Qualification Accredited

OCR
Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/04 Summer 2024 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. 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 4 series overview

J259/04 Depth in Physics is one of the two examination components aimed at Higher tier candidates studying GCSE (9–1) Twenty First Century Science Suite, which assesses content across the teaching chapters P1 to P7, including assessment of P8 Practical Skills. Questions 1–3 are overlap questions with the Foundation paper. The examination assesses the three Assessment Objectives: AO1 demonstrating knowledge and understanding of scientific ideas, techniques and procedures; AO2 applying that knowledge to solve problems; and AO3 analysing information, drawing conclusions and improving experimental procedures. Most of the paper assesses candidates' demonstration and application of their knowledge with 20% of the paper assessing their ability to analyse, interpret and evaluate information. With all J259 examinations there is a requirement to assess mathematical skills which make up approximately 30% of the paper – these include calculations and graphical interpretation. This paper includes two LOR Questions, Questions 1 (b) (ii) and 6, and a synoptic question, Question 7 (b) (ii), where candidates are required to demonstrate and apply knowledge from the different teaching chapters in the specification.

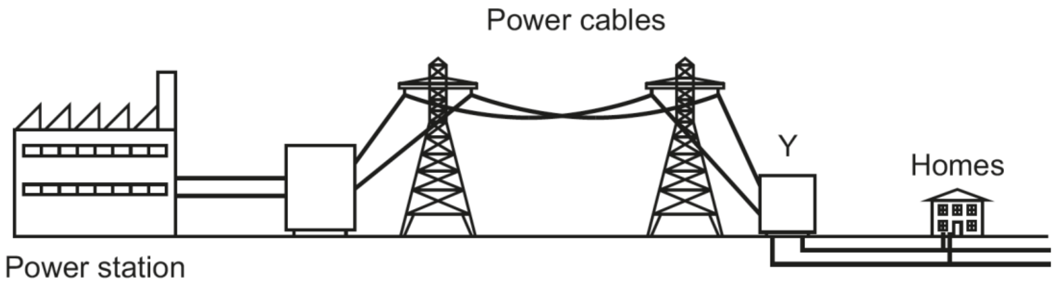
Only a very small number of candidates achieved marks that indicated that the Foundation tier examination would have been a more appropriate paper for them. Candidates' overall performance indicates the accessibility of the paper and that candidates have been entered for the correct tier of entry.

In the 2024 examination series, Centres were given the J259 01/02/03/04 Equation Sheet which included all the equations that are assessed in the J259 specification.

<table>
<tr><th>Candidates who did well on this paper generally:</th><th>Candidates who did less well on this paper generally:</th></tr>
<tr><td>selected, rearranged and substituted numbers into equations with their working shown clearly
developed their reasoning or justifications with correct and suitable scientific terminology
had good comprehension of command terms such as describe, explain, evaluate, etc.
had good understanding of the nuclear model and properties of the different types of radiation
used data to compare the trends in the changing use of different energy resources.</td><td>did not convert units, e.g. µm to m
did not determine and use units correctly
did not demonstrate understanding and use of specific scientific terminology to explain:
electromagnetic induction and how a potential difference is induced and hence a current is induced when there is a complete circuit
the mechanism of the greenhouse effect – terms such as transmit, absorb and emit for different radiations in the electromagnetic spectrum and how this causes a heating effect in an atmosphere which contains greenhouse gases such as carbon dioxide.</td></tr>
</table>

Question 1 (a) (i)

1 The diagram below shows part of the National Grid.



(a)
(i) What is the domestic mains supply voltage to homes in the UK?

Tick (✓) **one** box.

60 V a.c. ☐

60 V d.c. ☐

230 V a.c. ☐

230 V d.c. ☐

[1]

Candidates performed well on this question. Around two thirds of candidates correctly ticked 230 V a.c. as the mains supply voltage to homes in the UK. The most common distractor was 230 V d.c.

Question 1 (a) (ii)

(ii) The electricity is transmitted along the power cables at around 230 000 V.

Explain how this high voltage makes the energy transfer along the power cables more efficient.

....

....

....

.... **[2]**

Overall, performance on this question was variable, as under half of candidates did not score marks. Higher achieving candidates performed better as they demonstrated a more confident understanding of how a high voltage makes the energy transfer along the power cables more efficient in terms of reduced energy loss in the cables. These higher performing candidates were then able to explain that this was due to a lower current in the power cables to score 2 marks.

