

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250

For first teaching in 2017

J250/06 Summer 2018 series

Version 1

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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. 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.

Paper J250/06 series overview

This is the first sitting of the examination for J250_06. This component is part of the new 9-1 GCSE Combined Science, the questions are of a different style and now include multiple choice questions, there is far less scaffolding within some of the questions in Section B.

General comments on performance

Very few candidates showed their workings when doing calculations and so most candidates could not be credited with any compensatory marks if their stated answer was incorrect. For questions that required calculations it was common for candidates to either be credited with all the marks or zero marks.

The use of correct scientific language and terminology was very poor. This limited candidate achievement in questions where the correct use of technical language was required to demonstrate the understanding.

Examples of this include:

- Q11(b)(i) where candidates wrote that lead stops the movement of 'radioactive isotopes' not 'radiation';
- Q13 candidates found low demand questions on transformers and the National Grid very challenging, with very high omit rates; up to a quarter of candidates;
- Q14(b)(ii) candidates described 'heat' rising rather than the 'warm water';
- Q14(c) candidates did not write about 'energy stores' although they were instructed to do so in the stem of the question;
- Q15 where few candidates understood the concepts of 'thinking distance', 'braking distance' and 'stopping distance';
- Q16(a) candidates could not explain a scientific procedure.

Large numbers of candidates described when the stem of the question asked for an explanation.

Section A overview

This section consisted of 10 multiple choice questions. Virtually all candidates attempted these questions. Candidates did best at mathematical skill questions. The questions in Section A are ramped from low to high demand. However, most candidates found the questions that assessed knowledge of theory and concepts challenging, even at low levels of demand.

Question 1

- 1 A transverse wave and a longitudinal wave travel in the direction shown by the arrow.



The table shows how the particles in these waves vibrate as the waves travel.

	Transverse wave	Longitudinal wave
A		
B		
C		
D		

Which row of the table is correct?

Your answer

[1]

Just under half the candidates selected D as the correct answer.

Question 2

- 2 Which of these electromagnetic waves has the **smallest** wavelength?

- A Gamma-ray
- B Micro-wave
- C Radio wave
- D X-ray

Your answer

[1]

Only around 30% of candidates identified the correct answer.

Question 3

- 3 Atoms contain electrons. An atom can lose its outer electrons.

What is this process called?

- A Friction
- B Ionisation
- C Radiation
- D Radioactive decay

Your answer

[1]

Nearly 60% of candidates achieved this question

Question 4

- 4 Energy is transferred when a machine is switched on.

- 1000 J is the **input energy transfer**
- 750 J is **useful output energy transfer**

Use the equation: $\text{Efficiency} = \frac{\text{Useful output energy transfer}}{\text{Input energy transfer}}$

Calculate the efficiency of this machine.

- A 0
- B 0.25
- C 0.75
- D 750

Your answer

[1]

Almost every candidate was able to substitute numbers into the equation to achieve this mark.

Question 5

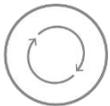
5 What is the speed of sound in air?

- A 30m/s
- B 100m/s
- C 340m/s
- D 300 000 000m/s

Your answer

[1]

This was a low demand question about the candidates' everyday experience. Only one in three of the candidates could recall the speed of sound in air, and most candidates appear to have randomly selected an answer. Distractor A is the typical speed of a car on a motorway, D is the speed of light so candidates were expected to be choosing between B and C.



AfL

It can help candidates to cover the available responses and see if they can predict the correct answer, and then uncover the responses to see if their prediction is there. Of the four options to a multiple choice question (MCQ) one will be the correct answer and another the main misconception or most common error. In Q5 candidates would be expected to know that D is the speed of light and if A was correct then cars would break the sound barrier on dual carriageways.

Key

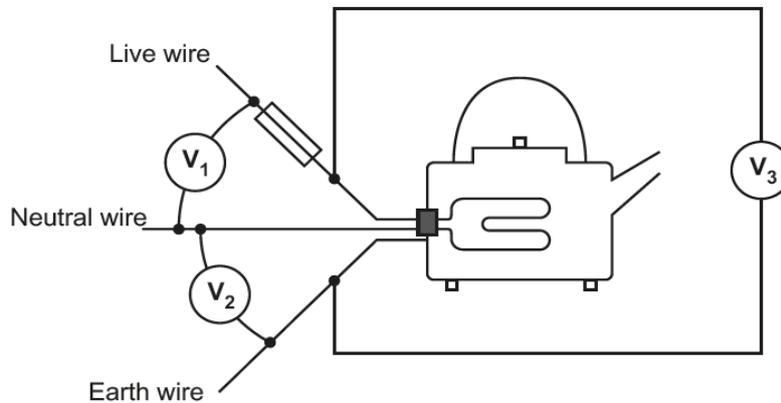


AfL

Guidance to offer for future teaching and learning practice.

Question 6

- 6 An electric kettle is plugged into a socket. The kettle is switched on. A qualified electrician uses three voltmeters, V_1 , V_2 and V_3 .



Use the relationship: $V_3 = V_1 + V_2$

Which row in the table, **A**, **B**, **C** or **D**, shows the correct readings for the three voltmeters?

	V_1 (V)	V_2 (V)	V_3 (V)
A	0	230	230
B	230	0	230
C	230	230	0
D	0	0	230

Your answer

[1]

Just under a half of all candidates achieved this mark

Question 7

- 7 An element gives out a beta (β) particle.

The table shows how the atomic number and mass number of the element change.

