m

shows person A had a faster reaction time, as they reacted in a smaller distance.

Person A $\frac{25}{8}$ = 3.125 Person B $\frac{25}{4}$ = 6.25

Person B has a much steeper gradient

The candidate has calculated both the thinking distances (i.e. 25 × 1 = 25 and 25 × 2 = 50) and rates of deceleration (i.e. 2.125 and 6.25) for both A and B respectively. They have compared the two time velocity graphs and suggested a plausible reason for the differences: A was better prepared as their reaction time was shorter and they were able to decelerate more gradually while B may have been tired as their reaction time was longer and they had to decelerate more rapidly. This is a good example of a Level 3 response. The candidate has also reviewed their answer and made corrections by striking through. A single line is through an answer is better than scribbling out, which is unnecessary and wastes time.

The candidate carried out their mathematical analysis of the date in the space below the answer line. A better approach would have been to do their workings next to the graphs and annotate the velocity time curves.

Question 14 (a) (i)

14 This question is about nuclear radiation.

(a) **Q** and **R** are different radioactive isotopes. **Q** has a different half-life to **R**.

(i) Explain what is meant by the term **half-life**.

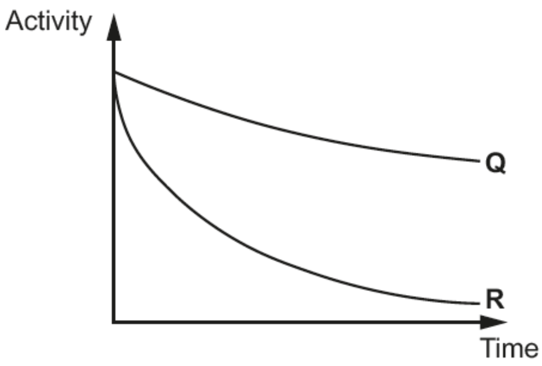
....

.... **[2]**

Most candidates gained one mark for the correct mention of time taken but they were usually not clear about what was actually being measured. A common mistake was to think that the atoms were halving or the isotope was decaying. Only one in five candidates were credited with both marks.

Question 14 (a) (ii)

(ii) The graph shows how activity of isotope **Q** and isotope **R** change with time.



Which isotope, **Q** or **R**, has the **longest** half-life? Explain your answer.

....

.... **[1]**

This question was not well answered with many candidates failing to make a comparison between Q and R in their response. There were multiple ways for candidates to explain their choice although all of them involved a comparison between both curves, for example "Q takes longer to become less active."

Question 14 (b)

(b) The table shows information about different elements.

Element	Symbol	Atomic number
Antimony	Sb	51
Caesium	Cs	55
Iodine	I	53
Tellurium	Te	52
Xenon	Xe	54

Iodine-131 is a radioactive isotope. Iodine-131 decays, emitting a beta (β) particle.

Write a balanced nuclear equation for iodine-131 decay. The first part is done for you.

$^{131}_{53}\text{I} \rightarrow$ .... **[3]**

Few candidates were able to write a balanced equation using standard nuclear notation, the conventional representation (P4.3c). 'I' was frequently given as the isotope with the correct mass number but an incorrect atomic number. The beta particle was usually the only part of the nuclear equation that was correct.

Question 14 (c) (i)

(c) The table shows how the activity of iodine-131 decreases with time.

Time (days)	Activity (10^{12} Bq)
0	4.6
4	3.2
10	1.9
16	1.2
20	0.8

(i) Use the table to calculate the ratio: $\dfrac{\text{activity after 4 days}}{\text{activity after 20 days}}$

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

This part of the question was answered well by most candidates.

Question 14 (c) (ii)

(ii) Use your answer to **(c)(i)** to calculate the half-life of iodine-131.

Answer = ... days **[2]**

This part of the question was not well answered by candidates. Many appreciated that the half-life was between 4 and 10 days but only a few calculated it as 8 days.

OCR support The Mathematical Skills Handbook provides guidance on the use of ratios, fractions and percentages.

http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf

Question 15 (a) (i)

15 The table shows some information about electrical appliances in the home.

Appliance	Power (W)	Current (A)	Resistance (Ω)
Electric drill	800	3.48	66.1
Iron	2000	8.69	26.5
Kettle	2500	10.86	21.1
Security light	500	2.17	105.8
Toaster	1650	7.17	32.1

(a) (i) Use the table to describe the relationship between power and resistance.

