Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/07 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 7 series overview

J260/07 is one of the four examination components for the higher tier GCSE (9-1) Twenty First Century Science Combined Science B. This component assesses the contents of the physics chapters P1 to P6 and the practical skills in chapter BCP8. The question styles used include objective, short answer and one extended Level of Response.

Candidate performance overview

Candidates who did well on this paper generally did the following:

- Produced clear and concise responses to the Level of Response question (Q3) covering all aspects of the question and giving detailed trends and explanations.
- Recalled and rearranged equations, clearly showing the stages of calculations in a logical sequence: Q5bi, Q7ai, Q7b, Q9a, Q7b(ii), Q9ci, Q9cii, Q9b.
- Used scientific terminology appropriately when applying knowledge of ideas.
- Showed the ability to analyse information to make conclusions.
- Applied knowledge of mathematical mean, standard form, gradient and area of graphs, and conversion of units: Q2b, Q5bi, Q9a, Q9ci, Q9cii, Q9dii

Candidates who did less well on this paper generally did the following:

- Found it difficult to analyse new situations and apply scientific principles to them.
- Did not state equations being used and had difficulty rearranging them.
- Lacked the knowledge required for recall questions: Q1a, Q1b, Q1c, Q4ai, Q4aii, Q5a, Q8a, Q8b, Q9bi.
- Used everyday words and phrases rather than scientific terminology.

There was no evidence that any time constraints had led to a candidate underperforming.

Most successful topic/question/	***Least successful topic/question***
• How electricity is generated Q1 • Comparing energy resources Q3 • Light Q8	• Ultrasound Q5 • Motion Q9 • Matter Q11

Question 1 (c) (i)

(c) Appliances can be connected to the mains electricity supply in homes using 3-pin plugs.

(i) What is the potential difference (voltage) of the mains electricity in a home?

Potential difference (voltage) = ... V **[1]**

Q1a, Q1b and Q1c(i) required candidates to recall information about the National Grid. The majority of candidates across the full ability answered correctly at least two of these questions. The voltage in part c(i) caused the greatest difficulty with answers ranging from a few volts to 1000s of volts.

Question 1 (c) (ii)

(ii) Amaya thinks of a hazard with using mains electricity.

Amaya
It is dangerous if there is a connection between the live wire and an earthed object.

Explain why Amaya is correct.

....

....

....

.... **[2]**

This question required candidates to give a consequence of touching a live wire together with an explanation. Around half of the candidates gave a consequence but very few candidates explained it.

Exemplar 1

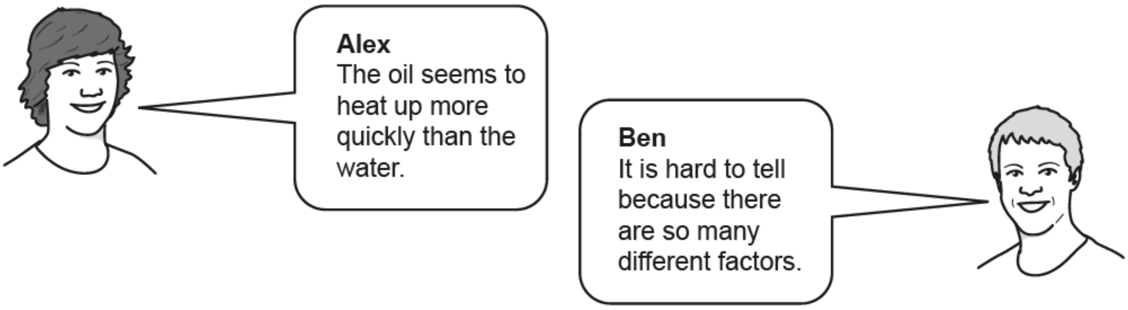
Because this could cause harm or problems to the earthered object ~~the~~ for example electrocution. It also means that the earthered object can pass electricity through it which may be dangerous and harmful. **[2]**

Turn over

The candidate has given electrocution as a consequence but not explained why this happens, such as a high current or a.c.

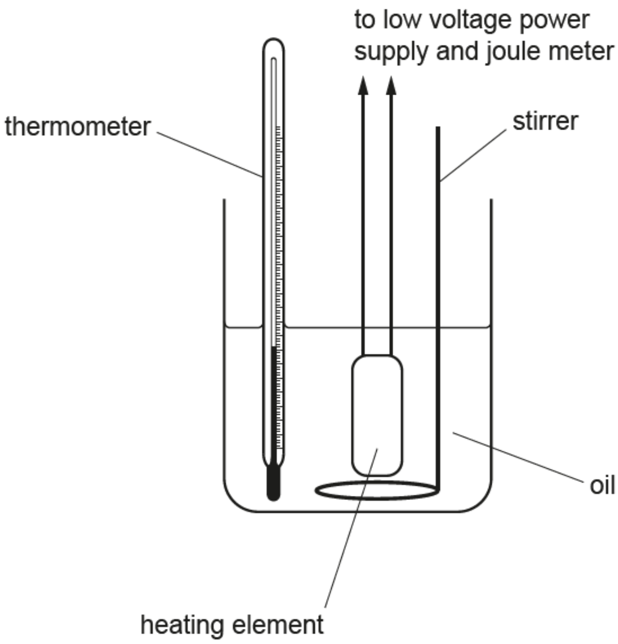
Question 2 (a)

2 Alex is frying potatoes in oil. Ben is boiling potatoes in water.



Their teacher suggests they compare the specific heat capacities of oil and water.

Alex and Ben set up the apparatus shown in this diagram to measure the specific heat capacity of the **oil**.



(a) Explain how they can safely use the apparatus, to take measurements, and to determine the specific heat capacity of the oil.

....

....

....

....

.... **[3]**

In this question, candidates were asked to do three things: how to use the apparatus safely, how to take measurements, and how to determine the specific heat of oil from these measurements. About half the candidates gave at least one correct response, usually about using the apparatus safely. Very few mentioned how to determine the specific heat capacity. Comments about measurements were often too vague, e.g. use the thermometer to measure the temperature difference, rather than use the thermometer to record the initial and final temperatures.

