Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249
For first teaching in 2016

J249/02 Summer 2019 series

Version 1

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.

Paper 2 series overview

This paper is designed to assess content from Topics P5 to P8 with assumed knowledge of Topics P1 to P4 and P9. Thus, this paper requires candidates to have knowledge and understanding of all the topics within the course.

There was no evidence to suggest that candidates were short of time in answering the paper.

Section A of the paper has fifteen multiple choice questions, each worth one mark. Candidates should be given the opportunity to practise these types of questions under timed conditions. In particular, candidates should be encouraged not to spend too long on any particular question but also to read the whole question including all the possible options. Other helpful tips include using the "white" space around the question to write done working and/or equations (to assist with answering the question and to help them to check their answer at the end of the examination) and eliminating incorrect options as they read through the question.

A number of questions required candidates to analyse information and ideas. Candidates should be encouraged to practise interpreting data both qualitatively and quantitatively from different sources. There were also a number of questions where candidates needed to interpret graphs. Candidates should understand the meaning of straight lines on graphs and how to determine direct proportion relationships.

There were a number of questions where candidates needed to carry out a numerical calculation. Where an equation needs to be recalled, candidates should be encouraged to write the equation down as a first step. In other numerical questions, candidates should identify the data to use and substitute the data into the equation, before calculating the answer. Candidates should also carefully consider the units of their data.

On this paper, there was one question, 21, where candidates had the opportunity to demonstrate their knowledge and understanding of physics by constructing their own answer. It is important that candidates answer the question set in a logical way with clear explanations. Candidates should also make sure that they answer the question set.

There were a number of questions where an explanation was required. Candidates should be encouraged to use the number of answer lines and the marks for the particular sub-part mark as a guide to the length of their answers. Candidates should also make sure that they use appropriate physics terms correctly in their answers. They should also be encouraged to include diagrams where appropriate.

The comments that follow tend to relate mainly to the opportunities that were missed by the candidates or not fully understood.

Section A overview

Candidates did well on questions 2,4,5,7,9,11 and 12 but found the rest of the questions challenging with less than half the candidates gaining credit.

Question 1

1 Which statement describes the domestic electricity supply in the UK?

A 50 V a.c. at 230 Hz

B 50 V d.c. at 230 Hz

C 230 V a.c. at 50 Hz

D 230 V d.c. at 50 Hz

Your answer ☐ **[1]**

This first question was a simple recall question. Candidates are expected to know that mains electricity is a.c. (ruling out options B and D) and candidates should be able to recall that the domestic supply in the UK is a.c. at 50 Hz and about 230 V.

Question 2

2 A teacher measures the speed of water waves in a ripple tank.

What apparatus should she use?

A Ammeter and stopwatch

B Newton-meter and ruler

C Ruler and protractor

D Ruler and stopwatch

Your answer ☐ **[1]**

The majority of candidates correctly identified that a ruler and a stopwatch should be used to measure the speed of water waves. A common incorrect response was an ammeter and stopwatch.

Question 3

3 What type of wave is light?

A A longitudinal electromagnetic wave

B A longitudinal P wave

C A transverse S wave

D A transverse electromagnetic wave

Your answer ☐ **[1]**

This question was not answered well. It was hoped that candidates would know that light is a type of electromagnetic wave and that all electromagnetic waves are transverse. This was a straightforward recall question from the specification.

Question 4

4 Which statement is **true** for electromagnetic waves?

A High frequency electromagnetic waves have a long wavelength.

B High frequency electromagnetic waves have no wavelength.

C Low frequency electromagnetic waves have a long wavelength.

D Low frequency electromagnetic waves have a short wavelength.

Your answer ☐ **[1]**

This question was also based on the electromagnetic spectrum section of the specification. Candidates had a better understanding of the main groupings of the electromagnetic spectrum from long to short wavelengths and from low to high frequencies. An alternative way of answering this question is to apply the wave equation realising that the speed of electromagnetic waves in a vacuum is constant.

Question 5

5 A boiler has an input energy of 720 kJ from the gas it burns.

It transfers 540 kJ of useful energy to the home.

What is the efficiency of the boiler?

Use the equation: efficiency = useful output energy transfer ÷ total input energy transfer

A 0.12

B 0.75

C 0.90

D 1.33

Your answer [ ] **[1]**

This question was well answered. Higher ability candidates used the space around the question for their working.

Exemplar 1

5 A boiler has an input energy of 720 kJ from the gas it burns.

It transfers 540 kJ of useful energy to the home.

What is the efficiency of the boiler?

540 720

Use the equation: efficiency = useful output energy transfer ÷ total input energy transfer

A 0.12

B 0.75

C 0.90

D 1.33

Your answer [B] **[1]**

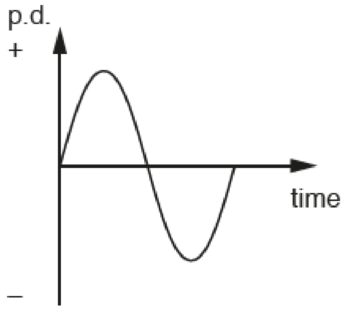
This exemplar shows the candidate identifying the correct numbers for the given equation.

Question 6

6 Here are some graphs for the potential difference (p.d.) of four electrical supplies.

Which graph shows a direct voltage?

A



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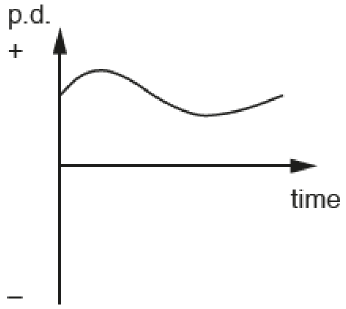

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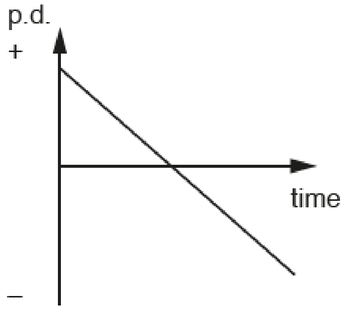

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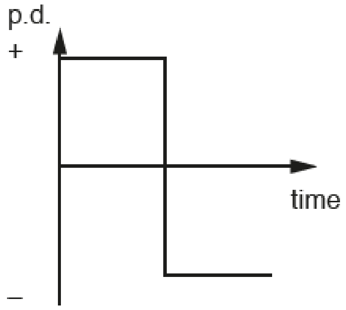


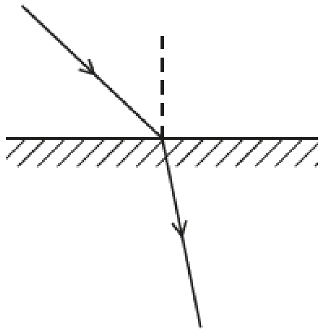
Your answer ☐ **[1]**

Candidates found this question very challenging. It tested whether candidates understood that direct current was a flow in one direction. A large number of candidates incorrectly gave response C presumably since they thought that this demonstrated a constant potential difference. The correct response shows a varying direct current.

