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OCR
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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/02 Summer 2023 series

Version 1

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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. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

Paper 2 series overview

This paper is designed to assess content from Topics P5 to P8 as well as P9 and with assumed knowledge of Topics P1 to P4. Thus, this paper requires candidates to have knowledge and understanding of all the topics within the course. The last two questions overlap with the Higher tier paper.

While there was no evidence to suggest that candidates were short of time in answering the paper, the last question on radioactivity proved to be very challenging with several parts omitted.

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.

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 show how they substitute the data into the equation, before calculating the response. Candidates should also carefully consider the units of their data.

On this paper, for Question 17 (a), candidates had the opportunity to demonstrate their knowledge and understanding of physics by constructing their own response. It is important that candidates respond to the question set, and do so in a logical way with clear explanations.

In questions where an explanation is required, candidates should be encouraged to use the number of answer lines and the marks for the particular sub-part as a guide to the length of their responses. Candidates should also make sure that they use appropriate physics terms correctly in their responses.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• used the white space in multiple choice questions for working and eliminated incorrect responses • in numerical questions stated the equation used, rearranged the equation and substituted the data before writing the response • used technical terms correctly • structured responses logically • related explanations to the question.	• did not use the white space in multiple choice questions for rough work • in numerical questions, often just wrote down a final response, omitting both a relevant rearranged equation and the substitution of the data • gave vague responses rather than relating their explanations to the question set.

Section A overview

Section A of the paper has fifteen multiple choice questions, each worth 1 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 question, and also to read the whole question including all the possible options.

In numerical questions, candidates should be encouraged to use the "white" space around the question to show equations and working. This should help them to respond to the question and assist them with checking their response.

In other questions, as candidates read through the question, a useful technique is to use small crosses to eliminate incorrect options.

Question 1

1 The domestic supply in the UK is a.c.

What does a.c. stand for?

A Alternative charge

B Alternating current

C Amplitude charge

D Amplitude current

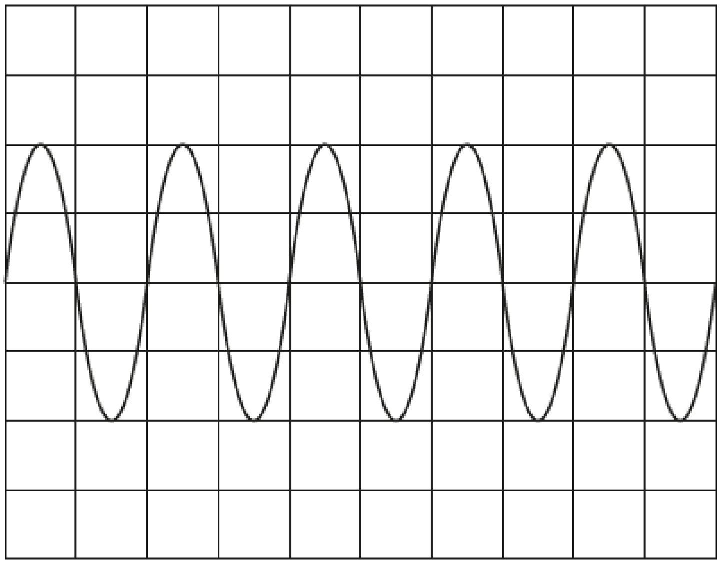
Your answer ☐ **[1]**

This question was generally well answered; however, a range of incorrect responses were seen.

Question 2

2 An oscilloscope is used to display a wave.

How many complete waves are shown on the oscilloscope screen?



A 2

B 4

C 5

D 10

Your answer ☐ **[1]**

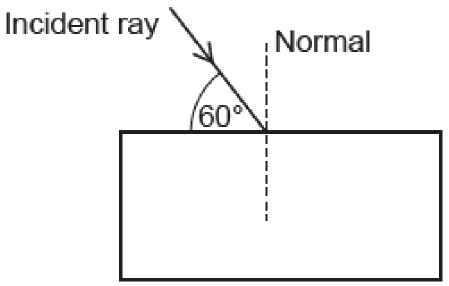
Overall, the majority of candidates chose the correct response (5 complete waves). A large minority of candidates chose B, the peak-to-peak distance.

Assessment for learning

Candidates should understand the terms amplitude, frequency, period and wavelength and be able to interpret information to determine these quantities.

Question 3

3 The diagram shows a ray of light hitting a rectangular glass block.



not to scale

What is the angle between the normal line and the incident ray?

A 30°

B 60°

C 90°

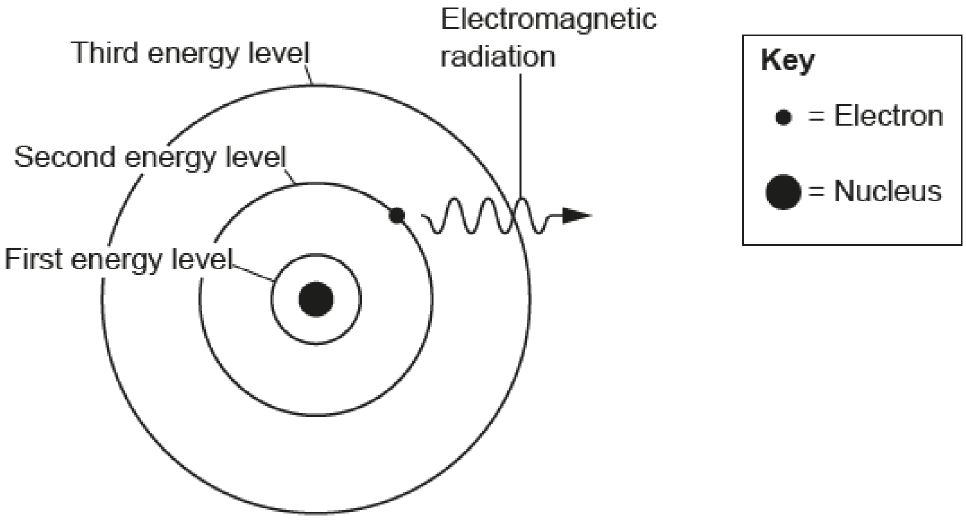
D 120°

Your answer ☐ **[1]**

Most candidates answered this question correctly.

Question 4

4 This diagram shows an electron in the second energy level in an atom.



What happens to the electron when it emits electromagnetic radiation?

A It becomes excited.

B It is lost from the atom.

C It moves to the first energy level.

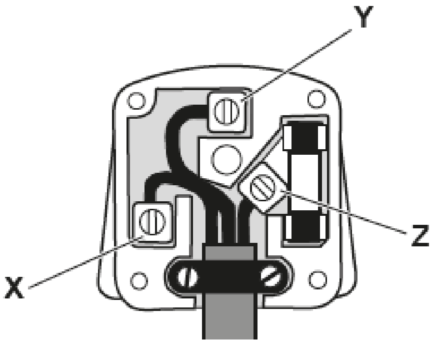
D It moves to the third energy level.

Your answer ☐ **[1]**

This question was poorly answered. The majority of candidates chose option B, presumably confusing the electromagnetic radiation leaving the atom with an electron being lost.

Question 5

5 This diagram shows the wiring inside an electric plug.



Which row shows the correct names of the three pins labelled **X**, **Y** and **Z**?