	Atomic number	Mass number
A	Decreases by 2	Decreases by 4
B	Decreases by 4	Decreases by 2
C	Increases by 1	Stays the same
D	Stays the same	Increases by 1

Which row of the table is correct?

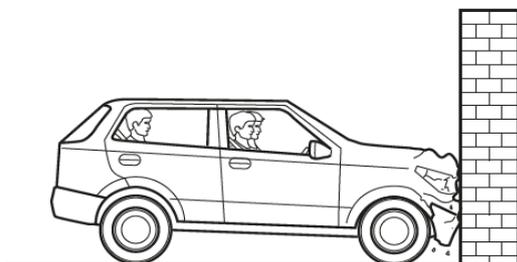
Your answer

[1]

All four possible responses were selected in almost equal proportions by candidates across the ability range and only a quarter of candidates achieved this mark

Question 8

- 8 A moving car crashes into a wall.



Which row in the table describes one of the energy transfers?

	Energy store before crash	Energy store after crash
A	Chemical	Electrical
B	Gravitational	Electrical
C	Kinetic	Gravitational
D	Kinetic	Thermal

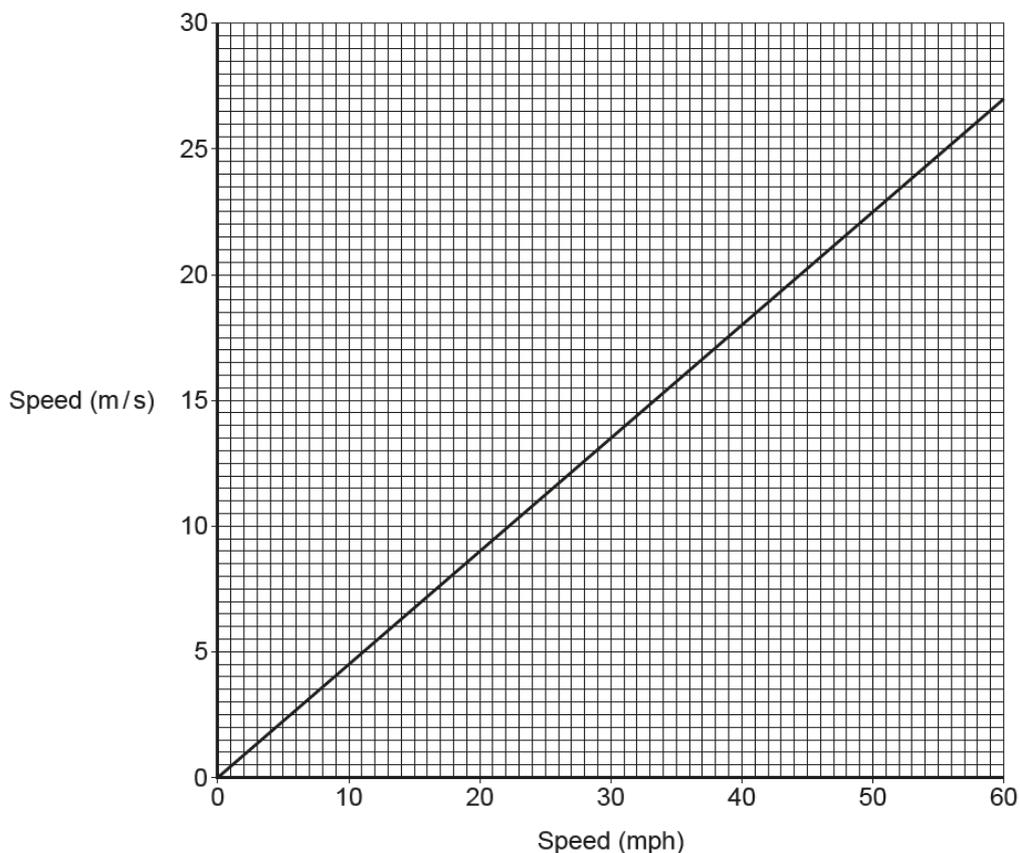
Your answer

[1]

One third of candidates achieved this mark and identified the transfer from the kinetic to thermal energy store during the crash. Option C was the most popular distractor.

Question 9

- 9 The graph shows how speed in miles per hour (mph) is related to speed in metres per second (m/s).



A car travels at 20 mph.

What is the speed of this car in m/s?

- A 8m/s
- B 9m/s
- C 43m/s
- D 45m/s

Your answer

[1]

Just under 60% of candidates were able to interpret the graph correctly.

Question 10

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

Use the equation: Kinetic energy = $0.5 \times \text{Mass} \times \text{Speed}^2$

What is the kinetic energy of this car?

- A 4000 J
- B 8000 J
- C 40000 J
- D 80000 J

Your answer

[1]

Most candidates found the calculation questions Q4 and Q10 straight forward. These were the two MCQs that most candidates were able to answer correctly

Section B overview

The Questions in this section were mostly short structured questions or calculations. There was one 6 mark level of response question

Question 11(a)

11 This question is about radioactivity.

(a) Two isotopes of nitrogen are shown below.



Explain what is meant by the term **isotopes**.

.....

.....

..... [2]

Although this was the first question in Section A and was a low demand question assessing knowledge of P4.3c, candidates found it very challenging. Many candidates' responses were contradictory which prevented them from accessing the first marking point. For example they wrote that *'the atomic number stays the same but the number of protons changes'*.