Question 7

7 Which diagram shows reflection of a light ray using a plane mirror?

A



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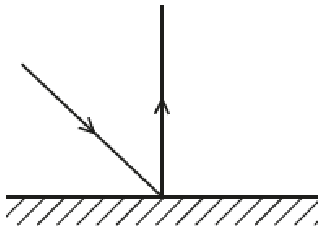

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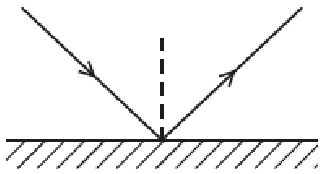
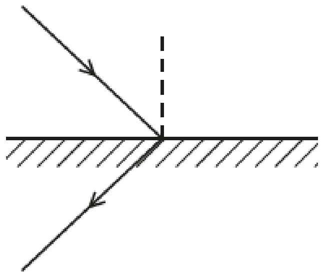


D



Your answer ☐ **[1]**

This question was answered correctly by the majority of the candidates. A small number of candidates opted for D

Question 8

8 Which row in the table is correct?

	Electromagnetic wave	Use
A	Radio	Killing bacteria
B	Microwaves	Mobile phones
C	X-rays	Optical fibres
D	Gamma rays	Tanning beds

Your answer ☐ **[1]**

There was evidence that a large number of candidates were unaware of the practical uses of electromagnetic waves. A common incorrect answer was C.

Question 9

9 A runner has a mass of 80 kg and moves at a speed of 5 m/s.

Calculate the kinetic energy of the runner.

Use the equation: kinetic energy = 0.5 × mass × $(\text{speed})^2$

A 200 J

B 1000 J

C 2000 J

D 40 000 J

Your answer ☐ **[1]**

This question was very well answered. Candidates correctly squared the speed. Again, higher ability candidates used the space around the question for their working.

Question 10

10 Which row in the table correctly describes how the national grid transfers electrical energy efficiently?

	Voltage	Current	Reason
A	High	High	To increase heating in wires.
B	High	Low	To reduce heating in wires.
C	Low	High	To reduce heating in wires.
D	Low	Low	To reduce heating in wires.

Your answer ☐ **[1]**

Candidates generally realised that the reason was to reduce heating in wires but were confused with whether the voltage was high and the current low or the voltage was low and the current was high.

Question 11

11 The acceleration of a car is $2\,m/s^2$. The mass of the car is 1000 kg.

Calculate the resultant force on the car.

A 20 N

B 200 N

C 2000 N

D 20 000 N

Your answer ☐ **[1]**

This question was answered well with candidates being able to recall the equation relating acceleration, force and mass.

Question 12

12 Which radioactive decay equation is correct?

A ${}^{14}_{6}\text{C} \rightarrow {}^{10}_{4}\text{Be} + {}^{0}_{-1}\text{e}$

B ${}^{14}_{6}\text{C} \rightarrow {}^{10}_{4}\text{Be} + {}^{0}_{0}\gamma$

C ${}^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{4}_{2}\text{He}$

D ${}^{14}_{6}\text{C} \rightarrow {}^{14}_{7}\text{N} + {}^{0}_{-1}\text{e}$

Your answer ☐ **[1]**

The majority of the candidates realised that the masses and charges needed to balance.

Question 13

13 The table shows the current and potential difference (p.d.) for four different transformers.

Which row shows the correct data for a **step-up** transformer?

	Primary coil		Secondary coil	
	p.d. (V)	**Current (A)**	**p.d. (V)**	**Current (A)**
A	6	4	12	2
B	12	2	3	8
C	12	2	12	2
D	12	2	24	1.5

Your answer ☐ **[1]**

This question initially looks straightforward. A and D are both step-up transformers since the p.d. has increased in the secondary coil. However, in D the output power is also greater than the input power which means that the transformer would be more than 100% efficient.

AfL	In these types of questions, candidates should be encouraged to work through each response perhaps indicating with a small cross any responses that can be eliminated. They should then work out each of the remaining responses. In this question, B and C could be eliminated since B is a set-down transformer and in C the p.d. remains the same. Then the power input could then be calculated for the remaining primary and secondary coils writing the values to the left and right of each row in the table.

Question 14

14 A sound wave travels in air and enters water.

What happens to the sound wave as it enters the water?

	Speed	Frequency	Wavelength
A	decreases	decreases	decreases
B	decreases	stays the same	decreases
C	increases	increases	increases
D	increases	stays the same	increases

Your answer ☐ **[1]**

This question proved very challenging. Many candidates incorrectly gave the answer as B without realising that the question referred to a sound wave. Candidates needed to know that sound travelled faster in water than in air.

Question 15

15 An electromagnetic wave transfers energy.

Which row in the table is correct?

	Electromagnetic wave	Energy transfer
A	Infra-red	From a heating element of a toaster to the bread inside
B	Radio	From a radio to a transmitter
C	Gamma rays	From a high voltage supply to heating water in food
D	X-rays	From bones in the body to an X-ray machine

Your answer ☐ **[1]**

This question required candidates to read the options carefully. Many candidates did not realise the direction was important.

Section B

Question 16 (a) (i)

16 A student investigates how the thickness of insulation affects the cooling of a cup of tea.

Fig. 16.1 is a diagram of her apparatus.

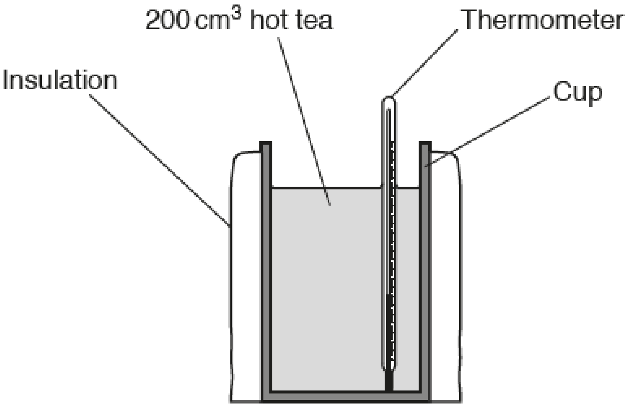


Fig. 16.1

The student wraps a layer of insulation around a cup containing 200 cm^3 of hot tea.

She measures the temperature of the tea at the start of the experiment and after 10 minutes.

She repeats the experiment with different thicknesses of the insulation.

Table 16.1 shows her results.