	X	Y	Z
A	earth	neutral	live
B	live	neutral	earth
C	neutral	earth	live
D	neutral	live	earth

Your answer ☐ **[1]**

The majority of candidates did not give the correct response. It is expected that candidates should be familiar with the wiring inside a standard mains plug.

Question 6

6 An electric lawnmower has this information.

The potential difference is 230 V.
The current is 7.0 A.

What is the power of the electric lawnmower?

Use the equation: power = potential difference × current

A 0.030 W

B 32.9 W

C 230 W

D 1610 W

Your answer ☐ **[1]**

This question was answered well.

Question 7

7 The mass of an aluminium block is 1.5 kg. Its temperature changes by 5 °C.

What is the change in thermal energy of the aluminium block?

The specific heat capacity of aluminium is 920 J / kg °C.

Use the equation:
change in thermal energy = mass × specific heat capacity × change in temperature

A 123 J

B 276 J

C 3070 J

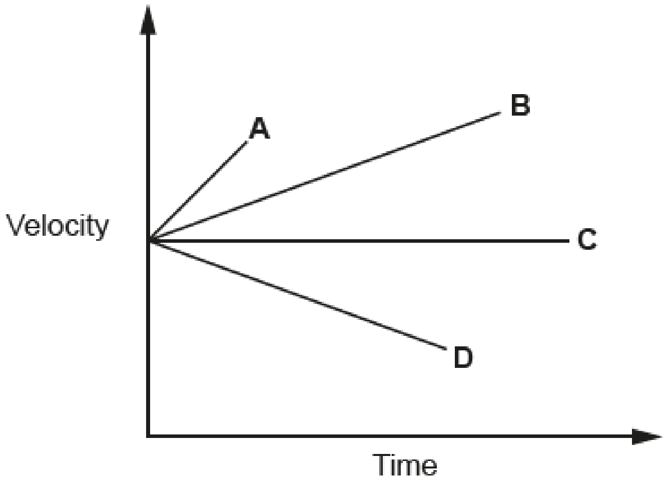
D 6900 J

Your answer ☐ **[1]**

This question was also answered well.

Question 8

8 The velocity–time graph shows how the velocity of four different vehicles changes.



Which vehicle has the **greatest** acceleration?

Your answer ☐ **[1]**

The majority of candidates chose the correct response. A number of candidates incorrectly selected either B or C.

Question 9

9 Energy use in the home can be measured in kW h.

How do you calculate energy use in kW h?

A Divide power in kilowatts by time in hours.

B Divide power in watts by time in seconds.

C Multiply power in kilowatts by time in hours.

D Multiply power in watts by time in seconds.

Your answer ☐ **[1]**

The majority of candidates did not gain credit for this question. Answer A was the most common incorrect response. Many candidates did not understand that kW h means kW × h and did not relate this to power × time.

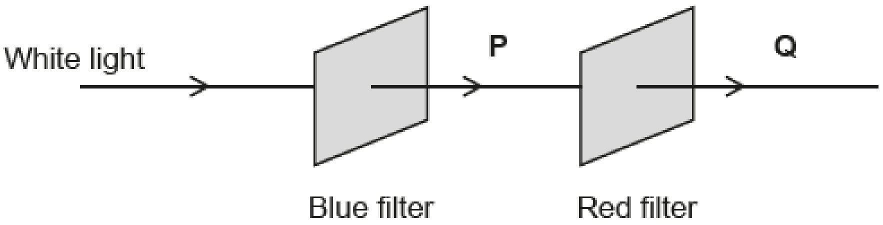
Assessment for learning

Candidates should be encouraged to understand compound units. For example, J / s is joule divided by time (i.e. the unit of power). It matches the equation power = work done ÷ time.

In this case kW h matches the equation work done = power × time.

Question 10

10 A student places a blue filter and a red filter in front of a source of white light.



Which row is correct?

	Light seen at P	Light seen at Q
A	blue	no light
B	blue	green
C	red	no light
D	red	green

Your answer ☐ **[1]**

Nearly half of the candidates selected answer A as the correct response. A common incorrect response was B.

Question 11

11 An astronomer observes that light from a distant galaxy is **red-shifted** compared to the same wavelength of light observed on the Earth.

Which row correctly describes the astronomer's conclusion?

	Observed wavelength of light from the galaxy	Movement of the galaxy
A	longer than on the Earth	moving away from the Earth
B	longer than on the Earth	moving towards the Earth
C	shorter than on the Earth	moving away from the Earth
D	shorter than on the Earth	moving towards the Earth

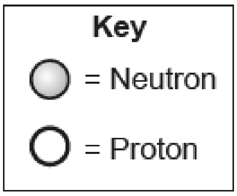
Your answer ☐ **[1]**

This proved to be a challenging question with a range of options selected.

Question 12

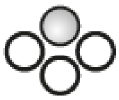
12 The symbol for an isotope of hydrogen is $^{3}_{1}H$.

What is the correct diagram of the nucleus of this isotope of hydrogen?

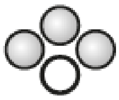


A

B



C



D

Your answer [ ] **[1]**

A small minority of candidates chose the correct response. The common incorrect response was C, where candidates understood that the '1' represented the number of protons, but did not recall that the '3' represented the number of protons + number of neutrons.

Question 13

13 In May 2021, SpaceX launched sixty Starlink satellites into our solar system.

Which row correctly describes objects in our solar system?

	Natural satellite of the Earth	Artificial satellite
A	Mars	Starlink
B	the Moon	Starlink
C	Starlink	Mars
D	Starlink	the Moon

Your answer ☐ **[1]**

Most candidates gained credit for this question.

Question 14

14 A sound wave travels from air into water.

Which quantity stays the **same**?

A Amplitude

B Frequency

C Speed

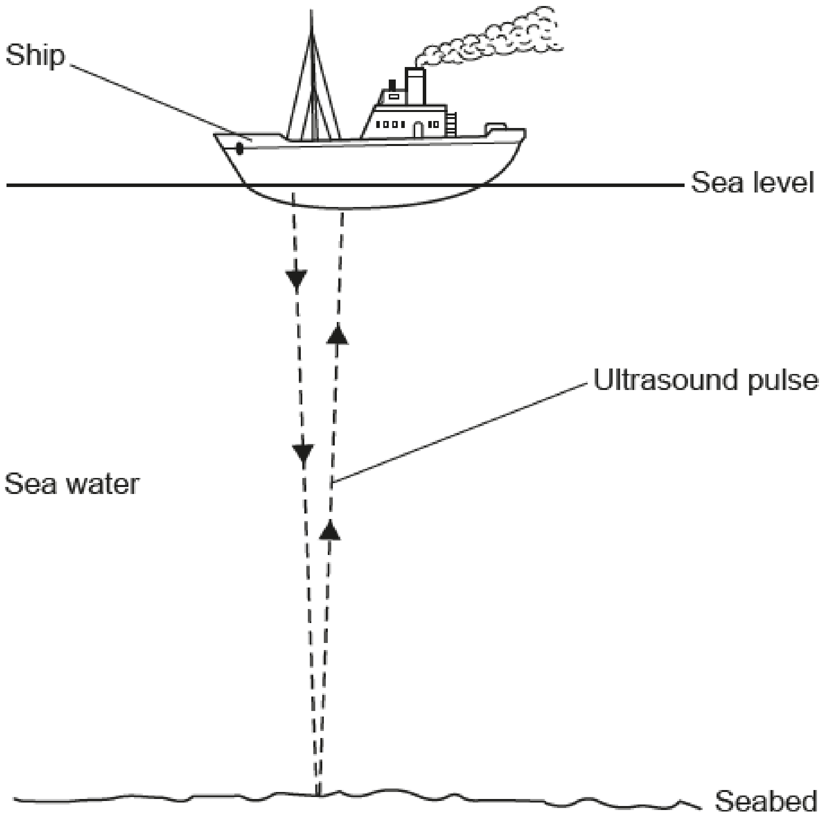
D Wavelength

Your answer ☐ **[1]**

This question proved challenging, with a range of responses given.