Exemplar 2

They should wear protective goggles and clothing, to prevent burns if the oil splashed onto them if ~~[illegible]~~ boiled. They should stir the oil to ensure the temperature is the same throughout the beaker. They should ~~[illegible]~~ monitor the temperature reading from the thermometer, ~~[illegible]~~ and use the kJ measurement from the joule meter to calculate specific heat capacity. **[3]**

This response is an example of an answer gaining all 3 marks, by giving one safety feature, wearing goggles, and two comments about measurements, stirring and using the joulemeter to record the energy.

Question 2 (b)

(b) Alex and Ben repeat their experiment 3 times. Their results are shown in **Table 2.1**.

Specific heat capacity of oil (kJ/kg °C)	**Experiment 1**	**Experiment 2**	**Experiment 3**
	1.94	2.23	1.98

Table 2.1

Calculate the mean specific heat capacity of the oil, using all the data in **Table 2.1**.

Mean specific heat capacity = ... kJ/kg °C **[2]**

The majority of candidates correctly calculated the mean as 2.05. Those who decided that the reading of 2.23 was an outlier and marked it as such were given one mark for an answer of 1.96.

Question 2 (c)

(c) **Table 2.2** shows accurate values for the specific heat capacities of the oil and water.

Liquid	Specific heat capacity (kJ/kg °C)
oil	1.7
water	4.2

Table 2.2

Compare the accurate value for the oil with Alex and Ben's calculated value in **(b)**.

Suggest a reason for the difference, and suggest how they could improve their experiment to get a more accurate result.

....

....

....

....

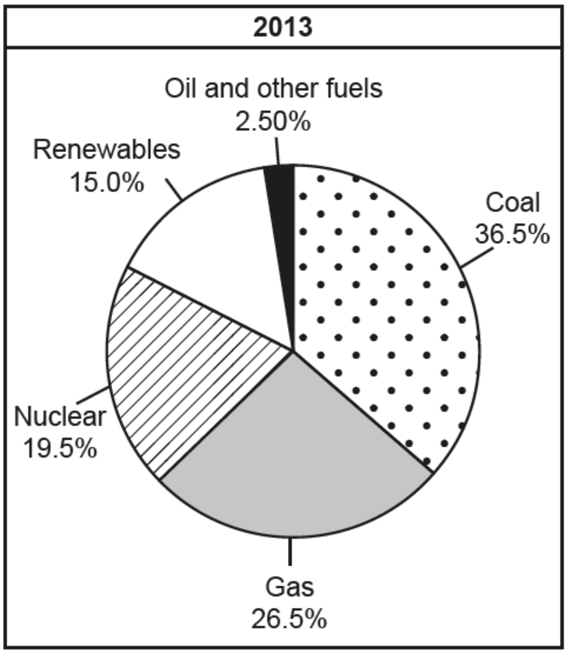
....

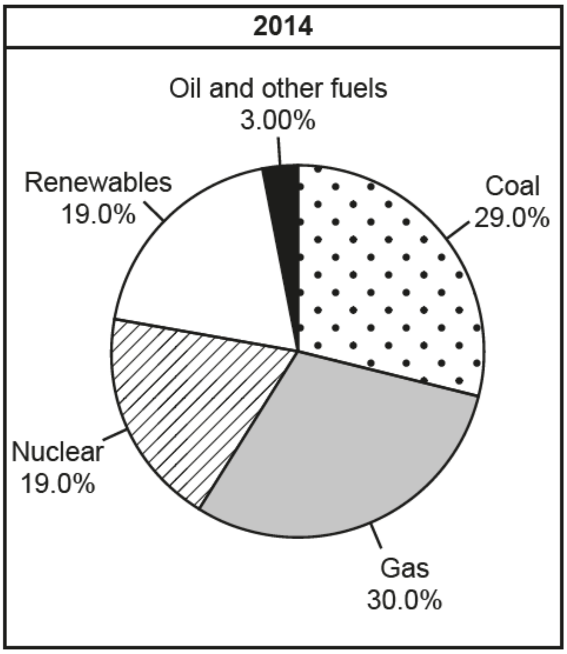
.... **[3]**

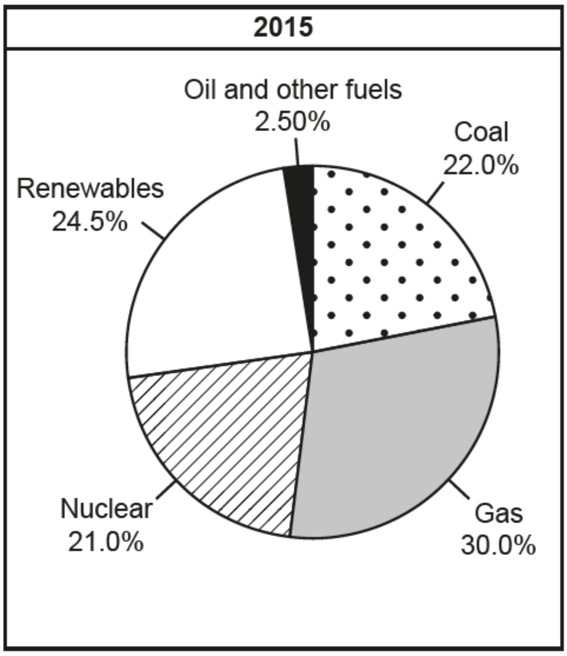
This question asked the candidate to do three things: compare the values, give a reason for the difference, and give an improvement. The majority of candidates did not gain any credit because they did not make a comparison and their stated reason and improvement were based on making a 'fair test' rather than improving the accuracy of their results. Very few candidates considered the thermal energy lost from the experiment and how this could be reduced.

Question 3

3* These pie charts show the energy resources used to generate electricity in the UK in **2013**, **2014**, and **2015**.







Describe in detail how the energy resources used to generate electricity in the UK have changed from 2013 to 2015.

Suggest reasons for these trends.

Use information from the pie charts to support your answer.

....

....

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....

....