Thickness of the insulation (mm)	Temperature of tea (°C)		
	Start	End	Difference
2	90	65	25
4	88	66	22
6	91	72	19
8	89	73	16
10	98	84	14
12	100	60	

Table 16.1

(a) **(i)** Calculate the temperature **difference** when the thickness of insulation is 12 mm.

Temperature difference = ... °C **[1]**

The majority of the candidates calculated the difference correctly.

Higher ability candidates often wrote 100 – 60 = 40

Question 16 (a) (ii)

(ii) The result when the thickness of the insulation is 12 mm is anomalous.

Suggest a reason why this result appears to be anomalous.

....

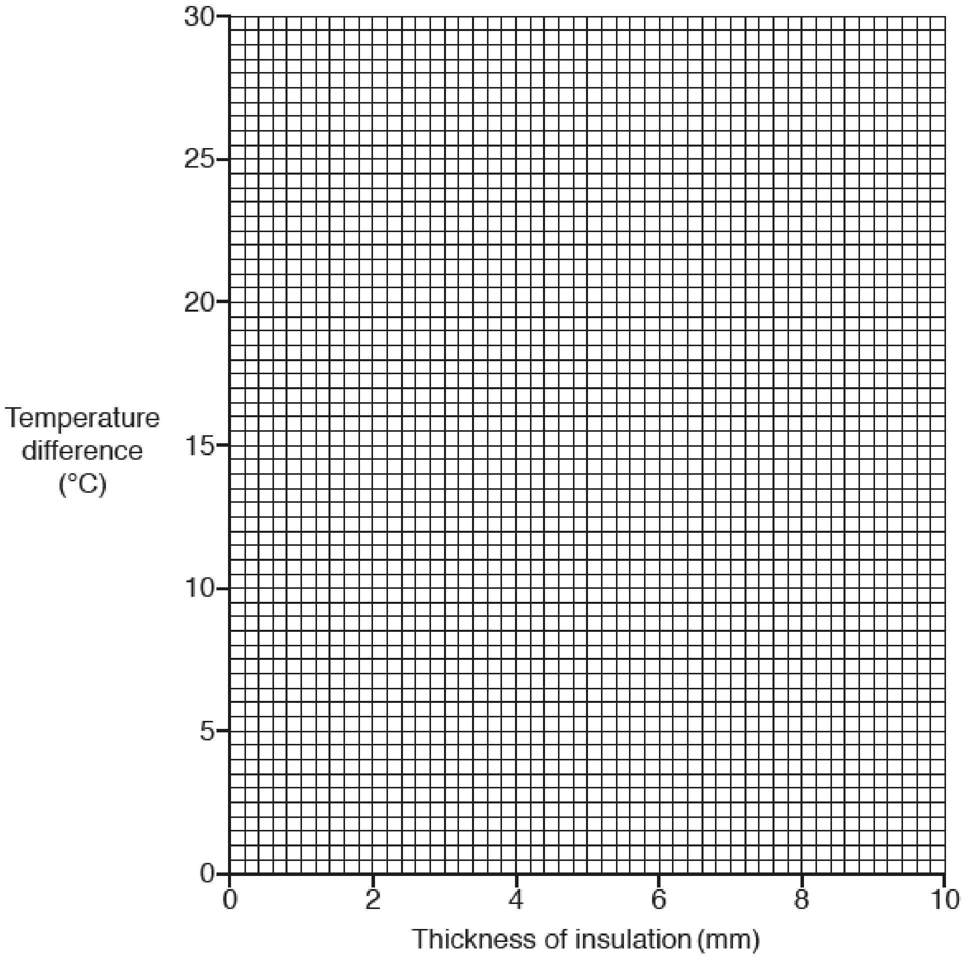
.... **[1]**

This question required candidates to identify that the last difference did not follow the pattern. The start temperature in this case was irrelevant and was not credited. Many candidates correctly identified that the end temperature was too low or that the temperature difference was too large. Candidates should be encouraged to include a comparison in this type of question.

Question 16 (b)

(b) Plot a graph of the results in **Table 16.1** and draw a line of best fit.

Ignore the anomalous result for 12 mm.



[2]

Many data points and lines were too thick. The second and fourth data points were often incorrectly plotted.

It was expected that a straight line of best fit would be drawn. A large number of candidates drew lines dot-to-dot.

	AfL	Candidates should be encouraged to plot graphs using a sharp pencil. The points should be indicated with a small cross. Straight lines should be drawn with a ruler. Candidates should be encouraged to check the plotting of their data points - particularly points which do not appear to fit a pattern. The line of best fit may not pass through every data point. There should be a balance of data points about the line of best fit.

Question 16 (c)

(c) Describe how the temperature difference is affected as the thickness of the insulation increases.

....

.... **[1]**

The majority of candidates correctly stated that the temperature difference falls as the thickness of the insulation increases.

Higher ability candidates included in their answer "as the thickness of the insulation increases".

Question 16 (d)

(d) Suggest how the thickness of the insulation affects the rate of cooling of the tea.

....

.... **[1]**

Many candidates omitted to indicate a direction of change for the thickness of the insulation. Other candidates did not understand the meaning of the term 'rate'.

	AfL	Candidates should be encouraged to practise explaining equations in terms of the effect of increasing a quantity on another quantity.

Question 16 (e)

(e) This experiment could be improved.

Describe two **different** ways of improving the experiment.

1 ....

....

2 ....

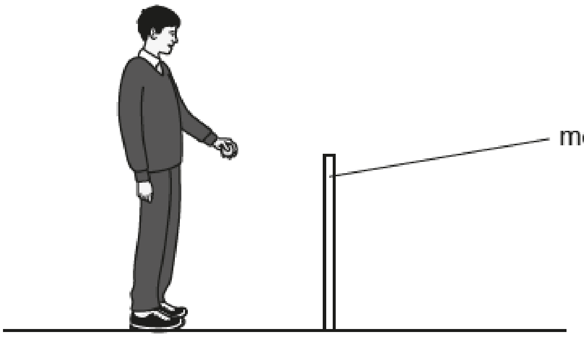
.... **[2]**

In this type of question, candidates need to give detailed ways of improving the experiment. Many candidates stated add insulation without being specific that the insulation should be either under the tea or as a lid. A number of candidates stated correctly that the start temperature should be the same and the room temperature should also be the same.

Question 17 (a) (i)

17 A student wants to investigate how a ball bounces.

He drops the ball from different heights and measures the bounce height each time.



He calculates the ratio bounce height / drop height.

The table shows his results.

Drop height (cm)	Bounce height (cm)	Bounce height / drop height
100	70	0.70
80	64	0.80
60	54	0.90
40	40	1.00
20		

(a) The student predicts the ratio bounce height / drop height to be 1:1 when the drop height is 20 cm.

(i) Suggest why he has made this prediction.

....

.... **[1]**

Many candidates answered this question correctly by referring to the previous bounce height being the same. This question again required candidates to interpret data from a table.