Misconception

Lower achieving candidates often gave a response that a high voltage resulted in a high current which demonstrated a misconception about the transmission of electricity along power cables and the role of transformers in the National Grid. While this question did not directly assess the use of transformers, candidates did have to apply their knowledge and understanding of how electricity is transmitted efficiently to our homes and that a low current is required to reduce energy losses from the cables. Some candidates gave responses in terms of the resistance of the cables as they tried to apply $V = IR$, rather than in terms of power loss by the indirect use and application of $P = IV$.

Question 1 (a) (iii)

(iii) Name the device at Y.

.... **[1]**

Candidates performed well on this question as the majority of candidates correctly named the device at Y as a transformer.

Question 1 (b) (i)

(b) Many different energy resources are used to generate electricity.

(i) State **two** types of **renewable** energy resources used to generate electricity.

1 ....

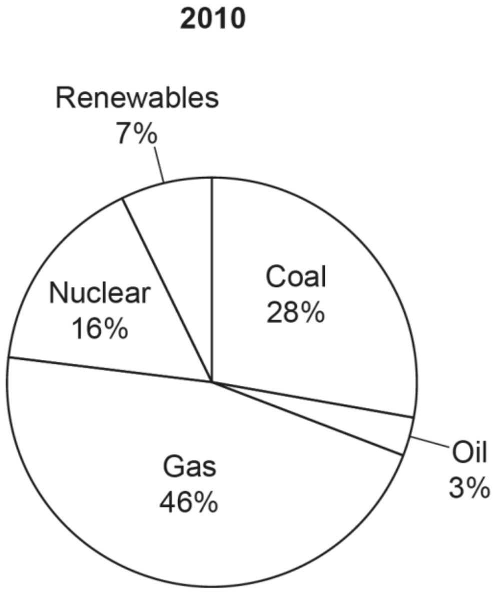
2 .... **[2]**

Candidates performed well on this question as most candidates correctly stated two types of renewable energy resources. The most common energy sources stated were solar and wind.

Question 1 (b) (ii)*

(ii)* **Fig. 1.1** shows the percentage of electricity generated by different energy resources in the UK in 2010 and 2020.

Fig. 1.1



Describe how the trends in the use of energy resources in the UK changed between 2010 and 2020.

Suggest reasons for these changes.

Use the data in **Fig. 1.1** in your answer.

....

....

....

....

....

.... **[6]**

Candidates performed well on this Level of Response question as the majority of all candidates gave L3 responses. Candidates confidently compared the data in the two pie charts to describe the trends in the differing use of energy resources in the UK in 2010 and 2020. They also gave reasons for these changes, usually referencing the environmental impact of renewable and non-renewable energy resources.

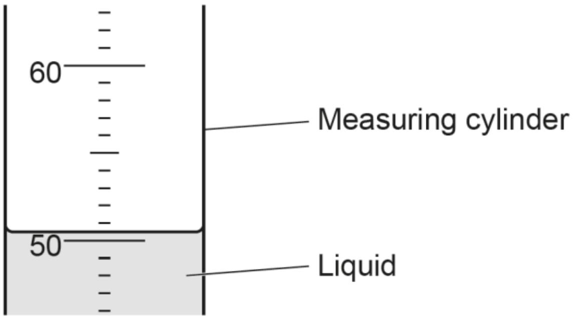
Question 2 (a)

2 A student is doing an experiment to find the density of an unknown liquid.

They pour some of the liquid into a measuring cylinder and measure the volume in cm^3.

Fig. 2.1 shows a close-up of the liquid in the measuring cylinder.

Fig. 2.1



(a) What is the volume of the liquid?

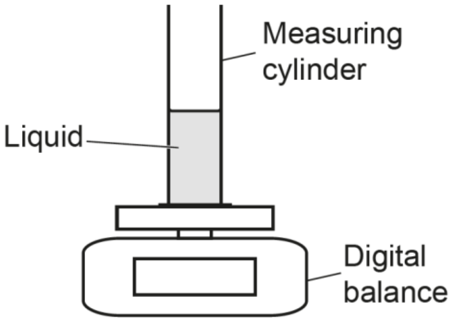
Use **Fig. 2.1**.

Volume = ... cm^3 **[1]**

Candidates performed very well on this question with nearly all candidates correctly determining the volume of the liquid between 50 cm^3 and 51 cm^3.