.... **[6]**

This extended Level of Response question gave candidates the opportunity to apply their knowledge and understanding (AO2) and to analyse information about energy resources and interpret the pie charts (A03). The majority of candidates gave responses at Level 2 by describing a trend in detail, such as coal decreased by 14.5% from 2013 to 2015. In order to gain Level 3 candidates needed to describe at least two trends in detail and give an explanation referring to coal and renewables. Only a few candidates answered at Level 3. Most of the explanations given by candidates were not specific enough, for example 'coal pollutes the environment' rather than of coal produces greenhouse gases or burning coal releases carbon dioxide.

Exemplar 3

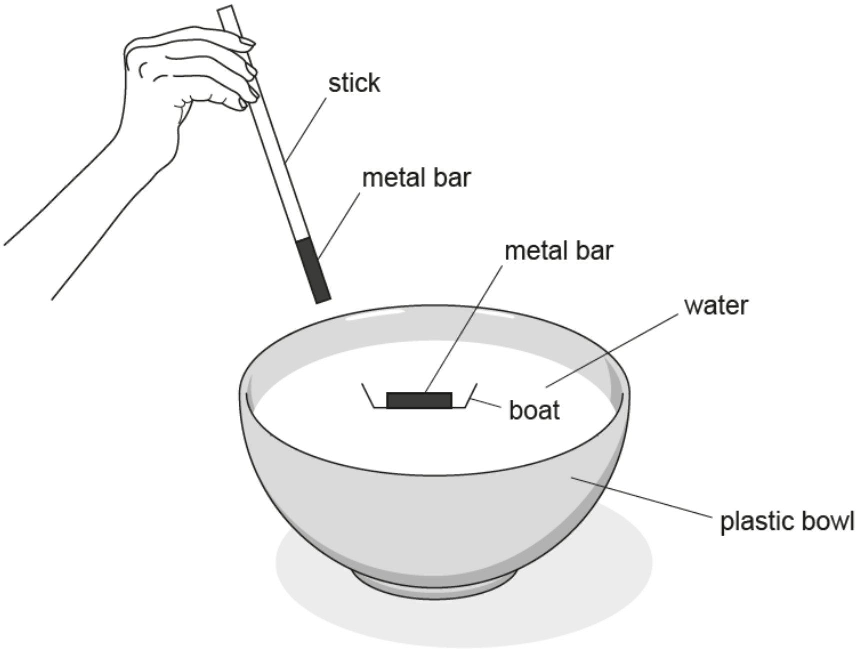
Overall, the % of renewables has increased the most from 2013 - 2015 with an increase of 9.5%. ~~The~~ This is because this is more sustainable therefore the government would be trying to increase the use of it. Renewable resources include wind turbine & solar pannels which do not emit CO_2 & therefore there was an increase in the use of them. Coal has had the biggest decrease with a decrease of 14.5 % in the use of it. This is because it is a fossil fuel which emits CO_2 into the atmosphere & therefore the government would be trying to decrease the use of it. Also, in 2015, people may be more aware of the effect of burning too many fossil fuels & therefore not use them as much. Nuclear had a slight increase of 1.5% from **[6]** 2013 to 2015 however it is ~~co~~ most likely still increasing as 2 years may not be an accurate ~~re~~ representative. Gas had a small increase of 3.5%.

This exemplar shows one way of achieving Level 3. The candidate has given two trends in detail, coal decreasing by 14.5% and renewables increasing by 9.5%, together with explanations for both, coal emitting carbon dioxide and renewables being more sustainable.

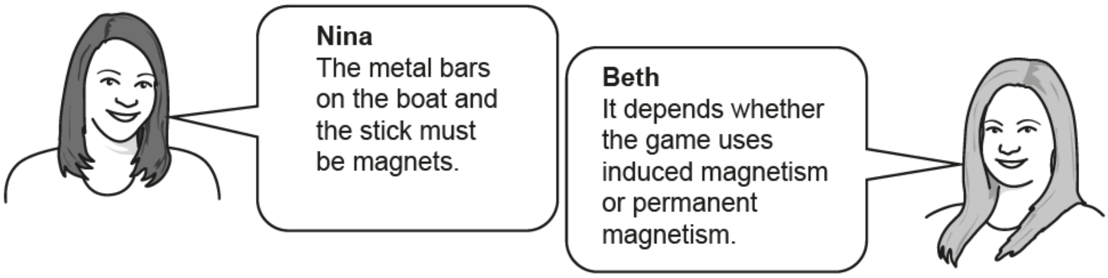
Question 4 (a) (i)

4 The diagram below shows a game that uses magnets.

When the stick is moved near the boat, the boat moves towards it.



Two students are discussing why the boat moves towards the stick.



(a) (i) Describe the difference between a permanent magnet and an induced magnet.

....

....

.... **[1]**

Higher ability candidates were able to gain this mark by describing correctly both sorts of magnets. Many candidates only described one or confused electromagnets with induced magnets.

Question 4 (a) (ii)

(ii) Describe what happens if the poles of two permanent magnets are brought close together:

When unlike poles are brought close together, they ....

When like poles are brought close together, they ....
[1]

The majority of candidates correctly answered with attract and repel, respectively. Some candidates struggled to find the correct word for repel.

Question 4 (a) (iii)

(iii) Describe how the strength and direction of the magnetic field change around a bar magnet.

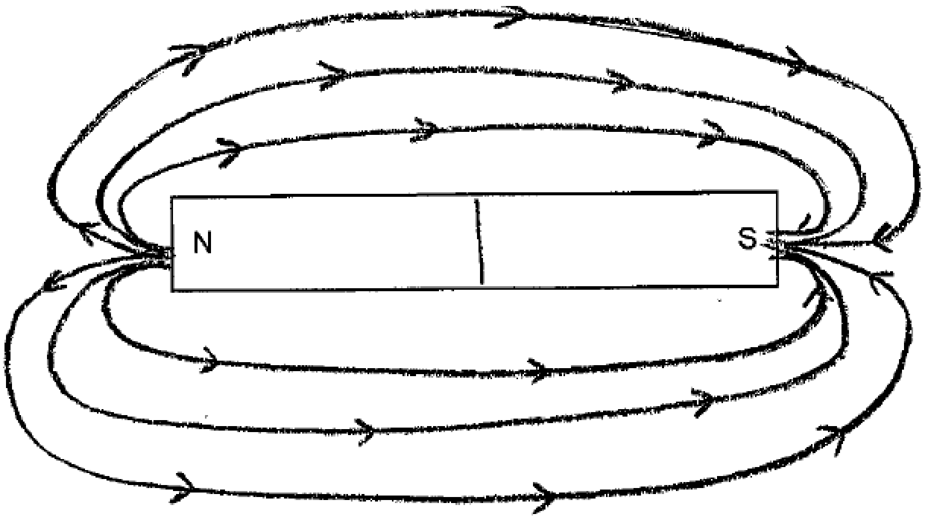
Add to the diagram to help you answer the question.