Question 17 (a) (ii)

(ii) Use ideas about energy to explain why this prediction cannot be correct.

....

.... **[1]**

There was a clue in the question regarding energy. It was anticipated that candidates would understand that there is likely to be energy losses both as the ball travels through the air and as it bounces. It was hoped that there would be reference to energy being transferred from the kinetic energy store to other energy stores as the ball bounces.

Question 17 (b)

(b) Suggest **two** improvements to his experiment.

1 ....

....

....

2 ....

....

....
[2]

This was another question which required candidates to consider experimental procedures. Many candidates suggested taking other readings. Some candidates tried to suggest methods of improving the measurement of the bounce height but often the explanations were vague and lacked the necessary detail.

	AfL	Candidates should be encouraged to consider improvements to experiments that are carried out as part of their practical course.

Question 17 (c) (i)

(c) The mass of the ball is 60 grams.

(i) Calculate the mass of the ball in kg.

Mass = ... kg **[1]**

The majority of the candidates correctly answered this question. Many candidates who did not gain this mark wrote 0.6 kg.

Question 17 (c) (ii)

(ii) Calculate the potential energy of the ball when it is 0.80 m above the ground.

Use your answer to **(c)(i)** and the equation:
potential energy = mass × height × gravitational field strength

Gravitational field strength = 10 N/kg

Potential energy = ... J **[2]**

This was well answered. Candidates should again be encouraged to show their working. There should be clear substitution of the numbers into the given equation. The advantages of this method are that candidates will then be able to use their calculator without having to look for the numbers and easily be able to check their answer later. It also enables candidates to gain one mark if there is an error in the calculation.

Question 18 (a) (i)

18 **(a)** Lenses can be used to help people see clearly.

Fig. 18.1 is a diagram of a convex lens.

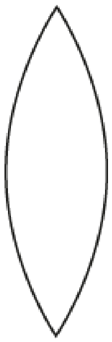


Fig. 18.1

(i) A student models the lens using two glass **prisms** and a glass **block**.

Complete the ray diagram **Fig. 18.2** to show how light rays travel through the model lens (glass prism and glass block).

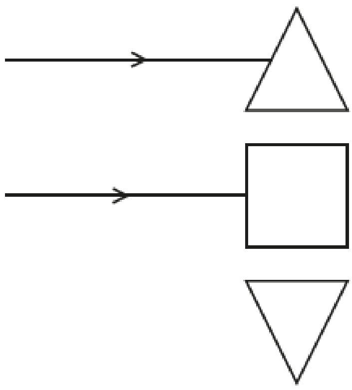


Fig. 18.2

[2]

This question required candidates to use a ruler to draw straight lines. A number of candidates did not have a continuous straight line passing through the centre of the block.

Candidates should be encouraged to read the question carefully. In this case there was no need to draw rays for the lower triangular block.

Question 18 (a) (ii)

(ii) Explain how a convex lens can correct long-sighted vision.

Use the model in **Fig. 18.2** to help you.

....

....

....

.... **[2]**

The explanations written by candidates were often vague. Candidates were expected to explain the meaning of long-sighted vision and then explain how the use of convex lens would focus the image on the retina.

Question 18 (b)

(b) A student looks at coloured paper in different coloured light.

Fig. 18.3 is a diagram of her experiment.

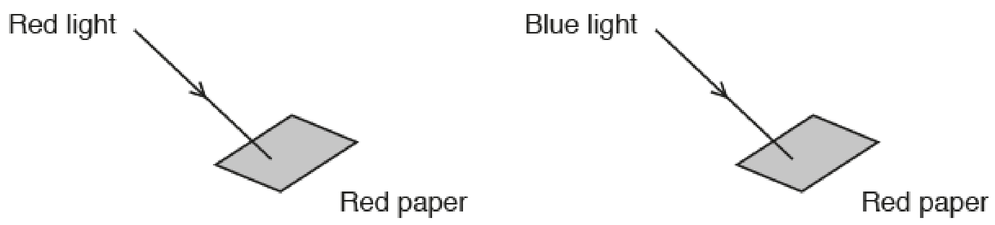


Fig. 18.3

She looks at red paper with red light. The paper appears red.

What colour does the red paper appear in blue light?

Explain your answer.

....

....

.... **[2]**

Few candidates realised that the red paper would appear black in blue light. Candidates often thought that the red paper would look purple.

Candidates that did state that the red paper appeared black and often reasoned that the red paper would absorb all the other colours.

	AfL	Candidates should be encouraged to understand the adding and subtraction of colours and be able to explain light being absorbed at surfaces.

Question 19 (a)

19 A student looks at two identical metal spoons, **A** and **B**.

Spoon **A** was placed in hot water at 70 °C.

Spoon **B** is at 20 °C.

(a) Which spoon emits the most radiation?

Tick (✓) **one** box.

Spoon **A** ☐

Spoon **B** ☐

Explain your answer.

....

.... **[1]**

Many candidates correctly ticked Spoon A but did not explain their answer correctly. It was expected that they would state that objects at higher temperatures would emit more radiation.

Question 19 (b)

(b) Explain why both spoons look identical to the student, even though they are at different temperatures.

....

....

.... **[1]**

The common incorrect answer to this question was to refer to the spoons not melting rather than stating that infrared radiation cannot be detected by the eye.

Question 20 (a) (i)

20 (a) Fig. 20.1 is a graph of a wave.

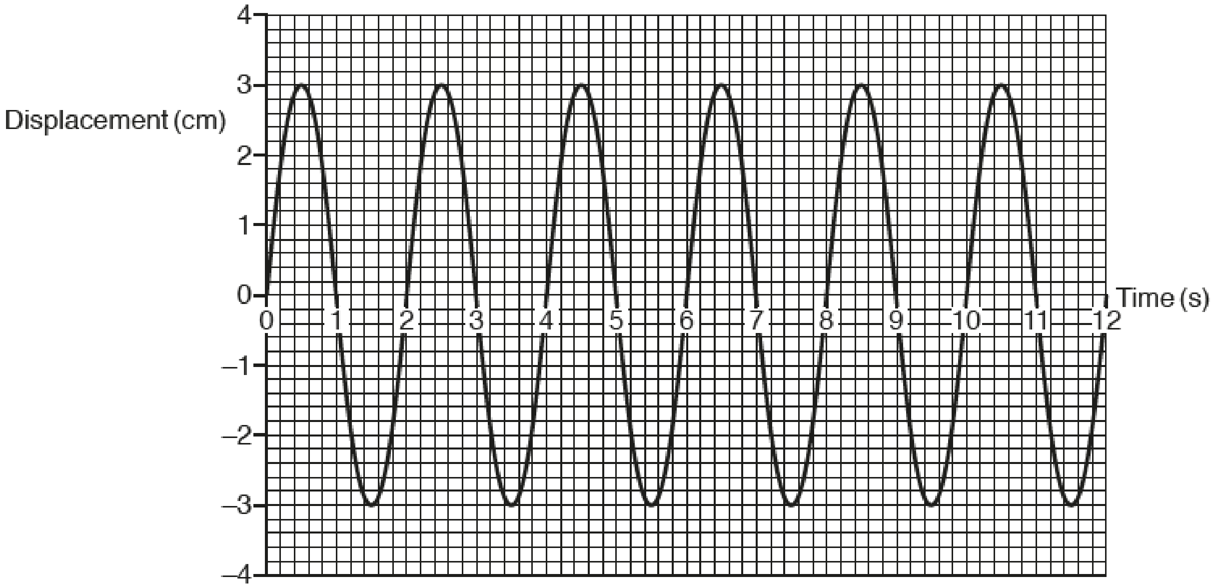


Fig. 20.1

(i) Use the graph in **Fig. 20.1** to work out the time period of the wave.