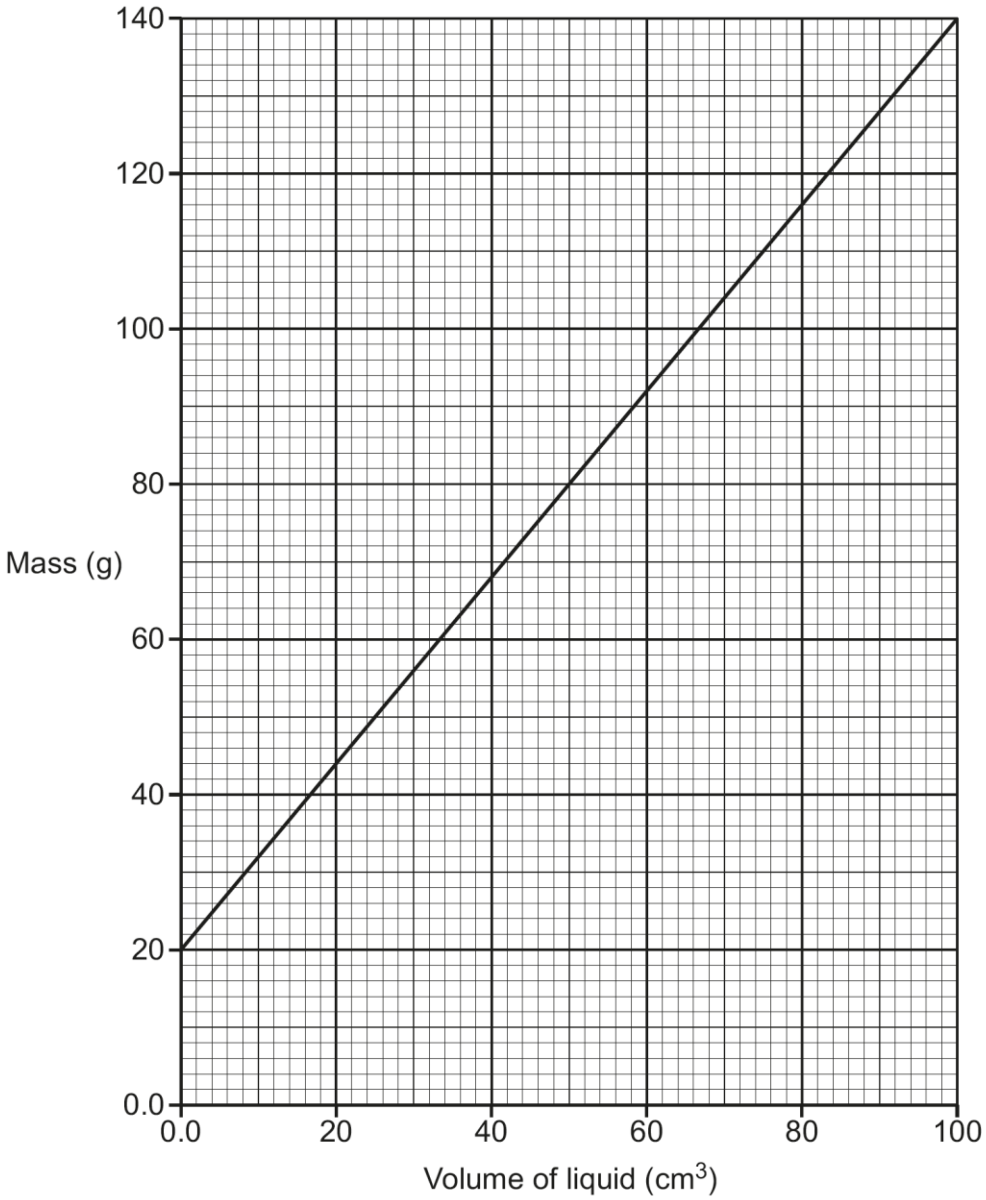
Question 2 (b) (i)

(b) The student places the measuring cylinder on to a digital balance and measures the mass of the measuring cylinder and the liquid.



They increase the volume of the liquid and repeat the measurements.

The graph shows their results.



(i) What is the mass of the empty measuring cylinder?

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

Candidates performed very well on this question, with nearly all candidates correctly using the graph to determine the mass of the cylinder as 20 g.

Question 2 (b) (ii)

(ii) Calculate the density of the liquid.