....

.... **[2]**

Answers could be given in words or by a clear diagram, or a mix of both. The majority of candidates gained at least one mark. Some candidates had contradictions between the words and their diagram such as stating the field goes from North to South but showing some arrows in the reverse direction, particularly coming out from the South pole.

Exemplar 4



..North......atracts.....to.....South.......so......the........arrows.....

...show.......which.......direction.........it........moves........in.......... **[2]**

In this exemplar both marks have been given for the clear diagram showing all arrows going from North to South and the field lines closer together at the poles.

Question 4 (b)

(b) Beth takes the stick away. Nina points the boat in a different direction. The boat slowly rotates to point to the left (⟵).

Nina then points the boat in other different directions. Each time, it slowly rotates until it points to the left (⟵).

What conclusions can you draw from this behaviour?

....

....

.... **[2]**

This question required candidates to say that the metal bar in the boat was a permanent magnet and that something about aligning with the Earth's magnetic field. The former was very rarely mentioned, and the latter only given by higher ability candidates.

Question 4 (c)

(c) Beth has a magnetic compass. It always points to Earth's magnetic north pole.

Explain what this tells you about the core of the Earth.

....

.... **[1]**

The most common correct answer given was that the Earth's core creates a magnetic field. Many candidates gave an answer about magnetic material which was not detailed enough. Either the Earth's core acts as a permanent magnet or a bar magnet was needed to gain the mark.

Question 5 (a)

5 An ultrasound scanner makes images of unborn babies using sound waves with a frequency of 3.5 MHz.

(a) Define frequency.

.... **[1]**

The idea of frequency was recognisable in many answers, although some candidate responses were not specific enough. To gain the mark candidates need to refer to the number of waves and the time period, i.e. in one second.

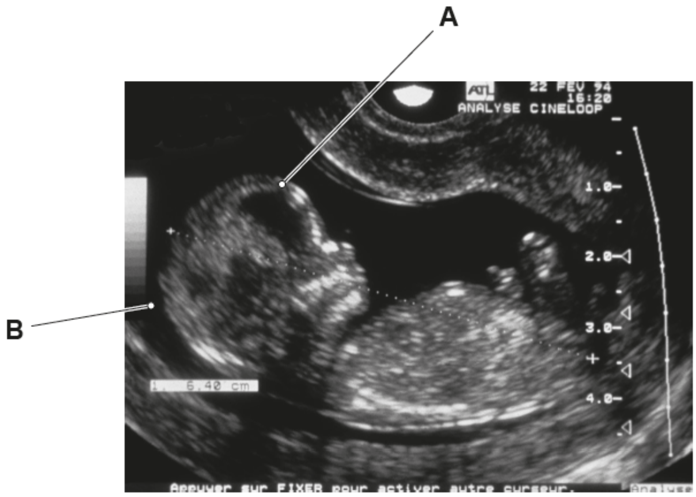
Question 5 (b) (i)

(b) A probe sends a beam of ultrasound into the body.

Part of the beam is reflected at each boundary between different tissues.

These reflections are detected when they arrive back at the probe.

This is an ultrasound image of an unborn baby. The size of its head, between points **A** and **B**, is measured by the ultrasound scanner.



(i) The ultrasound waves travel at a speed of 1540 m/s through the head.

Calculate the wavelength of the waves.

Use the equation: wave speed = frequency × wavelength

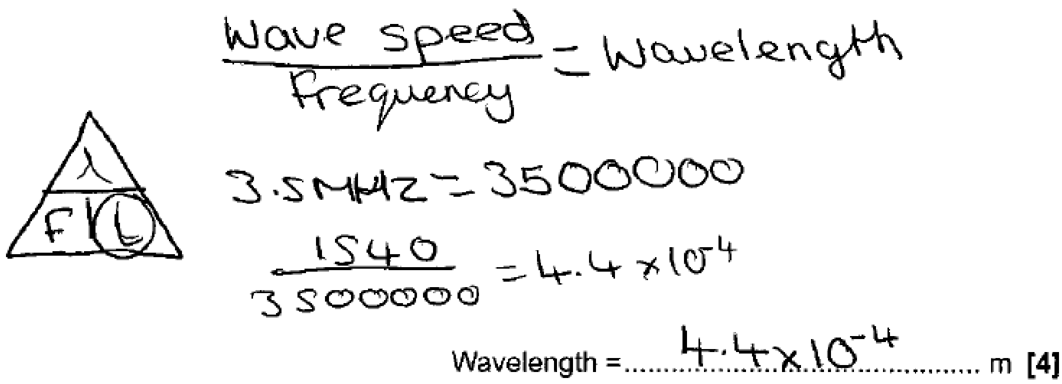
Give your answer in **standard form**.

Wavelength = ... m **[4]**

This calculation question required candidates to use the equation given in the question, substitute in the given data and then rearrange the equation. The frequency needed converting and the final answer was required to be in standard form. Half of all candidates were given 3 marks. The most common errors were no conversion / the wrong conversion, and not giving the final answer in standard form.

	AfL	Converting to standard units, should be second nature for all physics candidates. Setting down the values for the expressions in an equation and then converting them to standard units gives a candidate time to think. In class a mixture of units can be used in starter exercises or short homeworks, such as mph, kHz. Low states problem solving gives candidates the confidence to complete higher stakes problem solving in examinations.