Time period of the wave = ... s **[1]**

A small proportion of candidates gained this mark for a period of 2 s. The majority of candidates wrote 12 s being the total time shown. A few candidates wrote 1 s.

Question 20 (a) (ii)

(ii) Use the graph in **Fig. 20.1** to work out the amplitude of the wave.

Amplitude = ... cm **[1]**

Over half the candidates scored the mark for 3 cm. The common incorrect answer was 6 cm (peak to trough).

Question 20 (a) (iii)

(iii) The frequency of the wave in **Fig. 20.1** is 0.5 Hz.

What is meant by the term **frequency**?

....

.... **[1]**

Candidates often did not refer to a time of one second. The word "amount" was often used instead of "number". Many vague responses such as "how many times something happens" or "how fast something is" were seen.

Candidates are expected to define frequency (and wavelength).

	AfL	Candidates should be able to know and apply basic wave terms such as amplitude, wavelength, frequency and period.

Question 20 (b)

(b) A water wave has a frequency of 0.25 Hz and a wavelength of 6.0 m.

Calculate the speed of the wave.

Speed of the wave = ... m/s **[3]**

Candidates needed to recall the wave equation and substitute the numbers. Many candidates gained the marks on this question. Candidates who did not do well on this question often did not write an equation in their answer.

Exemplar 2

(b) A water wave has a frequency of 0.25 Hz and a wavelength of 6.0 m.

Calculate the speed of the wave.

frequency × wavelength = wave speed

0.25 × 6 = 1.5

Speed of the wave = ...1.5.......... m/s **[3]**

This candidate has stated the equation with the wave speed as the subject. The candidate has then substituted the numbers before calculating the answer.

	AfL	For calculations, candidates should show their working. The following steps are useful: 1. Recall equation (if not given in the question) 2. Rearrange equation 3. Substitute the numbers into the equation 4. Calculate the answer 5. Consider significant figures or decimal places

Question 20 (c) (i)

(c) Surface water waves can be modelled using a slinky spring.

A student holds one end of the spring on a table. The other end is fixed to a wall.

Fig. 20.2 shows the spring **viewed from above the table**.

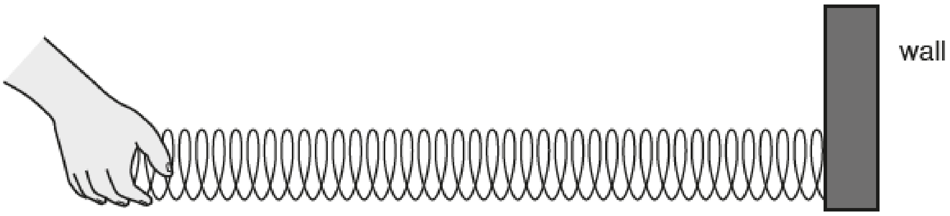


Fig. 20.2

(i) Draw two arrows **on the diagram** in **Fig. 20.2** to show the movement of the student's hand when he makes a transverse wave. **[1]**

This question required candidates to demonstrate their understanding of the differences between transverse and longitudinal waves. Many candidates drew arrows pointing left to right towards the barrier

Question 20 (c) (ii)

(ii) Describe what happens to the **transverse** wave at the wall.

....

....

.... **[1]**

It was expected that candidates would state that the wave would be reflected. Candidates should be encouraged to use technical terms such as "reflect" rather than "bounce". Many candidates stated that the wave would stop at the wall.

Question 20 (c) (iii)

(iii) In **Fig. 20.3** the student stops moving his hand.

This is what the coils in the spring look like after a short time:

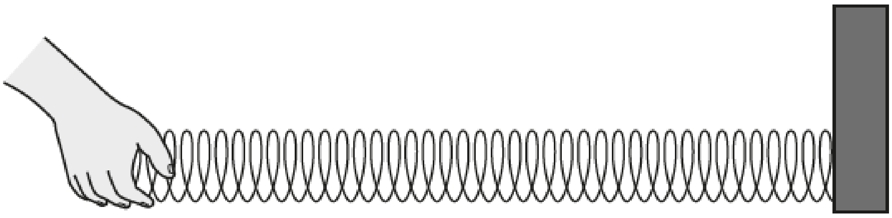


Fig. 20.3

This model of a water wave shows that the wave travels **not** the water.

Explain why.

....

....

.... **[1]**

This was a challenging question. Many candidates answered it by describing water waves rather than referring to the slinky spring model. To gain credit candidates needed to explain that the coils remain in the same positions.

Question 21

21* A student does an experiment using 0.2 kg of water.

Here is some information from the experiment:

The aim is to find the energy needed to raise the temperature of the water by 20 °C.
An electrical heater is used to heat the water. The temperature of the water increases by 20 °C.
The **specific heat capacity** of water is 4200 J/kg °C.

Describe how the student should carry out the experiment, including the equipment used.

In your answer calculate the change in internal energy for the water.

You may include a diagram in your answer.

....

....

.... **[6]**

This question gave candidates the opportunity to apply their knowledge and understanding of practical procedures related to specific heat capacity. The question is open ended so that candidates have the opportunity of demonstrating their knowledge as well as having the opportunity to structure their answers logically.

This question stated "You may include a diagram in your answer." A diagram of the experimental arrangement would have been very helpful. Many candidates did not include a diagram. The advantage of drawing a diagram is that it will also assist candidates in their procedures. Diagrams should be labelled. Several candidates drew diagrams with a beaker, heater and thermometer. Some candidates incorrectly drew diagrams of Bunsen burners heating water.

The question also required candidates to calculate the change in internal energy for the water. Higher ability candidates stated the equation from the data sheet and then clearly substituted the numbers from the question before calculating the answer. Candidates who did not calculate the change in internal energy correctly often did not include an equation.