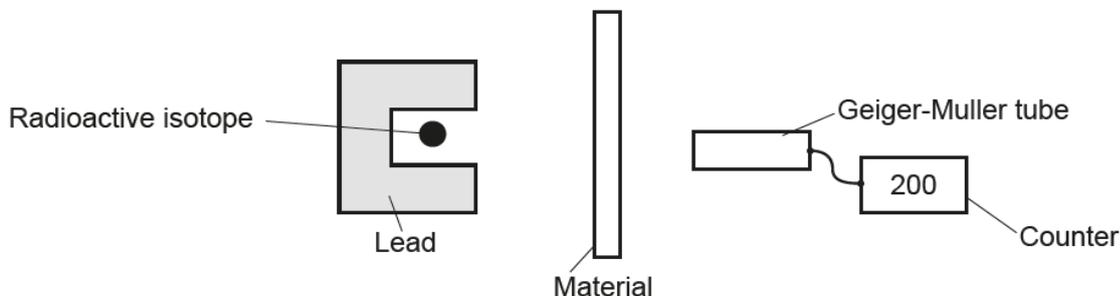
Misconception Candidates need to understand the definitions of atomic number and mass number. A common misunderstanding is to confuse standard nuclear notation for an isotope (showing atomic number and mass number) with the periodic table notation for the bulk element (showing atomic number and relative atomic mass).

Question 11(b)(i)

(b) A teacher shows his class an experiment. The teacher wants to identify the type of radiation given out by a radioactive isotope.

He uses a Geiger-Muller tube connected to a counter to measure the count rate.

He places different materials between the radioactive isotope and the Geiger-Muller tube.



The table shows the count rate for different materials.

Material	Count rate
No material (air)	200
Thick paper	200
Thin aluminium	197
Thick lead	3

(i) Suggest why the teacher places lead around most of the radioactive isotope.

.....
 [1]

Some candidates correctly wrote about radiation being blocked by the lead sheet. However, a number of candidates wrote that the isotope moved and was being blocked rather than the radiation. A significant number of candidates talked about lead stopping the reactions.

Question 11(b)(ii)

(ii) There are three types of radiation, alpha, beta and gamma.

Which type of radiation is given out by the radioactive isotope?

.....

Explain your answer.

Use the data in the table to help.

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

Half the candidates gave the correct answer, gamma radiation. The most common error was alpha radiation. Although many candidates explained that gamma was able to pass through the other material, very few obtained all three marks by explaining why could not be alpha or beta radiation. Several candidates provided no explanation. Many candidates seemed confused about what count rates were.

Exemplar 1

Which type of radiation is given out by the radioactive isotope?

gamma ✓

Explain your answer.

Use the data in the table to help.

AS you use thin Aluminium
& the radioactive isotope isn't
stopped by it however by
the lead. ✓ [3]

The candidate limits themselves to 2 marks only as they don't mention why it could not be alpha or beta

Question 12(a)

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

Appliance	Power (W)	Current (A)	Resistance (Ω)
Hairdryer	1800	7.8	29.6
Heater	800	3.5	66.1
Iron	2000	8.7	26.4
Kettle	2500	10.9	21.0

(a) A teacher says: 'As power increases, resistance increases'

Is she correct?

Use data from the table to explain your answer.

.....

.....

..... [2]

Most candidates could access this question and 70% of candidates got full marks.

Question 12(b)

(b) The kettle is switched on for 60 seconds.

Calculate the energy transferred.

Answer = J [3]

Candidates found this question very challenging and most were unable to recall the correct equation. Around one in five candidates were credited with all three marks, but most other candidates got zero. If candidates write down at least some of their working it was difficult to see where they were going wrong and therefore gain any compensation marks.



AfL

Encourage candidates to write down the stages of the process they are using when calculating answers. For example:

- the equation they are using
- the values they are using
- at least one partial calculation

It is easy for a calculator finger problem to cause an error. Estimating the expected result will help candidates identify obvious errors

Exemplar 2

Power x time ✓
 $2500 \times 60s$
 7500×0.016
 Answer = 41.6 J [3]

The candidate has the wrong answer but has shown some working. They have achieved 1 mark for the correct formula. The candidate has given the marker a choice as to the substitution, is unclear which substitution the candidate is going to use but the answer suggests he used the latter so no second mark credited.

Question 12(c)(i)

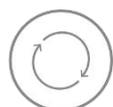
(c) Electricity companies do not use joules (J) in electricity bills. Electricity companies use kilowatt-hours (kWh).

(i) A hairdryer has a power of 1800 W.

What is the **power** of the hairdryer in kilowatts (kW)?

Answer = kW [1]

Most candidates attempted a conversion although only a third correctly divided 1800 by 1000. Common errors included multiplying by 1000 and dividing by 10 or 100.



AfL

The Mathematical Skill Handbook provides guidance and support on conversions and metric prefixes. <http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf>

Question 12(c)(ii)

(ii) Suggest why electricity companies charge for electricity using kWh.