Question 15

15 Ultrasound pulses can be used to measure the depth of the seabed.



The speed of ultrasound in sea water is 1500 m/s.

The seabed is 3600 m below sea level.

An ultrasound pulse is emitted from the ship.

How long is it before the ultrasound pulse **returns** to the ship?

Use the equation: distance travelled = speed × time

A 0.40 s

B 0.80 s

C 2.4 s

D 4.8 s

Your answer ☐ **[1]**

Very few candidates gave the correct response. Most candidates correctly calculated the time for the pulse to reach the seabed, but did not double their answer for the time for the pulse to return to the ship.

Section B overview

Candidates should be encouraged , to underline key information and data as they read each question.

When answering explanation type questions, candidates' responses should relate to the question. Their responses should include the relevant detailed knowledge and understanding. Vague responses do not gain credit.

In numerical questions candidates should be encouraged to write down the equation they are using, substitute the numbers into the equation and then evaluate the response, e.g.

- equation
- rearrange the equation
- substitute the data
- consider the units
- evaluate
- consider whether the response looks correct.

The level of response (LOR) question required candidates to plan an experiment. Candidates should have the opportunity of practising writing plans, to include the method including measuring instruments, identifying the quantities that need to be kept constant and relevant safety precautions.

Question 16 (a) (i)

16 This question is about the life cycle of the Sun.

(a) **(i)** Draw lines to connect each **stage** in the life cycle of the Sun with its correct **description**.

Stage	Description
nebula	A star producing no radiation formed from a white dwarf.
red giant	A low temperature star with a diameter much larger than the Sun.
white dwarf	A mass of interstellar dust and gas.
black dwarf	A star that has used most of its nuclear fuel and has collapsed.

[2]

Most candidates correctly joined the correct description for the red giant stage and the black dwarf stage. The understanding of the term nebula proved challenging.

Question 16 (a) (ii)

(ii) Which stage in the lifecycle of the Sun is missing from part **(a)(i)**?

Put a (ring) around the correct option.

black hole **main sequence star** **neutron star**

[1]

Main candidates did not realise that the main sequence star was missing from the lifecycle.

Assessment for learning

Candidates should understand the lifecycle of a star, including the names of stars at different stages.

Question 16 (b) (i)

(b) **(i)** What causes a nebula to collapse to form a star?

Put a (ring) around the correct option.

fission **fusion** **gravity** **radiation**

[1]

Many candidates did not realise that gravity caused the nebula to collapse to form a star. Fusion was often given as the answer.

Question 16 (b) (ii)

(ii) Complete the sentence to describe the forces acting in the Sun at the current stage in its lifecycle.

Use words from the list.

equal to	**greater than**	**less than**

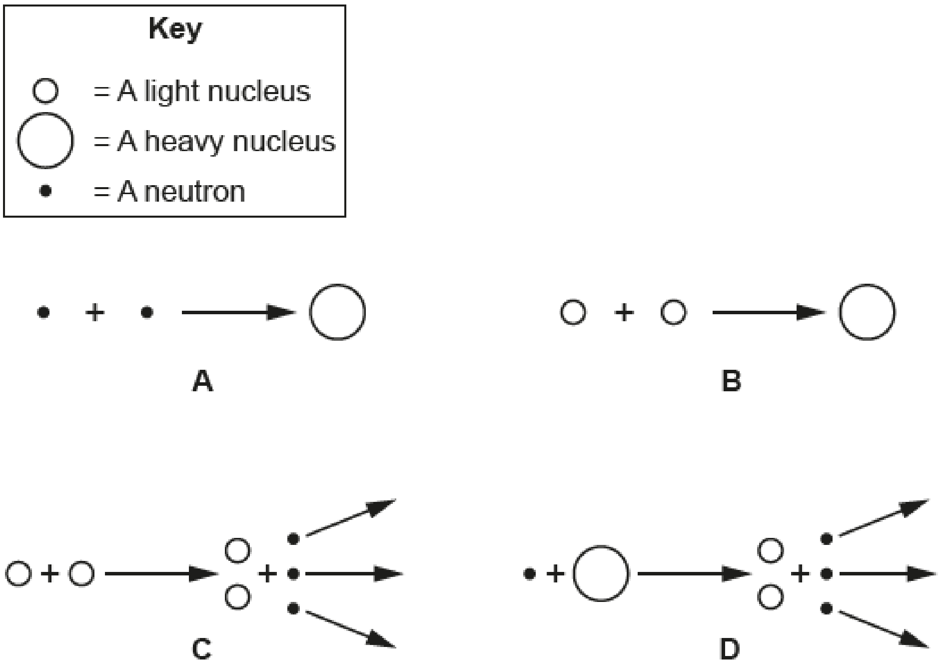
The gravitational force is .... the outward force.

[1]

Most candidates incorrectly stated that the gravitational force was greater than the outward force.

Question 16 (c) (i)

(c) The diagrams show possible nuclear processes for fission and fusion.



(i) Which diagram shows nuclear fusion?

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

Many candidates appeared confused. A range of responses were given. Some candidates selected A, not understanding that nuclei were involved in that diagram. Other candidates were clearly confused by the term fission and fusion.

Question 16 (c) (ii)

(ii) Which diagram shows nuclear fission?

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

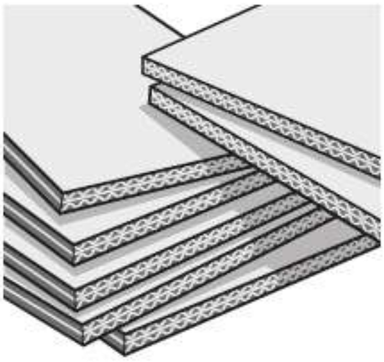
Again, a range of responses were given indicating a misunderstanding of fission and fusion.

Assessment for learning

Candidates should understand the various terms used in describing atoms, for example, atom, electron, neutron, proton, nucleus and how these relate to the processes of fission, fusion and radioactive decay.