Use:

- data from the graph
- the equation: density = $\frac{\text{mass}}{\text{volume}}$

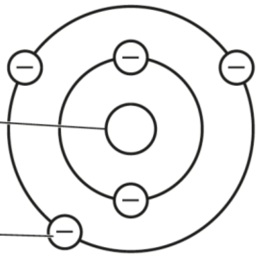
Density = ... g / cm^3 **[4]**

Candidates performed well on the question as the majority of all candidates achieved 2 or more marks for correctly applying the equation density = mass ÷ volume for values of mass and volume read from the graph. The most common mistake that candidates made when calculating the density of the liquid was to omit subtracting the mass of the cylinder from the value of the mass read from the graph. For example, a typical response from some candidates was the following calculation 140 ÷ 100 = 1.4 g / cm^3.

Question 3 (a)

3 In 1910 the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment provided evidence for the nuclear model of the atom.

The diagram shows the nuclear model of an atom.



(a) State **two** reasons why the model of the atom has changed over time.

1 ....

....

2 ....

.... **[2]**

Candidates performed well on this question, as the majority of all candidates achieved a mark. Over half of candidates achieved 1 mark for stating a reason why the model of the atom has changed, with most common reasons stating the nuclear model has changed due to the discovery of new particles (electron, proton or neutron), or due to the advancements in technology or scientific equipment. Candidates who did not achieve a mark often gave vague and unspecific responses which were insufficient to award marks, such as 'new things have been discovered' or 'more experiments have been carried out'.

Question 3 (b)

(b) Describe the structure of the nuclear model of the atom.

....

....

....

....

....

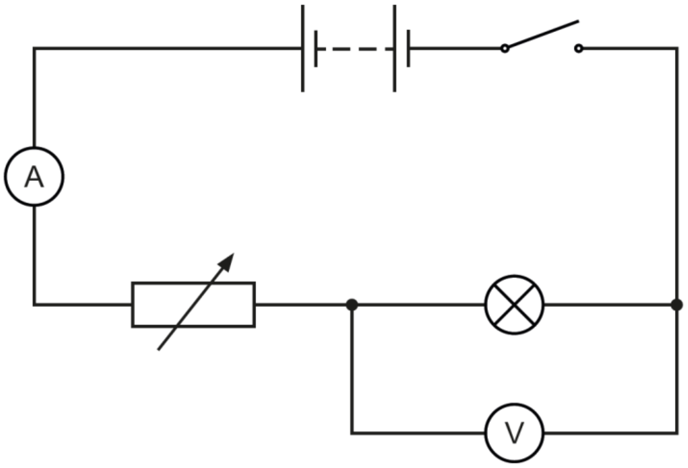
.... **[3]**

Candidates performed well on this question as the majority of candidates achieved a minimum of 1 mark for a correct description of the structure of the nuclear model. The most common responses given were that the nucleus contains protons and neutrons or that electrons orbit the nucleus in shells. Just under half of candidates achieved 3 marks for giving a complete and correct description of the structure of the nuclear model of the atom.

Question 4 (a) (i)

4 A student investigates the I-V characteristics of a lamp.

(a) He builds this circuit.



(i) He observes that the battery runs down too quickly for him to get all the required measurements.

Suggest how the student can stop this from happening.

....

.... **[1]**

Candidates did not perform well on this question, with only a small number of all candidates achieving the mark for correctly suggesting how the student can stop the battery from running down too quickly. The most common suggestion given by candidates was to use more cells, or a more powerful power supply. Some suggested closing the switch rather than opening it to prevent the battery from running down too quickly by stopping current flowing in the circuit.

Practical skill

This question was assessing a specific practical skill on how to prevent the battery from running down too quickly when investigating the I-V characteristics of a filament lamp. Candidates had to apply understanding that to prevent the battery from running down too quickly in between measurements, there either had to be **less current** in the circuit (by increasing resistance) or opening the switch so that the circuit was off and **no current** was flowing.

Question 4 (a) (ii)

(ii) Describe the transfer of energy in the circuit when the switch is closed.

Use ideas about energy stores in your answer.

[3]

Performance on this question was variable as many candidates did not score marks. Higher achieving candidates performed better as they demonstrated a more confident understanding of energy stores and energy transfers when describing the transfer of energy in the circuit. Many responses were confused as candidates described how the current flowed in the circuit through the different components, rather than a description of the transfer of energy from the chemical store in the battery via electrical working (or electrical energy) to the thermal store of the lamp and surroundings. A significant number of candidates described that the moving charges had a kinetic energy store which was transferred as the electrons moved in the circuit.