Exemplar 5

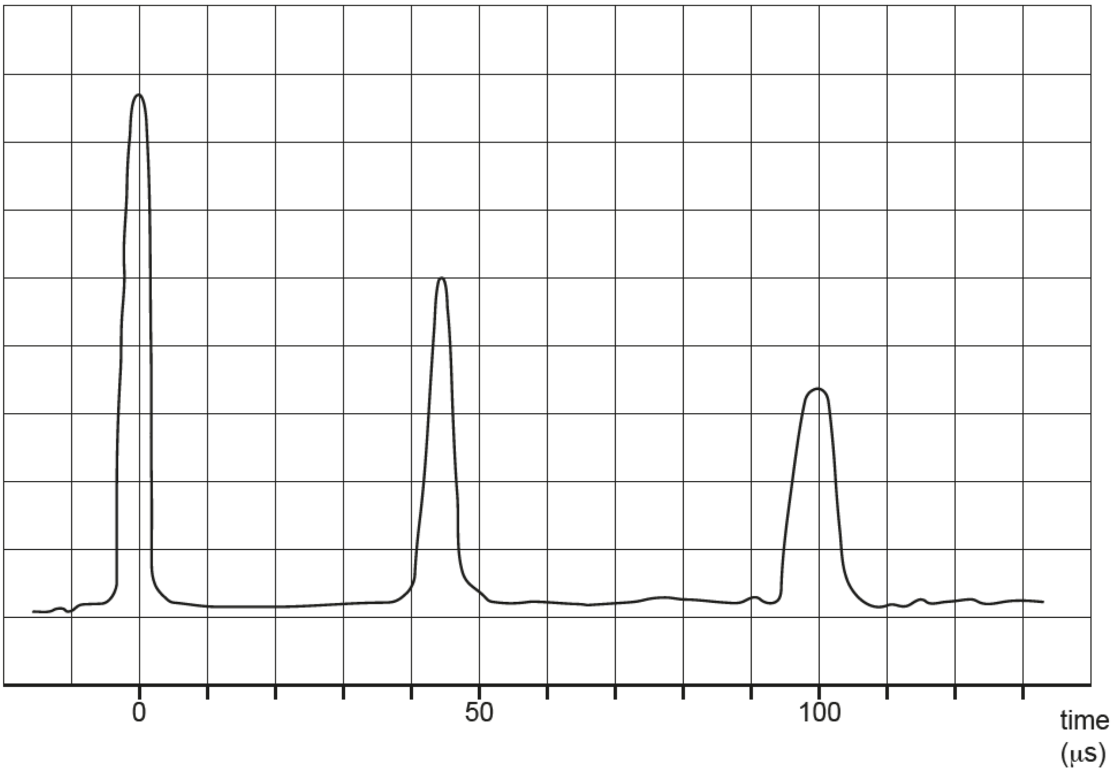


This is an example of a well laid out and fully correct response. The candidate has rearranged the equation, converted the frequency, substituted in the data, and finally given the answer on the answer line in standard form.

Question 5 (b) (ii)

Part of the beam is reflected at **A** and part of the beam is reflected at **B**.

The trace on the screen shows the original pulse and the two reflected pulses arriving back at the probe.



(ii) Use the trace to determine the **time delay** between the two reflections arriving back at the probe.

Time delay = ... μs **[2]**

More than half the candidates did not use the two reflected pulses to determine a value for time delay (55 μs) . Some of those that did recognise the need to look for the time between the pulses did not use the peaks and gave answers that were out of range (±4 μs).

Question 5 (b) (iii)

(iii) Calculate the size of the baby's head.

Size of baby's head = ... m **[5]**

Many candidates tried to measure the size of the baby's head using the diagram. Many of those candidates attempting to do a calculation used the frequency or their value of wavelength, rather than the speed and time delay. Very few candidates realised that this was an echo and needed to use speed, distance and time. The division of the calculated distance by 2 was missed by almost all candidates. Where the conversion of the time delay from microseconds to seconds had not been made final answers were extremely large for a baby's head.

	AfL	Where a question uses the command word 'calculate', candidates should use the data in the question and on the data sheet to perform a mathematical operation and show their working.

Question 6 (a) (ii)

(ii)

$$^{147}_{61}\text{Pm} \rightarrow \,^{\dots\dots\dots}_{\dots\dots\dots}\text{Sm} + \,^{\dots\dots\dots}_{\dots\dots\dots}\text{e}$$

[3]

Most candidates balanced the decay equation in part (i) but not the one in part (ii) and many candidates were not able to recall the mass number and atomic number for an electron.

Question 6 (b)

(b) Which of these two isotopes, **americium-241** or **promethium-147** is most suitable for measuring the thickness of the aluminium foil?

Isotope = ...

Explain your answer.

....

....

....

....

....

.... **[3]**

Very few candidates achieved full credit for this question. Most responses did not gain any credit as the relevant properties of the two isotopes and their decay products were not stated. Many responses stated that alpha particles can only go through a few cm of air, but candidates needed to say that alpha particles cannot go through aluminium foil to gain credit.

Exemplar 6

It is a beta ray instead of an Alpha (Americium-241) ray. The Alpha would not be able to penetrate the Aluminium but the Beta radiation could.

.... **[3]**

In this exemplar the correct isotope has been chosen and there are correct statements about the particles emitted by the isotopes and that alpha particles cannot penetrate aluminium. In order to gain the third mark, it needs to make clear that only some of the beta radiation will only go all the way through the aluminium foil.

Question 6 (c)

(c) The radioactive source has a safety-shutter at the front which is closed when it is not in use.

Explain why the safety-shutter is needed.

....

....

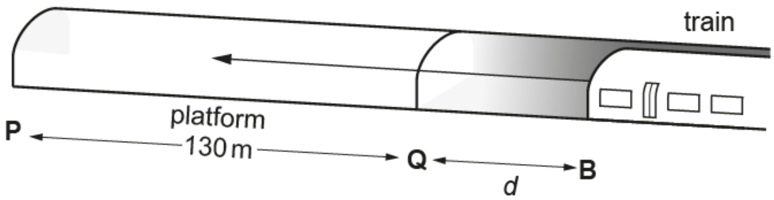
....