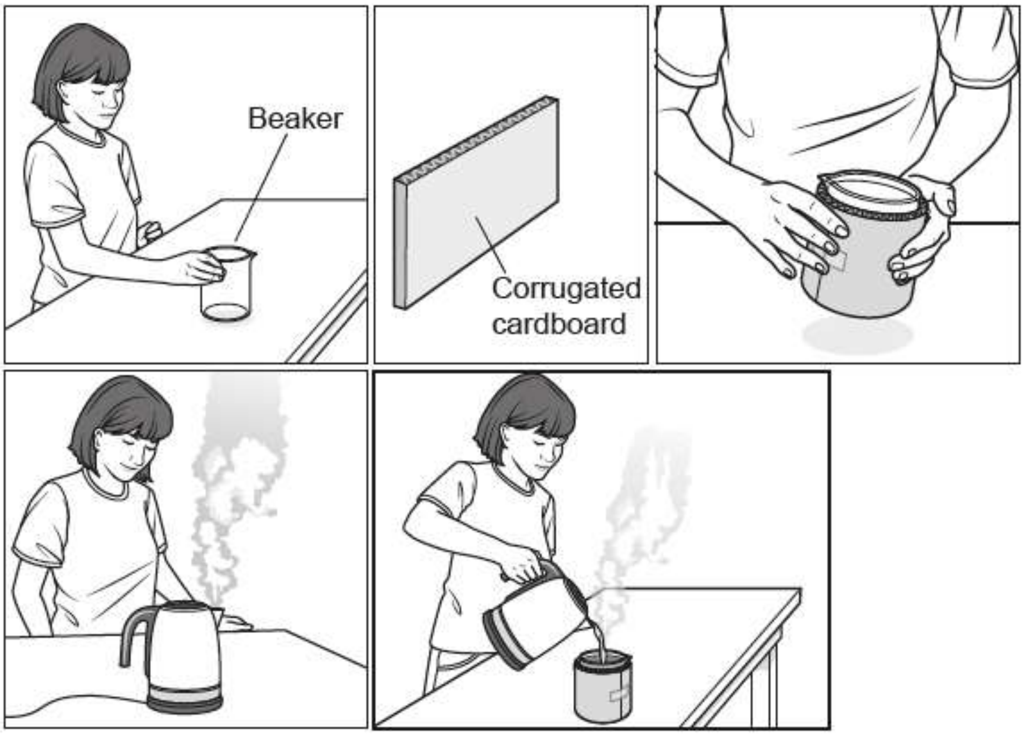
Question 17 (a)*

17 Corrugated cardboard can be used as an insulator around a beaker.



Student **A** does an experiment to investigate how the thickness of corrugated cardboard wrapped around a beaker affects the time it takes for hot water in the beaker to cool down.

The diagrams show how student **A** starts the experiment.



(a)* Describe how student **A** does the experiment.

You should write about:

- the **extra** equipment student **A** needs and what this equipment measures
- student **A**'s method
- a variable that needs to be controlled.

[6]

Many candidates correctly identified that a timing device such as a stopwatch and a thermometer would be needed.

Most candidates stated either the amount of water or starting temperature should be controlled. It would be better to state that the **volume** of the water is **kept constant**. This would then refer to a quantity (volume or mass) and would indicate what is meant by controlled.

The points above address the first and third bullet points, but do not answer the main question of describing the experiment or writing about student A's method (second bullet point). Candidates should be encouraged to include as much relevant information as possible.

Many lower scoring candidates just described the diagrams rather than extending the method. To gain a higher level, candidates could have discussed the measurement of the volume or mass of the water. Few candidates discussed varying the thickness of the cardboard or measuring the thickness with either a ruler or calliper.

Candidates should also have stated that they would either record the temperature after a fixed time or record the time taken for the temperature to decrease by a fixed amount. Some high scoring responses discussed recording the temperature every minute and plotting a graph of their results.

In describing the experiment, candidates should also include a relevant safety precaution.

Assessment for learning

Candidates should practise writing methods for experimental procedures. Methods should include:

- measuring the independent and dependent variables; including suitable measuring devices
- quantities that need to be kept constant
- safety precautions
- how to obtain accurate results.

Exemplar 1

- Student needs a thermometer and a timer.
- Controlled variable will be the thickness of the cardboard.
- using the same volume of water each time.
- insulate beaker And measure out the hot water into the beaker.
- ~~Put Sta~~ use a thermometer and record the temperature at the start.
- Put on the timer and check the thermometer at equal intervals to record the time it takes the water to cool down. **[6]**

This response clearly states the use of a thermometer and a timer, as well as stating that a quantity to be kept constant is the volume of water used. This answers bullet points one and three. The response also gives some method by checking the thermometer at equal time intervals, and stating measuring out the volume of water. Overall the scientific content is Level 2 and the communication mark is met, so this response was given 4 marks.

To improve this response, the candidate could have stated the measuring instruments to measure the thickness of the carboard and the volume of water. It could have been made clear that the experiment was being repeated for different thicknesses of cardboard. It could also have been made clear that the starting temperature was kept constant each time. A safety precaution could have been described.

Question 17 (b) (i)

(b) Student **B** does the same experiment using the same method as student **A**.

The table shows the students' results when there is **no** insulation around the beaker.

Time (min)	Temperature (°C)	
	Student A	Student B
0	80	80
1	75	76
2	71	71
3	67	68
4	65	65
5	63	63

(i) Describe the trend shown by the students' results.

....

.... **[1]**

The majority of candidates stated that the temperature decreased. High scoring responses stated that "as the time increased, temperature decreased". Many lower scoring candidates just stated that the two sets of results were the same (in effect, answering the next question).

Question 17 (b) (ii)

(ii) Describe how the table shows the students' results are reproducible.

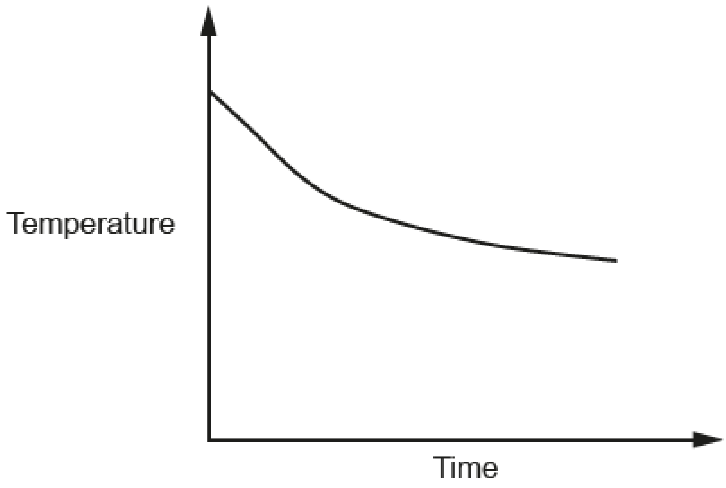
....

.... **[1]**

Many candidates correctly identified that the results were very similar.

Question 17 (b) (iii)

(iii) The student plots a graph of temperature against time.



State **two** reasons why the graph does **not** show that the temperature is directly proportional to time.

1 ....

2 ....

[2]

This question tested whether candidates know how a graph would show whether two quantities are directly proportional. Many lower scoring candidates stated vague responses about there not being numbers on the axes. The simplest responses referred to the line being curved or not being straight and to the line decreasing. Candidates could also have stated that the line did not pass through the origin.