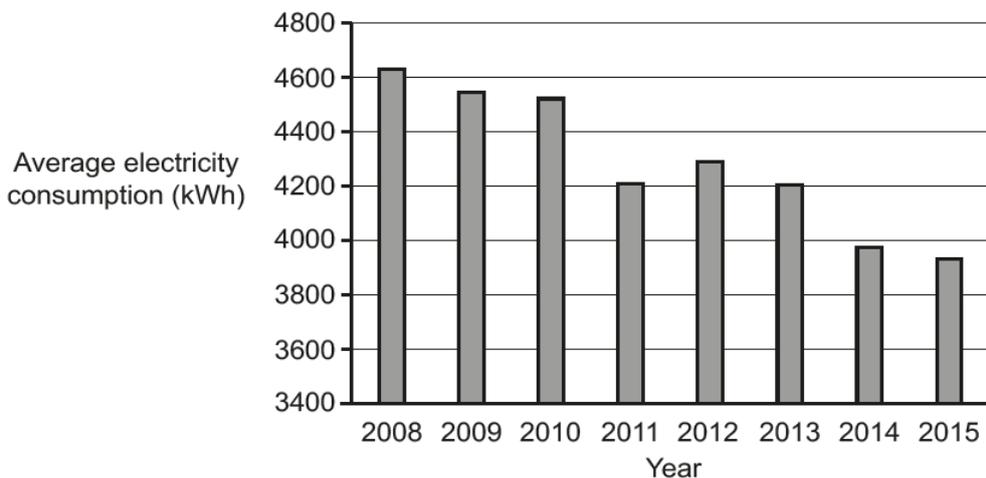
.....
 [1]

Only a few candidates obtained a mark here by suggesting a plausible scientific reason, such as the concept of the number of joules being very large. The most common misunderstanding was linking the use of joules to 'being easier' with no explanation of what they meant by this. Several candidates stated that it was a way for electricity companies to charge more.

Question 12(d)

(d) The average electricity consumption per household changes every year.

The graph shows how this changes from the year 2008 to the year 2015.



Describe **and** explain the trend shown by the graph.

.....

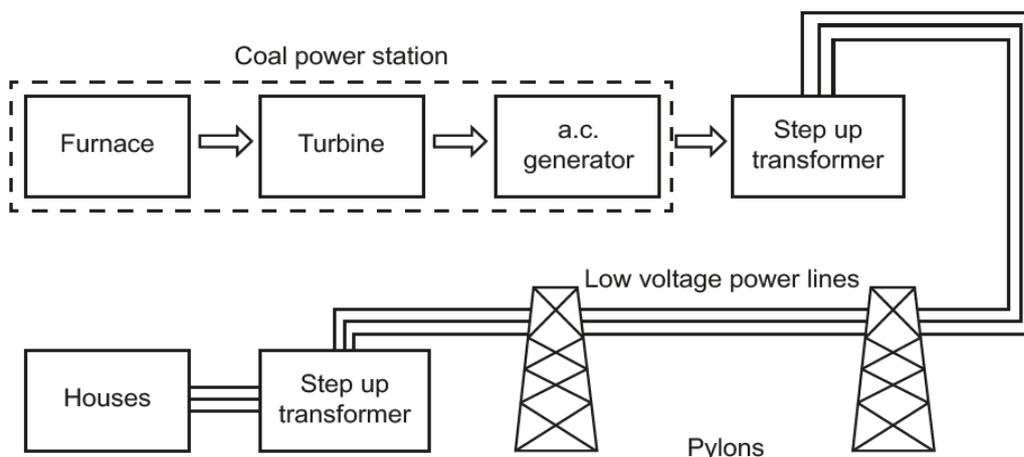
.....

..... [2]

Most candidates were able to identify the trend but very few attempted to explain the trend. Candidates tended to focus on the rise in the graph in 2012 rather than giving a reason for the overall trend. Correct explanations mentioned either modern technology/appliances being more efficient, or the use of solar panels.

Question 13(a)

13 A student draws a diagram to show the national grid.



(a) State the **two** mistakes in the diagram.

- 1.
-
- 2.
-

[2]

Most candidates attempted this question, and many obtained at least one mark for identifying that there should not be two step-up transformers. Very few candidates identified that there should be a step-down transformer between the pylons and the houses, or that the power lines should be high voltage.

Question 13(b)

(b) The national grid uses transformers.

Explain how using transformers makes the national grid more efficient.

-
-
-
- [2]

Transformers and the reason for the use of transformers on the National Grid are on specification knowledge (P6.2c, d, e). This was a low demand question which directly assessing knowledge of P6.2e. However, candidates found this question extremely demanding and fewer than 5% of candidates were credited with even one mark. Many thought that transformers increased power and very few of those who mentioned that voltage would be increased adding that current would be decrease. Many described efficiency in terms of electricity getting to the houses quickly while others claimed that no energy would be wasted or lost. . The idea of reducing the energy lost in transmission was hardly mentioned.

Exemplar 3

The ~~step up transformer~~ step up transformer increases the voltage which increases the current ~~so it flows quicker to~~ the step down which reduces the voltage [2]

The candidate has correctly stated that voltage increases but incorrectly stated that current increases this is then linked to the common misconception that transformers are there to change the speed that electricity reaches its destination

Question 13(c)

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

.....

 [2]

Most candidates attempted this question although very few were able to explain the difference. Most referred to voltage being taken to a destination, rather than the idea of one direction versus changing direction. Most of candidates tried to use the words direct and alternating but the context was 'direct to the houses' and 'alternating going to different places'.