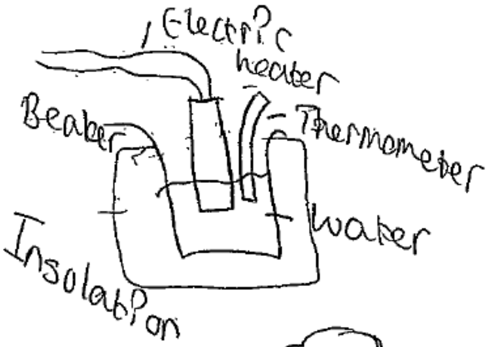
The question gave candidates the opportunity to discuss practical procedures. Again, several candidates used insulation and adding a lid. Some discussed stirring the water. A circuit diagram showing how the electrical heater was connected would have been useful.

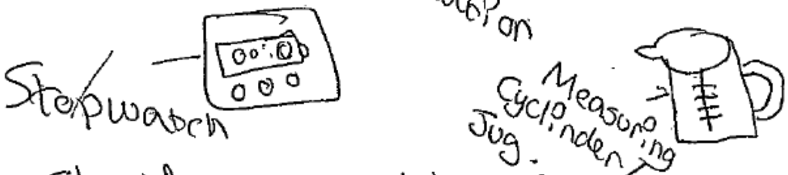
For the highest marks, it was expected that candidates would explain how a mass of 0.2 kg was measured and how the energy could be measured experimentally. Some candidates did mention the use of a stopwatch.

Exemplar 3

You may include a diagram in your answer.

Change in internal energy = mass x SHC x change in temp.
0.2 x 4200 x 20 = 16800 J





The student should accurately measure out the water, then pour into beaker. Then put the heater into the water and the ~~temp~~ thermometer, making sure they don't touch otherwise it will making the test inaccurate. Then time the experiment and find out how much ~~the~~ energy the heater gives out a second. Then heater the water 20°C and stop the time and turn off heater. Make sure to read thermemeter on eye level for most accuracy. **[6]**

This candidate has drawn a diagram showing the container is insulated with a heater and thermometer.

The calculation is clearly shown using an appropriate equation.

The candidate then describes the experiment; this could have included much more detail such as explaining how the water would be measured. This candidate hints at an energy determination when the energy per second of the heater is mentioned. The candidate also gives some extra detail when suggesting that the heater and thermometer should not touch.

The description of the procedure lacked appropriate detail but the calculation was correct. The information given by the candidate was relevant and was presented with some structure. Overall this response was assessed as being a Level 2 response worth four marks.

Question 22 (a)

22 Atoms can absorb and emit electromagnetic radiation.

(a) Describe **two** possible effects on an electron in an atom when it absorbs electromagnetic radiation.

1 ....

....

2 ....

....

[2]

This question tested candidates understanding of the effect on an electron that has absorbed electromagnetic radiation. Some candidates stated that the electron could gain energy and also the election could lose energy. It was expected that candidates would understand that the electron gains energy and may become excited and move to a higher energy level or escape from the atom. Credit was given for candidates who stated that the atom became ionised.

For this type of questions, candidates need to be precise in the use of terms. There was some confusion between atom and electron. Many candidates suggested that the electron lost charge. Candidates also need to take care over the use of "it". In this question, it was not always clear whether candidates were referring to the electron or the atom.

Question 22 (b)

(b) Alpha radiation is **not** emitted in the processes in part **(a)**.

Explain why.

....

....

.... **[2]**

The mark bracket for this question indicates [2], which means that candidates need to answer by giving two points. Few candidates understood that alpha particles are emitted from the nucleus and that alpha particles do not have electrons.

Question 23 (a)

23 (a) A radioactive isotope has a half-life of 6 hours.

50 g of the isotope are put in a container.

What mass of the isotope is left after 6 hours?

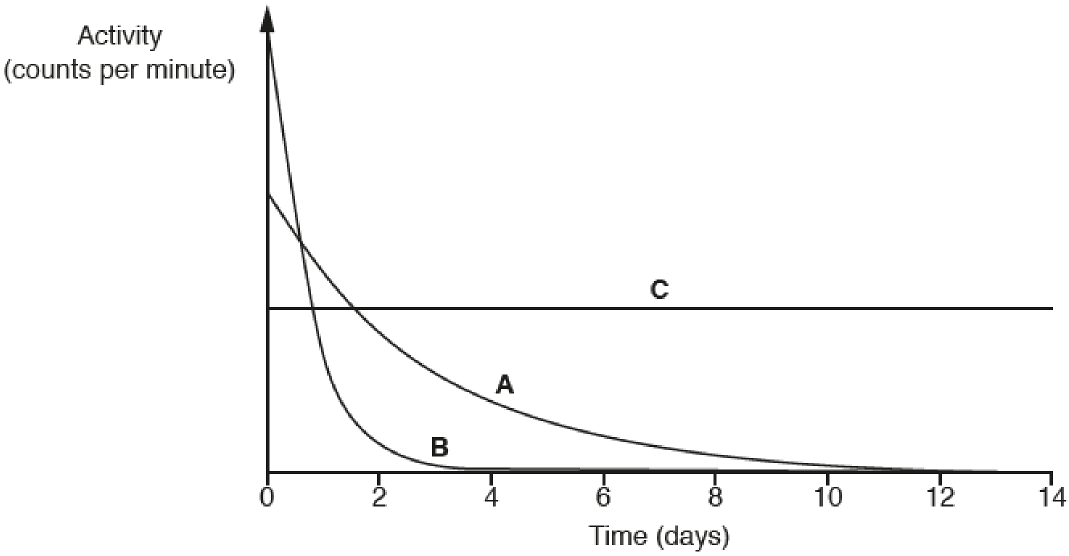
Mass = ... g **[1]**

About half the candidates correctly understood the term half-life and answered 25 g.

There was evidence that other candidates either multiplied the numbers together (300) or divided the numbers (8.3).

Question 23 (b) (i)

(b) This is a graph showing the radiation emitted from samples of three different isotopes **A**, **B** and **C**.



(i) Which isotope, **A**, **B** or **C**, takes the longest time to decay? **[1]**

Tick (✓) **one** box.

A ☐

B ☐

C ☐

A large majority of the candidates correctly identified C as taking the longest time to decay. The common error was A.

Question 23 (b) (ii)

(ii) Two scientists discuss the isotopes in the graph.

Scientist 1	Scientist 2
'I think isotope **A** is more hazardous than **B**. **A** has a higher activity than **B**.'	'I think isotope **B** is more hazardous than **A**. **B** has a longer half-life than **A**.'

Do you agree with the views of scientist 1 and scientist 2?

Use the graph and ideas about radioactivity and half-life to explain your answer.

Scientist 1 ....

....

....

....

Scientist 2 ....

....

....