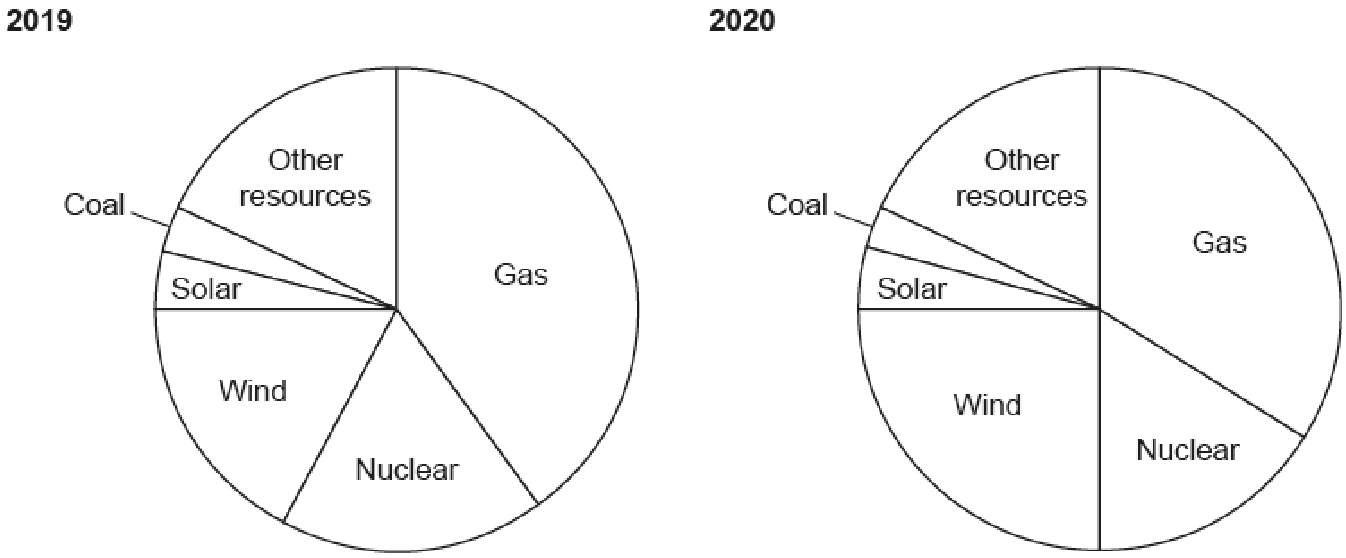
Assessment for learning

Candidates should understand how to test graphically that two quantities are directly proportional.

Candidates should understand that if two quantities are directly proportional, then a graph plotted between the two quantities should be a straight line that passes through the origin.

Question 18 (a)

18 The diagrams show how electricity was generated in the UK in 2019 and in 2020.



(a) Which **two** energy resources generated the **least** electricity in **2019**?

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

This question was well answered with most candidates stating coal and solar.

Question 18 (b)

(b) Estimate the percentage of electricity generated using wind in **2020**.

Electricity generated using wind = ... % **[3]**

Many candidates identified that the angle was 90° and went on to state 25%. Candidates should be encouraged to show their working.

A few candidates used a protractor.

A few candidates used data from the wrong year.

Question 18 (c)

(c) **Two** energy resources showed a significant change between 2019 and 2020.

Give the names of these **two** energy resources.

1 ....

2 ....
[2]

Most candidates correctly stated wind and gas. A common error was stating nuclear instead of gas.

Question 18 (d)

(d) From 2019 to 2020, the use of solar power changed from 3.9% to 4.2%.

Calculate the percentage change in the use of solar power.

Use the equation:

$$\text{percentage change} = \frac{(\text{new value} - \text{old value})}{\text{old value}} \times 100\%$$

Give your answer to **1** decimal place.

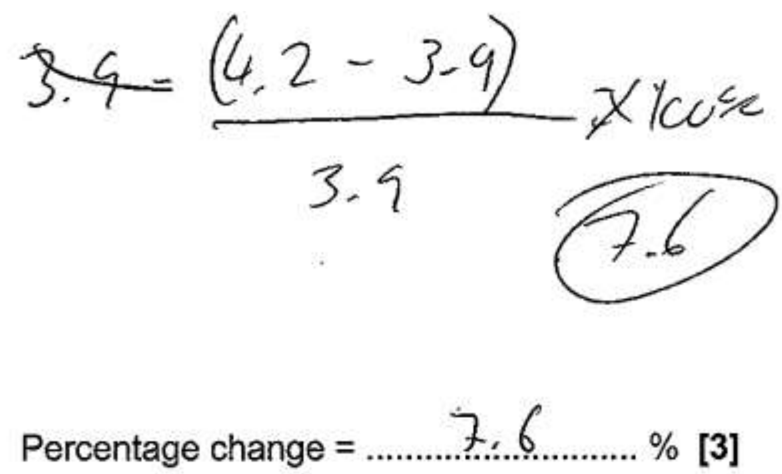
Percentage change = ... % **[3]**

High scoring responses clearly substituted the numbers into the given equation.

Some candidates used the wrong value for the denominator. Other candidates did not multiply by 100 giving an answer of 0.1%

Candidates should be encouraged to show their working. In this question, a candidate who showed their working, but omitted to multiply by 100 gained an answer of 0.0769. This rounded to 0.1%, which gained 2 marks. A candidate who just wrote 0.1% did not gain any credit, since there was no demonstration of how the candidate achieved the answer.

Exemplar 2



This response clearly substitutes the numbers into the given equation and scores 2 marks.

The candidate has then calculated the answer, but has not rounded it correctly to one decimal place. The candidate may have obtained the correct answer, if they had written down the calculator display (7.69230…), and then rounded the answer to one decimal place.

Question 18 (e) (i)

(e) Since 2013, the use of coal power stations to generate electricity has decreased.

(i) Suggest why.

....

.... **[1]**

Vague responses, such as it is bad for the environment, did not score marks. Candidates needed to explain why it was bad for the environment. Many candidates correctly identified that coal was non-renewable. Other candidates stated the change in commitment to greener energy policies.

Question 18 (e) (ii)

(ii) In 2020, a news article stated:

'The UK started up an old coal power station on Monday to meet the demand for electricity. The national grid confirmed coal was providing 3% of the UK's power.'

Suggest **two** reasons why the national grid had to use a **coal** power station to meet demand for electricity.

1 ....

....

2 ....

....

[2]

This question proved to be challenging, and many candidates gave a general response, rather than specifically why, on a particular day, coal was providing 3% of the UK's power. Answers in terms of people working from home due to covid did not gain credit.

Some candidates repeated the question, stating that the demand was not being met.

High scoring responses realised that there was perhaps not enough wind to drive turbines, and that the sun may not be shining to produce enough solar energy. A few candidates discussed that cold weather may have increased the demand.

Question 19 (a) (i)

19 A star like the Sun emits radiation as electromagnetic waves.

(a) Part of the electromagnetic spectrum is shown in the table.

radio	microwaves	infrared	visible			

(i) Complete the table to show the electromagnetic waves in order of **decreasing** wavelength.

Use the words in the list.

gamma-rays	**ultra-violet**	**X-ray**

[2]

The majority of candidates scored at least 1 mark. Candidates are expected to know the main groupings of the electromagnetic spectrum, and to know the order in increasing wavelength, frequency and energy.

Question 19 (a) (ii)

(ii) Complete the sentence about electromagnetic waves in space.

Use the words in the list.

decreases	**increases**	**stays the same**

As the wavelength of an electromagnetic wave increases, the frequency

....

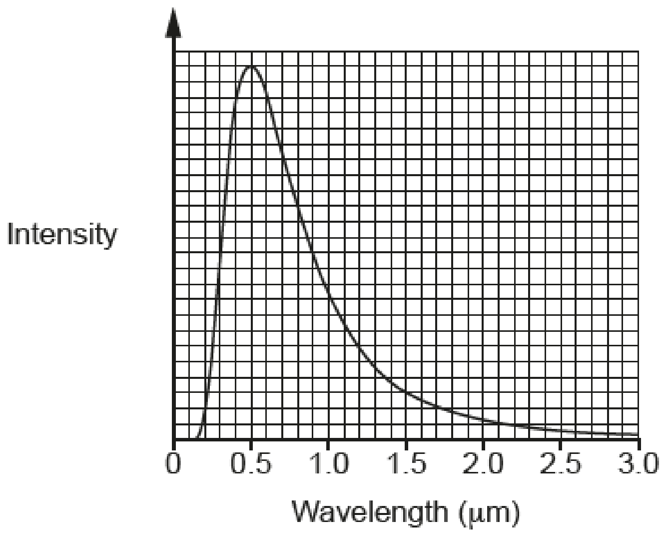
[1]

The majority candidates knew that as the wavelength increase the frequency decreases. The common incorrect response was 'increases'.