**OCR support**

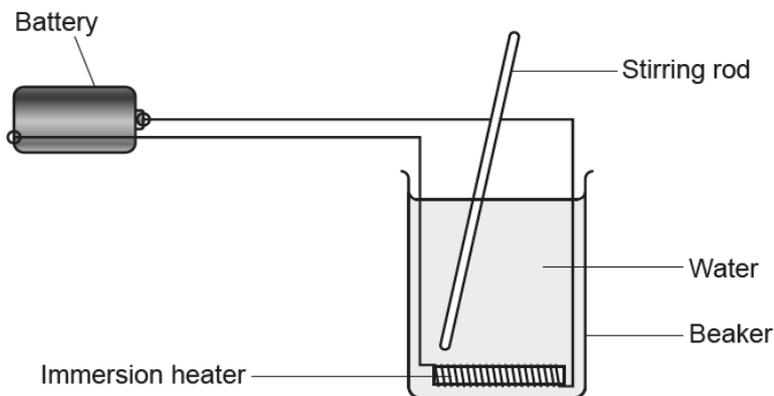
There is a KS3–KS4 Transition Guide (J249) and a KS4–KS5 Transition Guide (H557) that offer support on teaching about generation of and distribution of the domestic electrical supply:

<http://www.ocr.org.uk/Images/324646-electricity-ks3-ks4-transition-guide.pdf>

<http://www.ocr.org.uk/Images/309732-generating-electricity-transition-guide.pdf>

Question 14(a)

14 A scientist does an experiment to measure the energy transferred to water.



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

The scientist uses this apparatus:

- A beaker
- An immersion heater
- A stirring rod
- A 12V battery and wires.

(a) What two **other** pieces of apparatus does the scientist need for this experiment?

1.
2.

[2]

Candidates will have experienced a number of different pieces of suitable scientific instrumentation as part of the required practical activity program (for example P1 and P5) including electronic balance, voltmeter, ammeter, joulemeter or digital thermometer. A few candidates did one of these but the most popular pieces of equipment were a thermometer and a timer. A third of candidates either missed this question or could name any appropriate piece of equipment. A similar number of candidates could only list one piece of equipment.



AfL

Most candidates found had difficulty spelling the names of common laboratory equipment or identifying what apparatus they should use.

The following learning resource was shared with centres at our free regional Science Teacher Networks in Spring 2018 – Circuit and laboratory equipment cards resource:

<https://social.ocr.org.uk/groups/science/resources/circuit-and-laboratory-equipment-cards>

Question 14(b)(i)

(b) (i) Explain how the scientist could reduce energy transfer to the surroundings.

.....
 [1]

Most candidates found this question very challenging. Many candidates suggested using a less powerful battery or closing windows or using less water. It highlighted the need for candidates to have had the opportunity to modify practical work in class.

Question 14(b)(ii)

(ii) The immersion heater is placed at the bottom of the beaker.

Suggest why.

.....
 [1]

Many candidates suggested that placing the heater at the bottom would warm the water faster and most candidates stated that heat (rather than warm water) rises. Candidate responses implied that they understood the concept that the water was being heated by convection, but lacked the ability to articulate their understanding in an explicit scientific way. Where candidates could express the correct science in their own words they were credited. However, candidates who gave vague answers that relied on the reader's interpretation (such as heat rises) received no credit.

Question 14(c)

(c) The heater is connected to a battery. When the heater is turned on, energy is transferred.

Describe this energy transfer.

Use ideas about energy stores.

.....

 [2]

The transfers and stores model for teaching energy was introduced with this specification. Candidates found this question very challenging. Many candidates were confused by the term energy store, others did not use the term and those that did frequently described energy stores incorrectly. A common misunderstanding was that the energy was being transferred to a kinetic store and very few mentioned the battery as a chemical store. Only the more able candidates understood that energy was being transferred as electrical energy through the wires. Around 30% of candidates did not attempt the question.

Exemplar 4

Energy is transferred from chemical energy store to a thermal energy store.

A perfect answer for 2 marks

Exemplar 5

When the heater is turned on, energy is transferred, it is kinetic energy and thermal energy stored.

The candidate as not mentioned the energy stored in the battery, correctly noticed that energy is transferred but incorrectly identified it. But has recognised that thermal energy is stored

Question 14(d)(i)

- (d) (i) The current through the heater is 3.8A. The potential difference across the heater is 9.0V.

Use the equation: Power = Potential difference \times Current

Calculate the power of the immersion heater.

Answer = W [2]

Most candidates successfully answered this question. Candidates who stated an incorrect answer for the power of the heater were most likely to not provide any workings and so could not access the one mark available for substituting in the correct values for current and potential difference.

Question 14(d)(ii)

(ii) The scientist writes down more information about her experiment.

- Mass of water = 150 g
- Specific heat capacity of water = 4200 J / kg °C
- Temperature increase of water = 10 °C

Calculate the change in thermal energy of the water.

Answer = J [3]