....

.... **[1]**

The majority of candidates correctly identified the relationship between power and resistance.

Question 15 (a) (ii)

(ii) Explain this relationship. Use ideas about resistance in your answer.

....

....

.... **[2]**

Higher ability candidates explained the link between resistance and current. Many other candidates simply repeated their answer to Q15(a)(i) and linked power and resistance without using ideas about resistance.

Question 15 (b)

(b) The security light is switched on for 45 minutes every day for 7 days.

Use the equation: Energy transferred = Power × Time

Calculate the energy transferred in kWh.

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

Answer = ... kWh **[4]**

Higher ability candidates were able to convert 45 minutes to 0.75 hours and 500 W to 0.5 kW and express their answer to 2 s.f. A few candidates were able to multiply the power and time in terms of 500 x 315 for 1 mark. Common errors included converting 45 minutes to 0.45 hours, 315 minutes to 3.15 hours and 500 W to 5 kW. Some candidates correctly calculated the energy transferred but did not express their answer to 2 significant figures.

Question 15 (c)

(c) Explain the difference between direct voltage and alternating voltage.

....

....

.... **[2]**

The descriptions given by candidates were often confused and 80% of candidates provided no creditable response. Common misunderstandings included 'direct voltage is from a battery and alternating voltage is from the mains', 'direct voltage goes straight to the appliance but alternating voltage travels though different parts first' and direct voltage flows in one direction but alternating voltage flows in many directions'.

Question 15 (d)

(d) The electric drill does **not** need an earth wire.

Explain why.

....

.... **[1]**

Few candidates recognised the plastic casing or double insulation as the reason for not requiring an earth wire. Lower ability candidates thought that the reasons were that an earth wire is not needed because the drill is not plugged into the mains, it is battery powered or that only a small current is used.

Question 15 (e)

(e) Mains electricity can be produced in a power station that burns coal.

An electric iron is plugged into the mains and switched on. The temperature of the iron increases.

Describe this process.

Use ideas about energy stores in your answer.

....

....

....

....

.... **[3]**

This was the most challenging question on the paper with only higher ability candidates being credited with any marks. Very few candidates were credited with two marks for what was intended as a straight forward application of P5.1b. No candidate appeared to have a clear understanding of the stores and transfers energy model.

Misconception The stores and transfers model has been introduced across all the reformed GCSE and GCE science qualifications, in line with the guidance the Institute of Physics (IoP) and Association for Science in Education. Teachers need to ensure that their students are comfortable with explaining processes using the stores and transfers model. Some teachers may need to refresh their understanding particularly where they were taught using the "nine types of energy" model.

Exemplar 4

The burning of coal increases the amount of energy in the thermal energy stores. This energy is then transferred as electrical energy and is passed through the mains supply. This electric energy is then stored **[3]**

in the thermal energy stores in the electric Iron. Iron conducts heat and as the thermal energy stores gain energy it heats up.

This exemplar shows that even high ability were hampered in their ability to write about energy because of the contradictions between the current teaching model (i.e. stores and transfers) and the old teaching model which they may have been taught in primary school (i.e. nine types of energy).

They understand about the 'thermal energy store' but not that coal is a chemical energy store or how combustion allows energy to be transferred as electrical current through the National Grid to the thermal energy store in the iron. They could also have written about heating or mechanical transfers in the power station or the turbine/generator as a kinetic energy store.

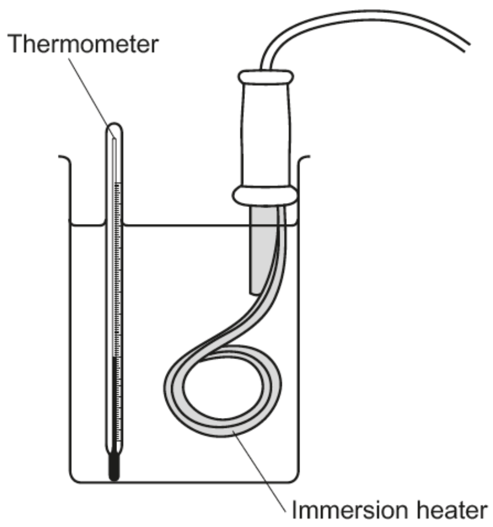
However by referring to 'electrical energy' and 'thermal energy' they contradict themselves. By trying to apply a hybrid model the candidate has contradicted themselves. With only very minor editing this could have been a three mark answer:

The burning of coal in a power station transfers energy from the chemical energy store to the thermal energy store in the iron. The energy is transferred as electricity through the wires of the mains supply. This flow of electricity causes the element in the iron to heat up and the energy is transferred by conduction to the thermal energy store in the metal base of the iron.