Question 19 (b)

(b) **Fig. 19.1** shows how the intensity of the Sun's radiation changes with wavelength.

Fig. 19.1



Use **Fig. 19.1** to find the wavelength of the Sun's radiation at **maximum** intensity.

Show your working on **Fig. 19.1**.

Wavelength = ... μm **[2]**

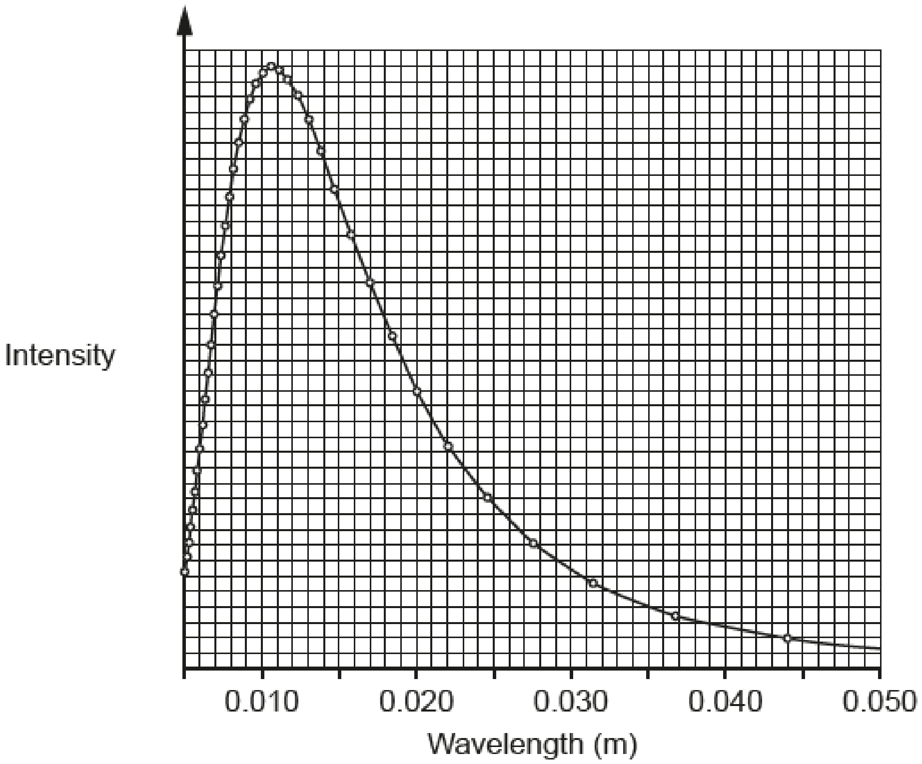
This question was answered well. Candidates should be encouraged to add a straight line to the graph to assist in the read-off from the graph.

Question 19 (c) (i)

(c) In 1965, two scientists detected electromagnetic waves coming from space.

Fig. 19.2 shows the graph for these electromagnetic waves.

Fig. 19.2



The table shows the wavelengths of some different electromagnetic waves.

Electromagnetic waves	Wavelength range (m)
radio	> 0.3
microwaves	0.000 025 – 0.3
infrared	0.000 000 75 – 0.000 025
visible light	0.000 0004 – 0.000 000 75

(i) Use the table and **Fig. 19.2** to name the electromagnetic wave at maximum intensity.

.... **[1]**

This question proved challenging, with all types of electromagnetic waves given as a response. It was expected that candidates would use a similar technique to the previous part by drawing a line on to the graph. Having determined the wavelength, candidates then needed to use the table to determine the type of electromagnetic wave.

Question 19 (c) (ii)

(ii) Which theory about the universe does the radiation for **(c)(i)** provide evidence for?

.... **[1]**

This question also proved challenging with a number of different theories proposed by candidates.

Question 20 (a)

20 This question is about energy transfers.

A car with a mass of 800 kg rolls down a hill with its engine switched off.

(a) The hill is 12 m high.

The gravitational field strength is 10 N/kg.

Calculate the potential energy of the car at the top of the hill.

Use the equation: potential energy = mass × height × gravitational field strength

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

This question was answered well, with most candidates correctly multiplying the numbers together. Higher scoring candidates clearly showed their working.

Question 20 (b)

(b) The speed of the car at the bottom of the hill is 10 m/s.

Calculate the kinetic energy of the car at the bottom of the hill.

Use the equation: kinetic energy = $\frac{1}{2}$ × mass × (speed)^2

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

This question was answered well, with most candidates correctly multiplying the numbers together. High scoring candidates clearly showed their working.

Some lower scoring candidates gave an answer of 4000 J – omitting to square the speed. Substituting the numbers into the given equation would have scored these candidates 1 mark and possibly helped them to calculate the final answer.

Assessment for learning

Candidates should make sure that working is shown for all numerical calculation questions.

A possible approach is:

- equation
- rearrange the equation
- substitute the data
- consider the units
- evaluate
- consider whether the response looks correct.

Question 20 (c)

(c) The kinetic energy at the bottom of the hill is **less** than the potential energy at the top of the hill.

Explain why.

Write about energy stores.

....

....

....

.... **[2]**

This question was challenging, and there were many vague responses. The question specifically asked for candidates to write about energy stores.

Very few candidates stated that the difference between the potential energy at the top of the hill and the kinetic energy at the bottom of the hill was because the thermal energy store had increased.

Possible explanations included the energy being transferred by heating due to work done against friction.

Assessment for learning

Candidates should understand energy stores and transfers when a system changes for common situations.

Question 20 (d)

(d) The test is repeated with a different car.

The potential energy of this car at the top of the hill is 120 000 J.
The kinetic energy of this car at the bottom of the hill is 48 000 J.

Calculate the efficiency of the transfer of energy from the potential store to the kinetic store.