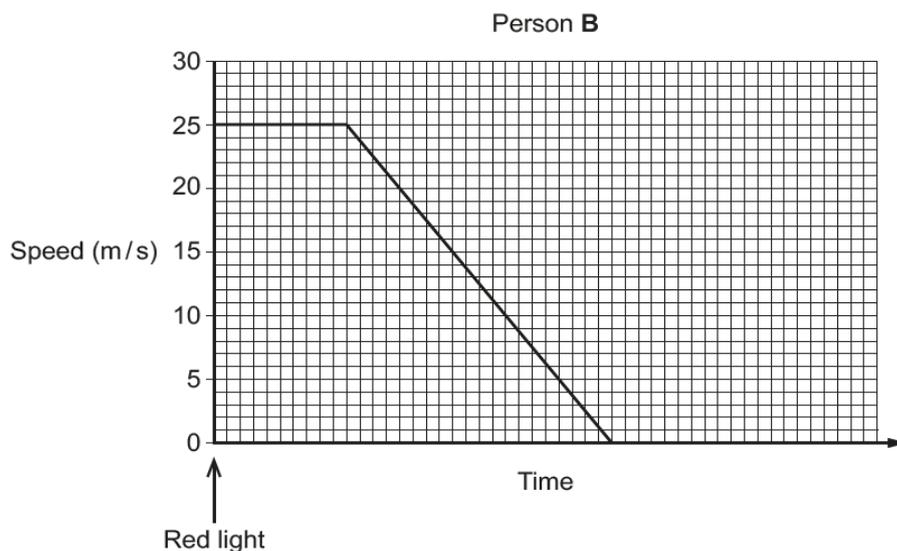
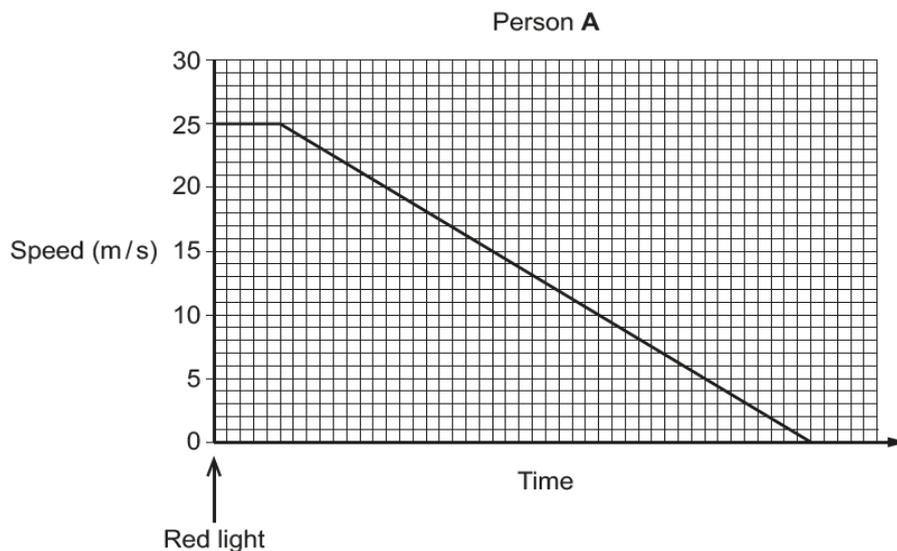
Only the highest ability candidates selected the correct equation, converted the mass to kg and correctly calculated the change in thermal energy. 55% of candidates forgot to convert mass to kg and calculated the energy change as 6300000 J, they were credited with two marks. Several candidates applied the specific latent heat equation for change of state or divided the product of mass and specific heat capacity by temperature.

Question 15*

15* 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 speed of each car **after** person **A** and person **B** see the red light.



The graphs are drawn using the same scale.

Describe the different ways the cars come to a stop.

In your answer:

- Suggest reasons why the cars take different times to stop
- Write about thinking and braking.

..... [6]

This level of response (LoR) question discriminated well although only 5% of candidates achieved at Level 3. The general standard of graph interpretation demonstrated was good, although a few did not identify the thinking distance. Many candidates did not suggest any reasons for the differences in the stopping distance, or they suggested a good reason but did not comment on the thinking distance. A minority of candidates covered all of the points asked for in the question stem to a good standard, and suggested appropriate reasons for both thinking and braking distances.

Around half of all candidates achieved at Level 1 on this extended question, the majority in the upper part of the band. Many candidates were not able to progress up to Level 2 because of their misunderstanding of scientific terms. This made their answers confusing and contradictory, for example describing the time taken to brake as 'thinking time'. Level 2 candidates could describe different ways the cars come to a stop but were not able to progress up to Level 3 because they could not demonstrate fully an understanding of the differences between thinking, braking and stopping distances.

Exemplar 6

Person A took longer than Person B to press the brakes in their car.

Person A had a longer braking distance than Person B.

So Person B had a quicker thinking distance than Person A.

~~ANSWER~~ Speed = distance \div time.

The longer the distance, the higher the time gives you a higher speed or braking distance.

Level 1 (2 marks) The candidate correctly interpreted the graph (AO2.1) but did give reasons for these differences (AO 1.1) needed to move out of the bottom band. There is evidence of correctly linking the braking and thinking distances to the graph.

Exemplar 7

L2

^

As for person B that took long to pull the brake because they might have been ~~distra~~ distracted by the people in side the car whereas person A ~~seem~~ seemed to see the red light and was ~~not~~ looking at the traffic light.

Person B might be thinking about something else not so focussed on the road as much as for person A even though they both have some ~~speed~~ starting speed.

Level 2 (3 marks) The candidate correctly interpreted that A reacted quicker than B from the graph (AO2.1) and gave a reason Distraction/thinking about something else (AO1.1) but could not get the top of this band as he did not refer and give reasons for the braking portion of the graph so he did not fully achieved the descriptor for this level.