.... **[2]**

Only a minority of responses were given any marks for this question. Damage to cells was the most common answer that gained credit. Many candidates thought the source came out rather than radiation from the source.

Question 7 (a) (i)

7 A London Underground train travels on a level track inside a tunnel.



(a) The brakes are applied at point **B**. The train stops at point **P**.

The braking force is 2.3×10^5 N and the work done by the braking force is 4.6×10^7 J.

(i) Calculate the distance, *d*.

Distance, *d* = ... m **[4]**

Over half the candidates were able to calculate the total braking distance (work done ÷ force = 200 m) of the train, but many then did not subtract the length of the platform.

Question 7 (a) (ii)

(ii) Describe the main energy transfers that take place when the train slows to a stop.

....

....

.... **[2]**

Many candidates identified that energy was transferred from the kinetic energy store of the train producing heat. This response gained the first mark. In order to gain the second mark, candidates needed to describe where the energy was being transferred to; the thermal store in the breaks of the train.

Question 7 (b)

(b) The total mass of the train and passengers is 280 000 kg.

Calculate the force required to accelerate the train from rest to a speed of 12 m/s over a distance of 56 m.

Use the equation: kinetic energy = ½ × mass × speed^2

Force = ... N **[5]**

Over half the candidates were able to calculate the kinetic energy correctly. Others did not square the speed or made calculations to find a different speed. Only the higher ability candidates went further with the calculation by applying a similar approach to 7(a), force = kinetic energy ÷ distance.

Question 7 (c)

(c) When the underground train system was built, the temperature of the air in the tunnels was about 14 °C.

Today it is about 23 °C and cooling systems are required.

Suggest why the temperature of the air in the tunnels has increased.

....

....

....

.... **[2]**

Less than half the responses followed the reasoning in Q7 about heat from braking, and were given any credit for this question. The most common misconception was that the temperature increase was caused by global warming.

Question 8 (a)

8 Jamal is choosing a lamp that emits coloured light.

He looks at a lamp which has a white light at the centre and glass prisms surrounding it. Each prism produces a spectrum.

Jamal knows this is because the light is **refracted** when it moves from air to glass and from glass to air.

(a) Explain what happens to the light that causes it to be refracted when it enters and leaves a glass prism.

....

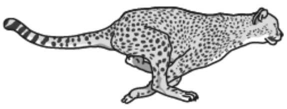
....

.... **[2]**

Half the candidates gained some credit for this question although only a few were given both marks. The most common misconception was confusing dispersion with refraction.

Question 9 (a)

9 A cheetah is the fastest land mammal. Cheetahs hunt gazelles.


Cheetah


Gazelle

A cheetah has a maximum speed of 110 km/h.

(a) Determine the cheetah's maximum speed in **metres per second**.

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

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

This was a straight forward conversion question requiring a specified number of significant figures in the answer. A third of candidates gained some credit but many gave their answer as three significant figures and so could not be given the final mark.

Question 9 (b) (i)

(b) (i) Explain the difference between a vector and a scalar quantity.

....

.... **[1]**

Most candidates showed some understanding of scalars and vectors quantities. However, the majority of these candidates did not describe both quantities and this was needed to get the mark.

Question 9 (b) (ii)

(ii) Which of the quantities below are **vectors** and which are **scalars**?

Tick **one** box in each row.

Quantity	**Vector**	**Scalar**
Acceleration		
Displacement		
Distance		
Speed		
Velocity		

[1]

Speed was the most popular choice as a scalar quantity. The most common misconception was to identifying acceleration as a scalar quantity by putting a tick in the scalar column.

Question 9 (c) (i)

(c) **Fig. 9.1** shows a speed-time graph of a gazelle which starts moving.

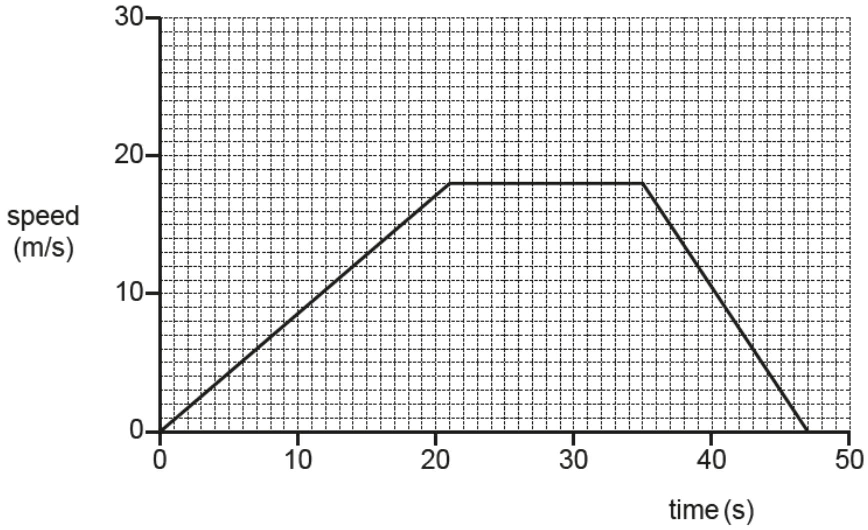


Fig. 9.1

(i) Use **Fig. 9.1** to calculate the deceleration of the gazelle.

Deceleration = ... m/s^2 **[3]**

Half the candidates calculated the deceleration correctly using the gradient of the graph and the correct values from the graph.

Question 9 (c) (ii)

(ii) Use **Fig. 9.1** to calculate the distance the gazelle travels as it decelerates.

Distance = ... m **[3]**

A minority of candidates were successfully calculated that the distance travelled by calculating the area under the graph.

Question 9 (d) (i)

(d) A second gazelle starts moving at the same time. The table below describes its motion.

Stage	Motion of second gazelle
1	Constant acceleration from 0 m/s up to a speed of 26 m/s
2	Constant deceleration of 0.3 m/s^2 for 20 s
3	Deceleration at a constant rate to a stop.
4	The total time for the motion was 45 s

(i) Plot a graph on **Fig. 9.1** for the motion of the second gazelle.