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

Efficiency = ... **[2]**

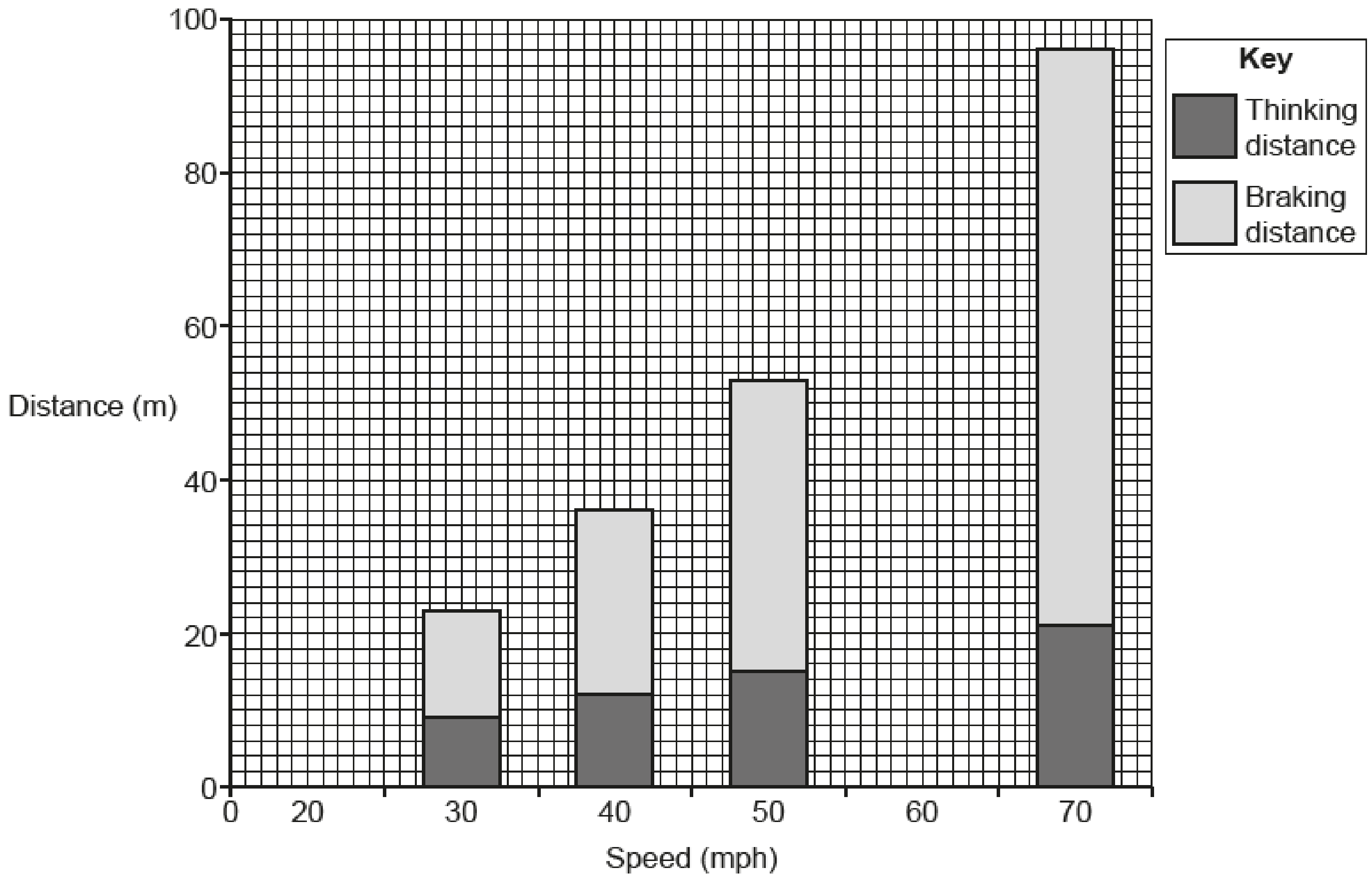
This question appeared to be more challenging. Higher scoring candidates correctly substituted the data into the given equation. Some candidates gave the efficient as a percentage – 40%; this gained full marks.

The common error was to divide 120 000 by 48 000, giving an answer of 2.5. Candidates should be encouraged to underline data in the question so that they can substitute the data correctly into an equation.

Other candidates found the percentage of energy transferred to the thermal energy store.

Question 21 (a)

21 The bar chart shows thinking distances and braking distances for a car moving at different speeds.



(a) For a car moving at 20 mph:
- The thinking distance is 6 m.
- The braking distance is 6 m.

Complete the bar chart for a car moving at 20 mph. **[2]**

This question was answered well, with the majority of candidates correctly completing the bar chart. Some lower scoring candidates omitted the question or drew the thinking distance as six small squares high rather than 6 m (three small squares).

Question 21 (b)

(b) Use the bar chart to estimate the thinking distance and braking distance for a car moving at 60 mph.

Thinking distance = ... m

Braking distance = ... m
[2]

The majority of candidates estimated that the thinking distance was 18 m. A range of 17 m to 19 m was allowed for candidates who used a ruler on the graph and estimated the thinking distance.

The braking distance value was often incorrect – many candidates choosing about 70 m (which is approximately the stopping distance). Many higher scoring candidates correctly chose 54 m and other higher scoring candidates estimated a sensible value from the graph which also gained credit.

Misconception

?

Many candidates did not appreciate the difference between stopping distance and braking distance.

Candidates should understand the terms thinking distance, braking distance and stopping distance.

Question 21 (c)

(c) Give the name of the distance represented by the **total** height of each bar.

.... **[1]**

A minority of candidates stated stopping distance. Lower scoring candidates often stated metres.

Question 21 (d)

(d) Complete the table below to describe how each factor changes the thinking distance and braking distance.

Use the words in the list.

decreases	**increases**	**no effect**

Factor	Thinking distance	Braking distance
Drinking alcohol	....	....
Higher speed	....	....
Wet road	....	....

[3]

This question tested the understanding of factors that affect thinking distance and braking distance. A number of candidates stated 'decreases' in their responses to thinking distance for both drinking alcohol and higher speed.

Few candidates scored full marks on this question.

Assessment for learning

Candidates should be able to describe the impact of different factors on thinking distance and braking distance.

Question 21 (e) (i)

(e) (i) A car decelerates to a stop. The braking force is 5600 N.

The braking distance is 20 m.

Calculate the work done by the brakes. Include the correct unit.

Use the equation: work done = force × distance

Work done = ... Unit .... **[3]**

Most candidates correctly multiplied the force of 5600 N by 20 m. However, many responses did not state a correct unit. The common error was to state N / m.

Assessment for learning

Candidates should understand how units combine together. For example, N m means N multiplied by m whereas N / m means N divided by m.

Question 21 (e) (ii)

(ii) A double-decker bus is travelling at the same speed as the car.

The double-decker bus stops in the same distance as the car.

Suggest why the double-decker bus needs a larger braking force than the car.

....

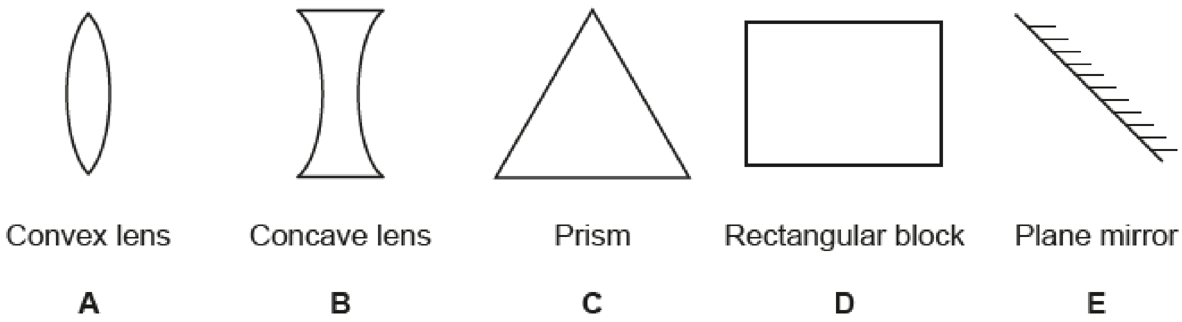
.... **[1]**

Most candidates realised that the double-decker had more mass. Ideally, in this type of question, candidates should be encouraged to state a quantity that it is changing. In this case the double-decker would have a large kinetic energy due to its mass. There were many vague responses such as heavier which also gained credit.