Exemplar 8

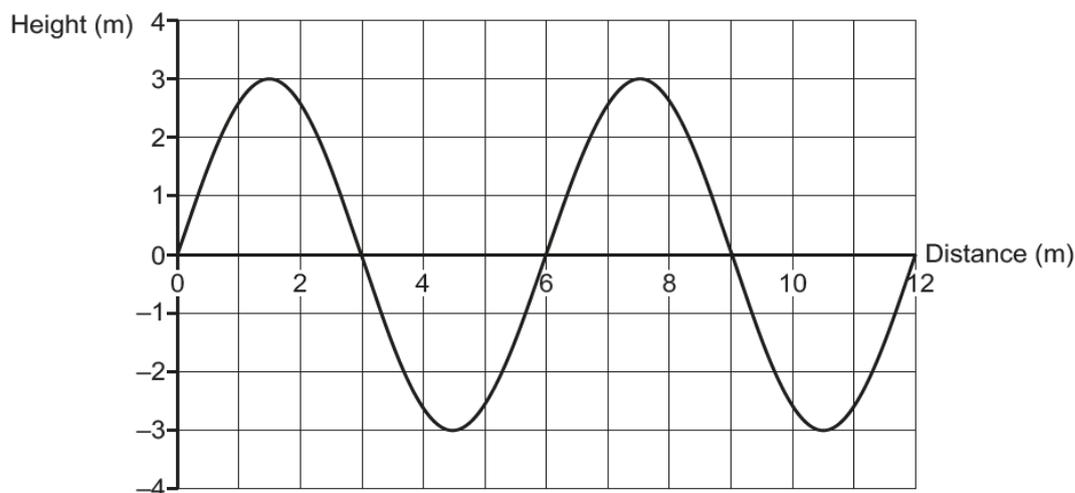
Person A's thinking distance is shorter than Person B's and this could be because of age or person B could have consumed a bit of alcohol which increases reaction time. However, the braking distance of Person A is longer than Person B and this could be due to the conditions of the road, as they were both driving on different days. For person A the road could have been more wet or icy than the dry person B drove on. Both of their cars may be different and the stopping distance could be due to their cars' condition. Also tiredness could be a cause for person B's reaction time to be slower.

Thinking distance compared for drivers and linked to alcohol/tiredness (AO1.1, 2.1 and 3.2) Braking distance compared for drivers and linked to wet/conditions of the road (AO1.1, 2.1 and 3.2)

Level 3 (6 marks) The candidate correctly identified the portions of the graph (AO2.1) and related these to reasons (AO1.1) but then went on to correctly link these to braking and thinking distances to draw a detailed conclusion (AO3.2b).

Question 16(a)

16 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]

Many candidates struggled to articulate their ideas clearly and correctly. It was encouraging to see that several annotated the graph to show the wavelength, which helped them to be credited with the mark if their written definition was not clear. Many candidates confused wavelength with amplitude e.g. 'a wavelength goes up and down'.

Exemplar 9

...The top wave measures a height of 3m
 ...and the bottom does too. Add them up = wavelength [1]

This shows a typical example of the candidate confusing amplitude with wavelength

Question 16(b)

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

Calculate the speed of this water wave.

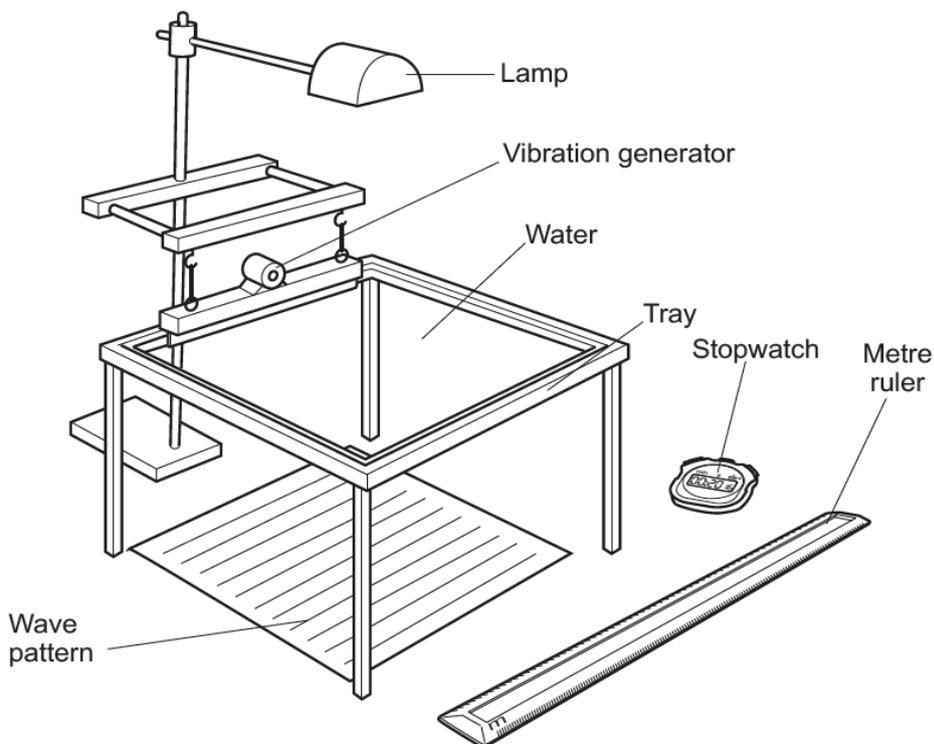
Answer = m/s [3]

Only the highest ability candidates were able to answer the question successfully. The most common errors were using 12 m as the wavelength or calculating the quotient rather than the product of $f \times \lambda$.

Question 16(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.

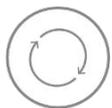
.....

.....

.....

..... [2]

It was clear from their written answers that most candidates had used/seen a ripple tank. The most common procedure given by candidates was the idea of using the stopwatch to measure time. Very few candidates linked their given procedure to a formula. Two thirds of candidates could not be credited with any marks because of confusing or imprecise language.