[3]

Most candidates gained some credit for this question. Many responses showed a straight line from speed 0 to 26 m/s for stage 1, any time between 1 s and 24 s was allowed. Some candidates had not made the connection with stage 2 and 4 and therefore did not gain credit as their time to reach 26 m/s exceeded 24 s. Some candidates wrongly drew Stage 2 as a horizontal line, rather than a negative slope (deceleration). Many candidates drew straight line from the end of stage 2 to 0 m/s at 45 s and gained the third mark point.

Exemplar 7

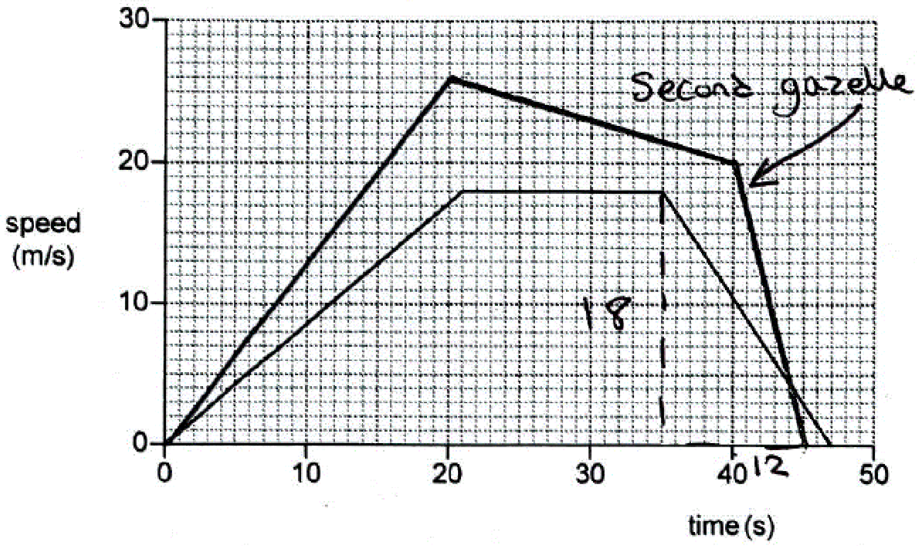


Fig. 9.1

This exemplar shows one correct solution with all three stages drawn.

Question 9 (d) (ii)

(ii) **Without** further calculation, judge which gazelle travelled furthest.

Explain your answer.

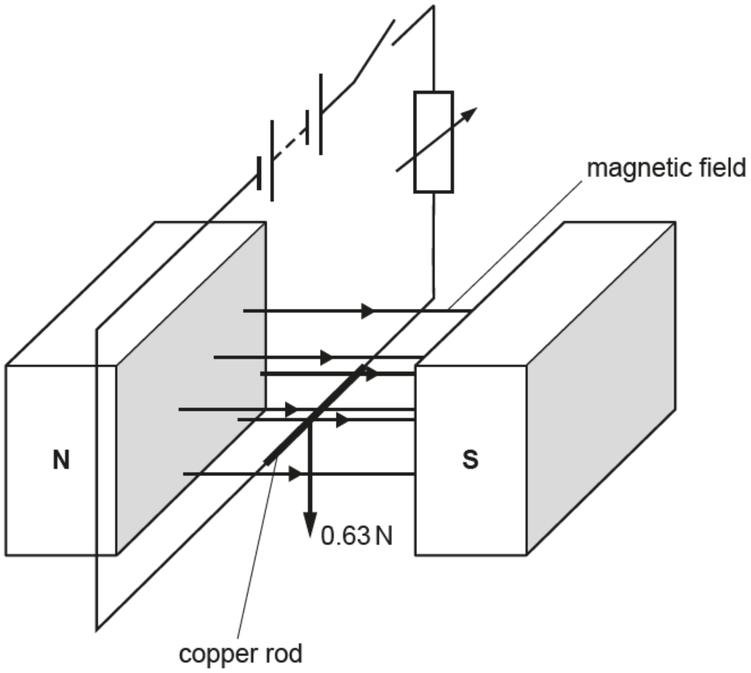
....

.... **[1]**

A minority of candidates gained this mark. Very few candidates referred to the connection between the total distance travelled and the area under the two graphs.

Question 10

10 The diagram shows a copper rod in a magnetic field.



The copper rod is 0.25 m long and weighs 0.63 N. The entire length of the copper rod is on a horizontal table in a magnetic field of flux density 1.8 T.

The magnetic field is at right angles to the table and the copper rod.

The copper rod is connected to an electric circuit which is switched on, and the current is slowly increased.

Calculate the **current** needed to cause a force on the copper rod equal to its weight.

Current = ... A **[2]**

Around half the candidates selected the correct equation from the data sheet and substituted in the values given in the question.

Question 11 (a)

11 Buildings need heating and cooling systems.

(a) Describe the changes that take place when a liquid is heated, and then changes state from liquid to gas.

Use ideas from the particle model in your answer.

....

....

....

....

.... **[3]**

A third of candidates gained some credit but very few were given more than one mark. Most candidates' descriptions were too vague to gain any credit. Common responses of this type included 'particles gain energy' rather than 'particles gain kinetic energy' or 'particles move around more' instead of 'particles move faster'. A few candidates described particles moving further apart as the liquid was heated for the second mark.

	Misconception	Understanding the relationship between heating a substance and temperature change is challenging for all candidates. The teaching narrative for P6.2 in the specification states: • When matter is heated, the particles are always moving • In the solid state they are vibrating • In the liquid state they are vibrating and jostling • In the gas state they are moving freely in random directions

	AfL	A solid substance becomes liquid when the particles are no longer locked together and have some freedom to move ('jostle') before hitting another particle. A liquid substance becomes a gas when the particles are no longer in contact and can move freely in random directions. Although molecules in a liquid 'vibrate' (as they do in a solid) 'jostling' is much more important in terms of the changes on heating because when particles are able to move freely in all directions without immediately hitting another particle the liquid substance has changed state to a gas.