.... **[4]**

This type of question gives candidates opportunities to demonstrate their knowledge of radioactivity as well as their skills in interpreting graphical information.

In answering this type of question, candidates should look at the information from the graph and discuss what happens initially while B had the higher activity and then discuss what happened after the two graphs crossed. There should also be a link between activity and hazardousness. For the highest marks, there needed to be a comparison between the relative activity / hazardousness of the isotopes initially during the first day compared to activity / hazardousness of the isotopes after two days.

Candidates could not gain the same mark twice, i.e. A had a longer half-life and B had a shorter half-life would only gain one mark. Again, the physics term "half-life" was expected to be seen.

Exemplar 4

Scientist 1 The fact that A has a higher activity ~~than~~ than B is correct as it also has a longer half life. A is more hazardous due to its high activity rate

Scientist 2 A has got a longer half life than B as it takes more days for the activity to decrease. B has a shorter activity than A causing it to ~~have~~ also have a shorter half - life than A. **[4]**

This candidate makes the link clearly between hazardous and activity and also clearly states on two occasions that A has the longer half-life. The candidate says that A has a higher activity which is assumed as overall. The writing at the end has been ignored and it would seem that the candidate did not fully understand the term half-life. To improve on this answer, some comment should have been made with regard to the graph initially during the first day. This answer was given 3 marks.

Question 23 (b) (iii)

(iii) **Scientist 1** wants to identify the type of radiation emitted by isotope **A**.

This is a list of equipment **Scientist 1** has in his laboratory:

- radiation detector
- piece of thick lead
- piece of cardboard
- piece of aluminium.

Describe how **Scientist 1** does the experiment and explain how they can work out the type of radiation emitted.

You may include a diagram in your answer.

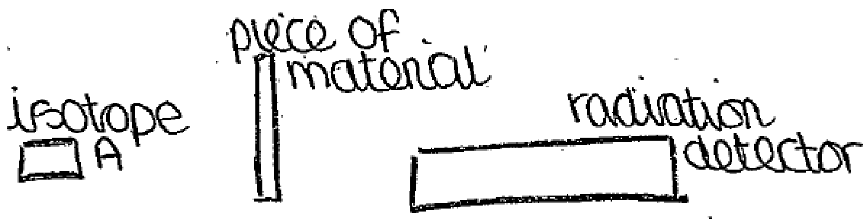
....

.... **[4]**

Good candidates drew a diagram to indicate the experimental set-up. Many candidates were able to describe how they would place the absorbers in front of the detector. It would be better if they had stated in turn. A few candidates under the procedure section stated that they would take a reading with no absorber present. A few candidates also stated that would take a reading without a source, i.e. taking a background count.

Several candidates were confused as to which absorber would stop which type of radiation.

Exemplar 5



The scientist should detect how much radiation the isotope has on it's own and then place each material (one at a time) between the isotope ~~as~~ and the detector. Gamma radiation is the strongest, therefore should pass through everything except aluminium. Alpha is the **[4]** weakest, so it should ~~b~~ be stopped by cardboard. Beta should be stopped by lead.

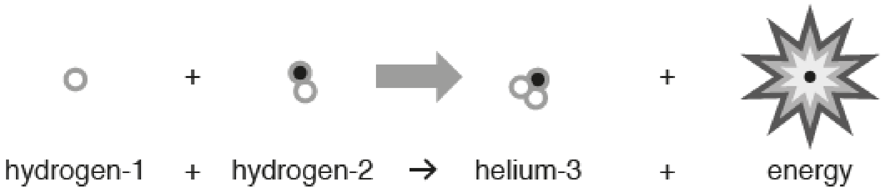
This candidate has a clear diagram, indicating the piece of material placed between the isotope and the detector. In the text, the candidate clearly states that each of the materials should be placed between the detector and isotope in turn ("one at a time").

The candidate's understanding of the likely results is muddled and not always correct (gamma radiation stopped by thin aluminium), but the candidate does correctly state that alpha should be stopped by cardboard. This answer was given 3 marks.

	AfL	Candidates should be able to explain experimental procedures using a labelled diagram.

Question 23 (c) (i)

(c) This is a diagram to show a nuclear fusion reaction:



(i) Explain why this is nuclear fusion.

....

.... **[1]**

There were many vague answers in terms of hydrogen reacting to produce large amounts of energy. Ideally candidates should understand that fusion is where nuclei join together.

Question 23 (c) (ii)

(ii) It is difficult for nuclear fusion reactions to occur on Earth.

Explain why nuclear fusion reactions occur in the Sun.

....

....

.... **[2]**

Examiners were keen that correct physics terms were used. Answers such as a lot of heat were not credited. Some candidates did mention very high temperatures. Other acceptable answers included high pressure and large gravitational forces. There needed to be some idea of size, e.g. high, large

Often only one comment was made when the mark bracket was [2] which indicates two points need to be made.

Question 23 (c) (iii)

(iii) What will happen to our Sun when it runs out of hydrogen?

....

.... **[1]**

The question required candidates to state what would happen when the sun ran out of hydrogen. Many candidates state what would happen to the sun eventually.

Question 23 (d)

(d) Some scientists say nuclear fission is renewable. Other scientists say it is non-renewable.

Suggest why the scientists disagree.

....

....

.... **[1]**

Many candidates incorrectly referred to fusion rather than fission. Candidates are advised to underline key phrases in the question paper before answering the question. Many candidates answered the question in terms of the dangerous waste products or that the waste products could be re-used.

Candidates had the opportunity to explain why either of the scientists could be correct in terms of the supplies of uranium being large enough so will not run out and therefore renewable or that the uranium is not being replaced so non-renewable.

Question 24 (a)

24 (a) A TV has a power rating of 0.2 kW.

Calculate the energy transferred, in kWh, if the TV is switched on for 4 hours.

Energy transferred = ... kWh **[3]**

Candidates needed to recall the equation, substitute in the numbers and calculate the answer. Few candidates wrote the equation.

Candidates should be encouraged to look at the unit on the answer line. In this question the unit is kW × h which should then give the hint that it is power measured in kW multiplied by time measured in hours.

A large number of candidates took the numbers and multiplied them together and also divided them giving possible answers of 0.8 kW h (correct) and 20 kW h (incorrect) – this did not score any marks since the candidate is not demonstrating that they understood the physics. Conflicting physics was not credited.

Exemplar 6

$0.2 \times 4 = 0.8$

$\frac{4}{0.2} = 20$ kWh

Energy transferred = ...20........................ kWh **[3]**

This candidate has written 0.2 × 4 = 0.8 which would have scored all three marks. However, the candidate then states that 4 / 0.2 = 20 kWh which incorrect physics and means that the question will not gain credit.

This candidate could have gained one mark by writing the equation that needed to be recalled. By writing this equation and then substituting in the numbers, the candidate may not have needed to possibly guess whether to multiply or divide the numbers.