Question 16 (a)

16 A scientist completes an experiment to determine the specific heat capacity of water.

She uses an immersion heater to increase the temperature of water in a beaker.



(a) Suggest **two** ways to ensure the scientist obtains accurate results.

1. ....

....

2. ....

....

[2]

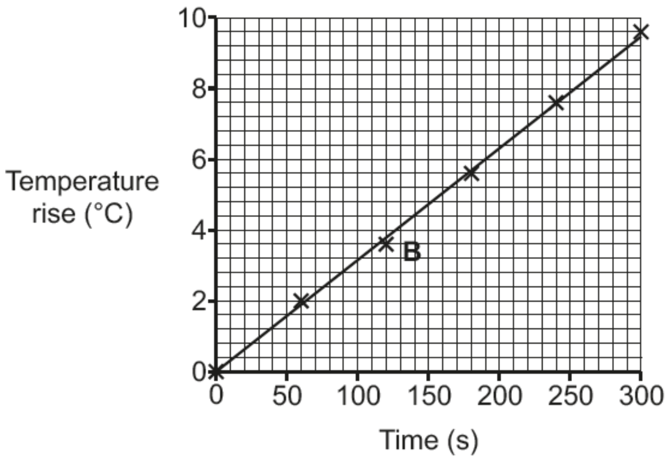
Only the highest ability candidates gained marks for this question. The most common correct answers were to use a digital thermometer, to insulate the beaker and to read the thermometer at eye level. Many candidates were unable to state ways to make the observations recorded more accurate with many candidates just writing down that the results need to be repeated. Repeats would make the results more 'precise' however the candidates were asked to suggest how to make the results more 'accurate' (i.e. closer to the true value).

OCR support The Glossary of Terms resource summarises the technical language appropriate to Working Scientifically (Appendix 5d). This includes terms such as accuracy, precision and anomaly.

http://www.ocr.org.uk/Images/467774-glossary-of-terms.doc

(b) The scientist measures the temperature of the water every 60 seconds.

She plots her results.



Question 16 (b) (i)

(i) Is there a random error in this experiment?

Explain your answer.

....

.... **[1]**

This was well answered by the majority of candidates but a few explained their implied answer but forgot to write 'yes' or 'no'.

Question 16 (b) (ii)

(ii) The scientist thinks the point labelled **B** on the graph is an anomaly.

Is she correct? Explain your answer.

....

.... **[1]**

This was answered well by most candidates but a few forgot to write 'yes' or 'no'.

Question 16 (c) (i)

(c) **(i)** Calculate the gradient (slope) of the graph.

Answer = ...°C/s **[2]**

This was generally answered well by candidates although some candidates did not abstract values correctly from the graph to calculate the gradient. Another common error was where candidates abstracted correct values from the graph but then processed these incorrectly. For example70÷2.4 to give 29.16 (rather than 2.4÷70 = 0.034) or 100÷3.2 to give 31.25 (rather than 3.2÷100 = 0.032).

Question 16 (c) (ii)

(ii) The scientist writes down more results.

- 0.1 kg of water used
- Power of immersion heater = 12.8 W

Use the equations:

Energy transferred = Power × Time

Change in thermal energy = Mass × Specific heat capacity × Change in temperature

Calculate the specific heat capacity of water.

Use the results **and** the gradient you calculated in part **(c)(i)**.

Answer = ... J/kg °C **[4]**

Most candidates were able to calculate the energy transferred by multiplying 12.8 by time. Many candidates rearranged the equation to make specific heat capacity the subject but the temperature rise used often did not match the time chosen to calculate the power.

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Section B, Q11

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