Question 11 (b)

In a sustainable office building, water is circulated to keep the building cool in the day.

This water is cooled by passing through a tank containing stainless steel spheres. Inside the spheres there is a material called a phase change material (PCM) that melts when the water is warm.

When the water is cooled by the night air it freezes the PCM again.

(b) Describe how the energy transfers involved help to cool the building at night.

....

....

....

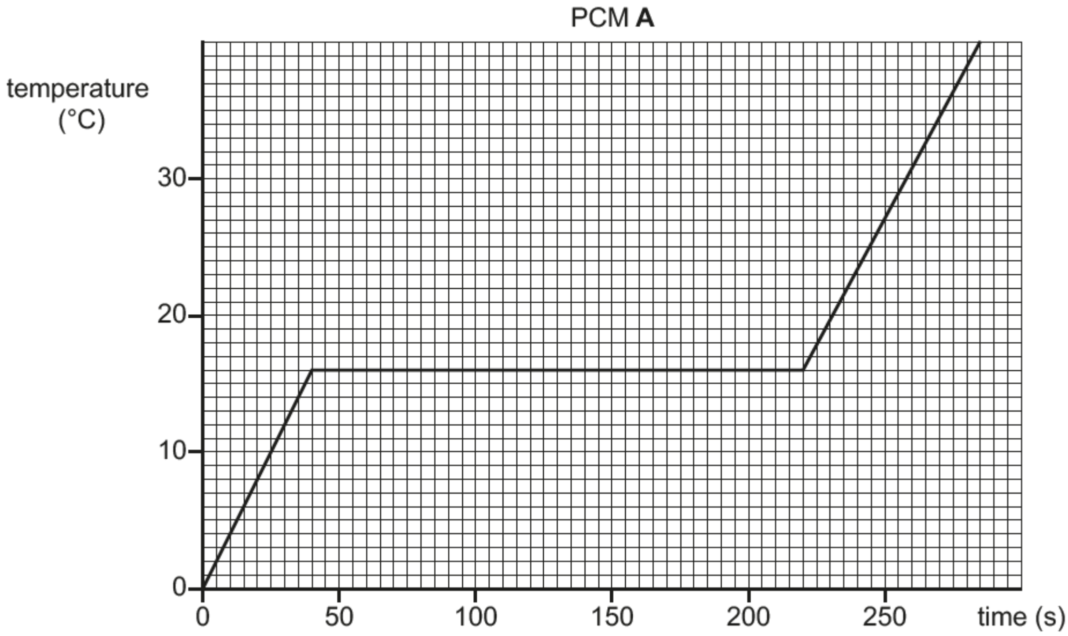
....

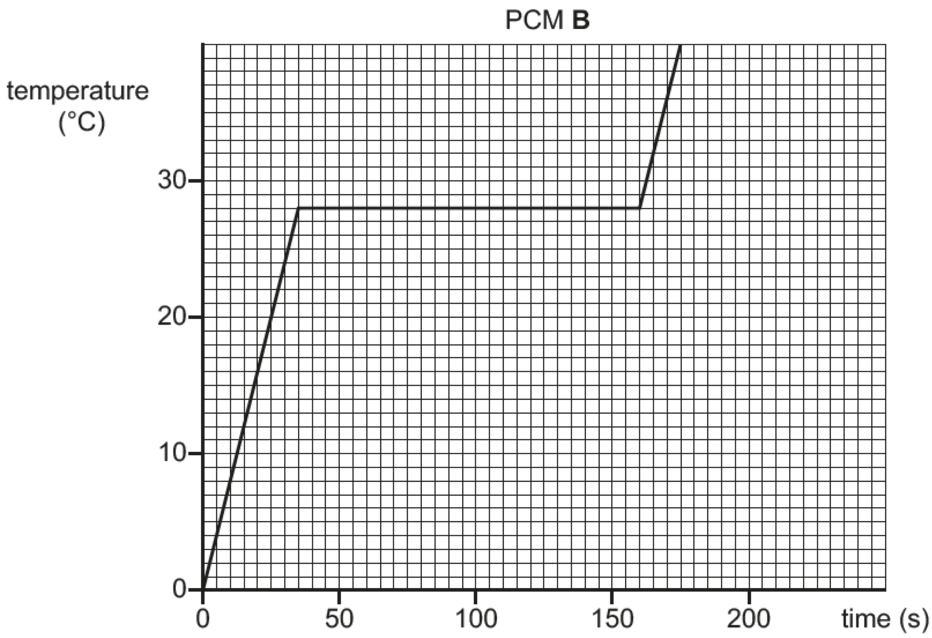
.... **[3]**

The majority of candidates did not appreciate that latent heat is always substantially greater than specific heat (for example the specific heat capacity of water is 4.2 kJ/Kg/K but the latent heat of melting of ice is 334 kJ/Kg). Many candidates attempted to describe the energy transfers between the water in the tank and PCM, but these were not specific enough to gain any credit.

Question 11 (c) (i)

(c) These graphs show the temperature change in a 100 g mass of PCM **A** and a 100 g mass of PCM **B** when they are each heated by a 120 W heater at the same constant rate.





(i) The ideal building temperature is 22 °C.

Which PCM, **A** or **B**, is more suitable for cooling the building? Justify your answer.

....

....

....

.... **[2]**

Although this (heating curves) was a more familiar context for assessing latent heat and heat capacity, most candidates did not identify that the horizontal lines on the graphs represented a change in state of the PCM. The expected response was PCM A as 16°C is the most appropriate temperature for cooling the water in an air conditioning system.

Question 11 (c) (ii)

(ii) Calculate the specific latent heat of PCM **B**.

Specific latent heat = ... J/kg **[5]**

Very few candidates gained any credit for this question. Some candidates selected the correct equation for specific latent heat from the data sheet but did not use an appropriate value of energy. A small number of higher ability candidates determined that the energy input = power x time and used the graph for PCM A to calculate the correct time of 125 s. As the units on the answer line were J/kg the final step needed was to convert from 100 g to kg to calculate the final answer.

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