Question 24 (b)

(b) A different TV works with a 12.0 V battery. It has a current of 3.19 A.

Calculate the power rating of the TV.

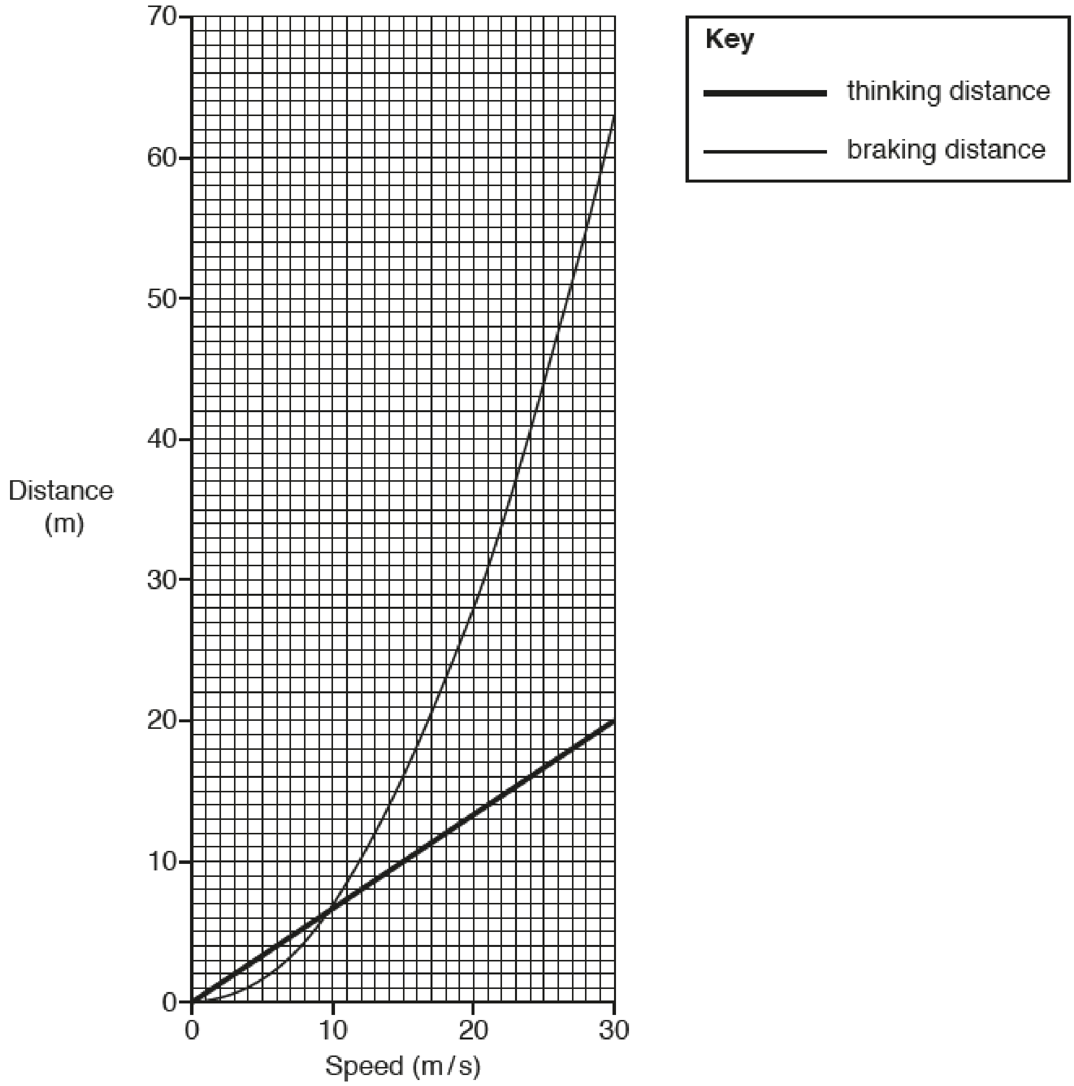
Power = ... W **[3]**

This question again required candidates to recall an equation, substitute numbers and calculate an answer. Candidates who used this method scored well.

Again, a significant number of candidates wrote both answers which multiplied and divided the numbers.

Question 25 (a)

25 The graph shows thinking and braking distances for a car at different speeds.



(a) Describe how **thinking distance** varies with increasing speed.

Use data from the graph in your answer.

....

....

....

.... **[2]**

Most candidates stated that the thinking distance increased with increasing speed. Few candidates stated that the thinking distance was directly proportional to the speed.

The question does indicate that candidates should use data from the graph. In this case, candidates could easily see that the thinking distance line is a straight line through the origin. Alternatively, they could have read the thinking distance at a speed of 15 m / s and 30 m / s to see that the thinking distances are 10 m and 20 m. This means that as the speed doubles the thinking distance doubles.

	AfL	Understand how to test from a graph whether two quantities are directly proportional. 1. Take a quantity on the *x*-axis and double it and read off the *y*-axis values and see whether they double as well 2. See whether there is a straight line through the origin.

Question 25 (b) (i)

(b) **(i)** Use the graph to find the **thinking distance** at 24 m/s.

Thinking distance = ... m **[1]**

This question was generally answered well.

Question 25 (b) (ii)

(ii) Calculate the **thinking time** at 24 m/s.

Use your answer to **(b)(i)** and the equation: distance travelled = speed × time

Give your answer to **2** decimal places.

Thinking time = ... s **[3]**

Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.66667 before rounding the answer to 0.67.

A number of candidates wrote their answer exactly from the calculator as $0.6\dot{6}$ which was not acceptable for two decimal places.

Question 25 (c) (i)

(c) **(i)** State **one** factor that could **increase** thinking distance.

.... **[1]**

Many candidates correctly answered this question. The common factors were alcohol, drugs and tiredness. Some candidates did not score the mark for factors related to braking distances.

Other candidates did not give an appropriate direction for the change, e.g. 'speed' was not credited but 'increasing speed' was credited.

Question 25 (c) (ii)

(ii) Calculate the **stopping distance** at 15 m/s.

Use the graph to help you.

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

The majority of the candidates gained one mark for correctly reading off either the thinking distance or the braking distance. Many candidates did not read the question carefully to realise it was the stopping distance that was required.

Higher ability candidates clearly showed both the values from the graph and the addition.

Question 25 (d)

(d) How does the speed affect the **kinetic energy** and **braking distance** of the car?

Use the graph in your answer.

....

....

....

....

.... **[3]**

Many answers to this question were vague. This question again required candidates to indicate the direction of the change in speed, e.g. as the speed increases. A small minority of candidates realised that both the kinetic energy and the braking distance increased with increasing speed. Very few used their graph to show that as the speed doubled the braking distance and kinetic energy quadrupled.

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