Question 22 (a)

22 (a) A student shines three parallel rays of red light at different glass objects. **Fig. 22.1** shows the glass objects.

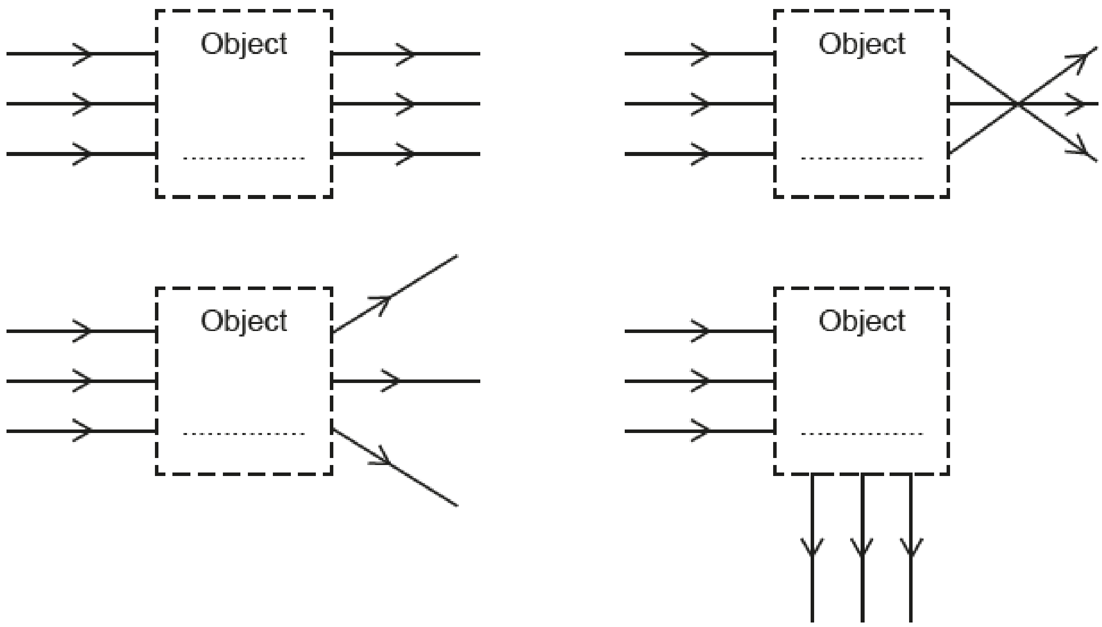
Fig. 22.1



The student draws ray diagrams to show what happens to the three parallel rays of red light.

Write **one** letter in each box in **Fig. 22.2** to identify which glass object produces that ray diagram.

Fig. 22.2



[4]

The majority of the candidates correctly identified two of the objects. The common error was to interchange convex and concave lenses.

Question 22 (b)

(b) The wavelength of red light in glass is 4.33×10^{-7} m.

The speed of red light in glass is 2.0×10^{8} m/s.

Calculate the frequency of the red light in glass.

Use the equation: wave speed = frequency × wavelength

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

Frequency = ... Hz **[4]**

This question required candidates to rearrange the equation, so that frequency was the subject. Many lower scoring candidates just multiplied the numbers together.

Having substituted the data into the equation, candidates then needed to give the answer to two significant figures. Common mistakes were to omit the power of ten (10^{14}) from the final answer or to incorrectly round the answer. Candidates should be encouraged to write down the figures from the calculator display before rounding.

Question 22 (c) (i)

(c) A football player wears a red shirt with a white number 3 on the back.

(i) What is the colour of the shirt and the number when viewed under **blue** light?

Colour of shirt ....

Colour of number .... **[1]**

The common mistake was to state that the colour of the shirt would be purple rather that understanding that blue light would be absorbed by the red shirt.

Question 22 (c) (ii)

(ii) Another football player says, 'Under **red** light, I cannot read the number on the shirt.'

Explain why.

....

.... **[1]**

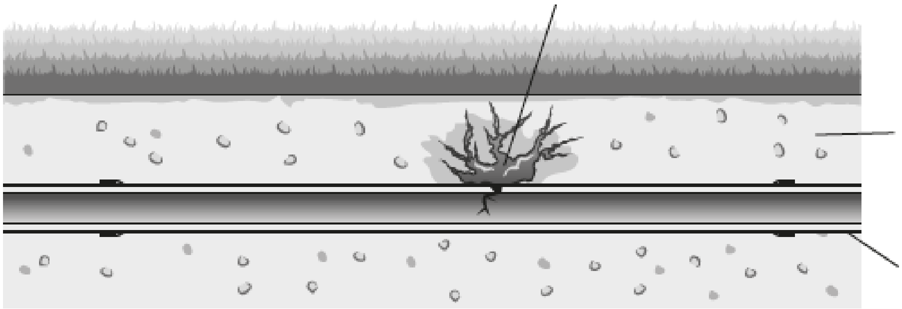
Candidates needed to understand that the white number would reflect the red light, so that the number would also appear red. Some candidates incorrectly stated that the red light would be absorbed. Other candidates gave vague responses explaining that the shirt and number would 'blend in' without explaining why.

Assessment for learning

Candidates should understand the absorption and reflection of different coloured light.

Question 23 (a) (i)

23 An underground water pipe has a leak, as shown in the diagram.



A tracer called sodium-24 is used to detect leaks in underground pipes.

(a) **(i)** Sodium-24 has a half-life of 15 hours.

Give **two** reasons why this is useful.

1 ....

....

2 ....

....

[2]

Answers were often vague. Some candidates stated that the half-life was long enough for the leak to be detected. Very few candidates stated a detailed reason why 15 hours was short enough. There were many vague responses in terms of less harm, rather than stating it would not be radioactive or contaminate for too long.

Assessment for learning

Candidates should understand the meanings of the words radioactive, contamination, irradiation and the phrase ionising radiation.

Question 23 (a) (ii)

(ii) Sodium-24 emits beta and gamma radiation.

Explain why this makes sodium-24 a good tracer.

....

.... **[1]**

This question was challenging. A few candidates stated that beta and gamma were very penetrating, but did not relate the response to the question, and that the beta and gamma would be able to pass through the earth.

Question 23 (a) (iii)

(iii) Sodium-24 decays to form a stable isotope.

Explain why this is important.

....

.... **[1]**

Answers to this question often lacked the necessary detail. It was expected that candidates would relate their responses to radioactivity, with a statement that the stable isotope would not emit ionising radiation.

Question 23 (b)

(b) The tracer is monitored using a gamma radiation detector.

How is the location of the leak found?

....

....

....

.... **[2]**

This question was challenging, with many candidates not understanding that the amount of radiation detected would increase where the leak was situated.

Question 23 (c)

(c) A 12 mg mass of sodium-24 is added to water.

The half-life of sodium-24 is 15 hours.

What mass of sodium-24 remains in the water after 30 hours?

Mass remaining = ... mg **[2]**

A small minority of candidates gained credit on this question. Credit was given for realising that there were two half-lives. To determine the mass remaining there were two methods. One method was to take the mass and multiply it by $0.5^{\text{number of half-lives}}$, e.g. $12 \times 0.5^2 = 3$. The alternative method was to take 12 and half it twice, e.g. $12 \rightarrow 6 \rightarrow 3$.

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