AfL

Students can find it difficult to apply their practical science skills to new contexts. Often they write too much and get themselves confused. As a starter exercise show candidates an experimental set up and ask them to:

- identify a physics equation that could be investigated
- write a procedure in a small (stated) number of bullet points

Exemplar 10

When the generator makes ripples, the light shine on it so you can see the waves on it at the bottom so ~~use~~ you use the metre ruler and stopwatch to measure the frequency of the waves [2]

A typical answer (0 marks). The candidate shows familiarity with the apparatus and the fact that calculating frequency involves the use of a stopwatch, but gives no practical details as to what they are going to measure.

Exemplar 11

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

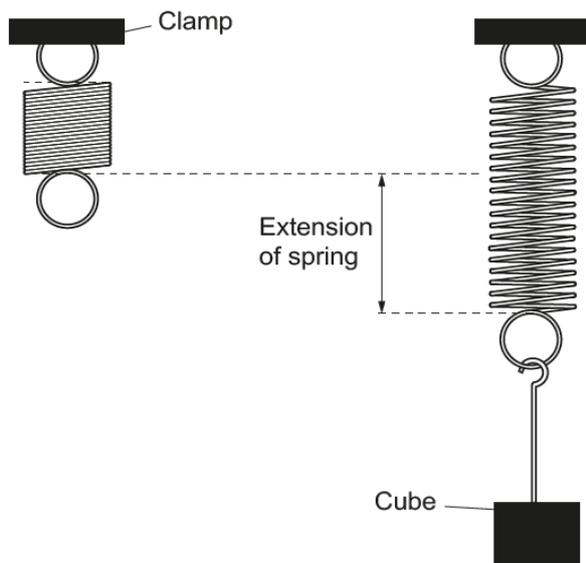
They use the equipment to measure how many waves pass by each second by using a stopwatch. Frequency of wavelength is how many times it passes by each second by one point they would time how long it took using stopwatch and they would measure the wavelength using a meter ruler. The vibration generator will create the waves and the water to power in the tank [2]



A good answer (2 marks). The candidate shows an understanding of what frequency is and how they are going to measure it by counting the number of waves, using the stopwatch to measure a set time. By the word 'point' in the fourth line, they have both marks and by the second mention of 'stopwatch' they have reinforced their understanding of the concept of frequency. The rest of the answer explains how a ripple tank is used but is not relevant to the question.

Question 17(a)

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

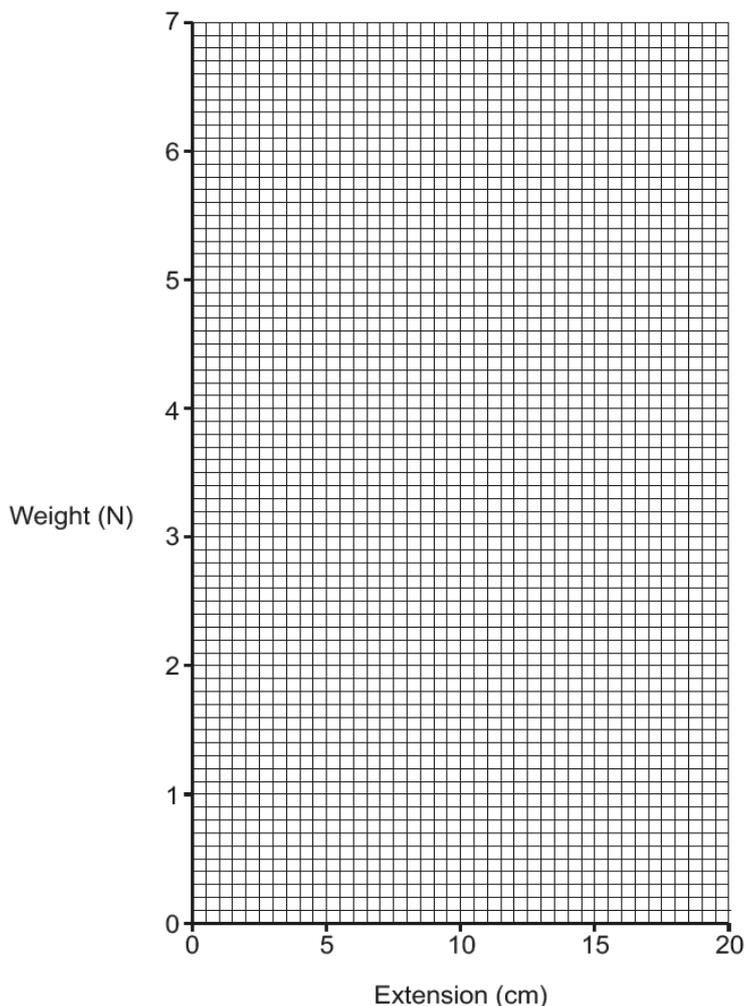


He hangs different cubes from the spring. He measures the extension of the spring for each cube.

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

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



[1]

40% of candidates completed this question successfully.

Question 17(b)

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

.....

 [3]

Candidates needed to calculate the gradient of the line of best fit or use the data to calculate $k = F/e$. Nearly half of the candidates omitted this question. Those that did attempt it mainly using the proportion method, and very few were credited with any marks. The mark scheme provided for any appropriate method to be credited. However as most candidates showed no workings they could not be credited with any compensatory marks.

Question 17(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]

Three quarters of all candidates attempted this question and half of them were credited with both marks. The most common misunderstanding was not selecting the correct equation from the data sheet, and then multiplying the spring constant by the extension. Other candidates selected the correct equation but did not square the extension.

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Section B, Q12d

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