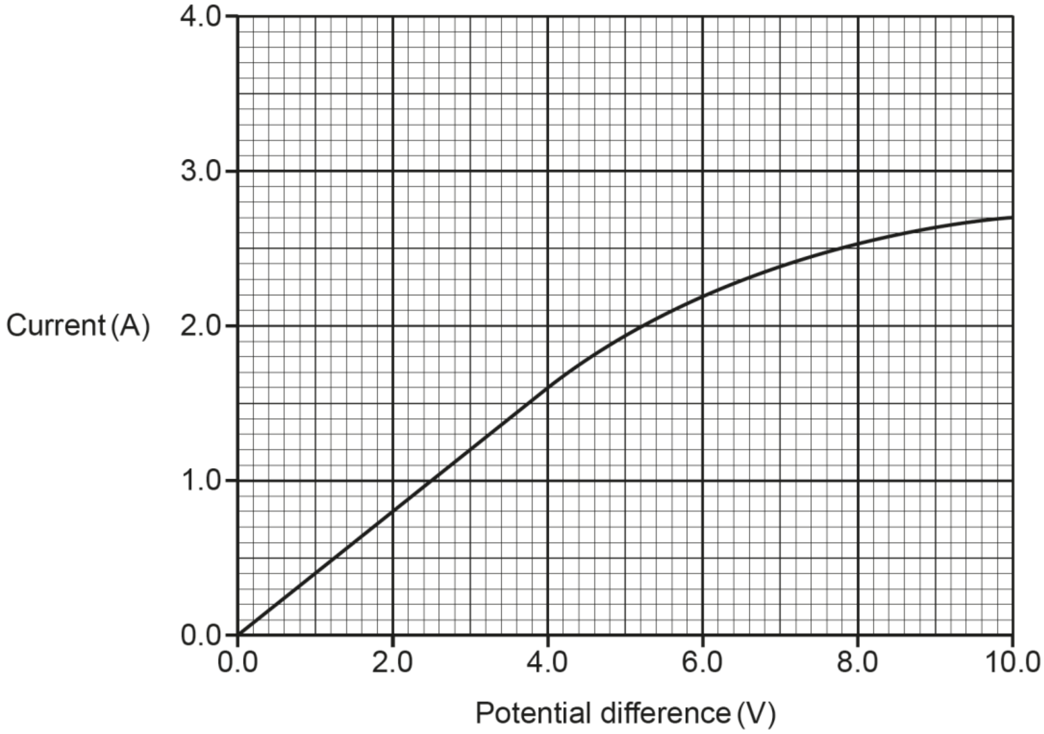
Exemplar 1

The energy ~~current~~ will ~~trad~~ ~~tr~~ go from the chemical store in the battery ~~to the~~ ~~the~~ electrically to ~~t~~ its electrical store which then travel to the filament lamp which will make some of that electrical energy into thermal energy which would be lost to the surroundings.

Exemplar 1 shows a correct response where the candidate demonstrates a clear understanding of energy stores and energy transfers. They clearly describe the transfer of energy from the store of chemical energy in the battery being transferred electrically to the lamp to finally the thermal store transferred to the surroundings, to achieve 3 marks. This candidate has not only correctly stated the energy stores but has also clearly described where the transfer of energy is occurring in the circuit.

Question 4 (b) (i)

(b) The graph shows the student's results.



(i) Calculate the power dissipated by the lamp when the potential difference is 5 V.

Use the Equation Sheet.

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

Candidates performed well on this question as the majority of all candidates correctly selected the equation $P = I\,V$, and applied it with a correct value of the current read from the graph for the potential difference of 5 V.

Question 4 (b) (ii)

(ii) The student writes this conclusion:

'As the potential difference increases, the resistance of the lamp increases.'

Determine whether the student is correct.

Use:

- data from the graph
- calculations
- the equation: potential difference = current × resistance

....

.... **[4]**

Overall, candidates performed well on this question as the majority of candidates scored at least 1 or 2 marks, usually for giving a quantitative response with a supporting calculation of resistance for a value of potential difference. The most common marks given were 3 marks for correctly rearranging the given equation to calculate two values of resistance for different values of potential difference and current, read from the graph. The most common reason for candidates not being given 4 marks was for either omitting units for resistance, or for an incorrect read off for a value of current for a corresponding value of potential difference.

Question 4 (c)

(c) A current of 2.8 A passes through the lamp for 120 s.
The energy dissipated in the lamp is 4 kJ.

Calculate the potential difference across the lamp.

Use the equations:

charge = current × time

energy transferred = charge × potential difference

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

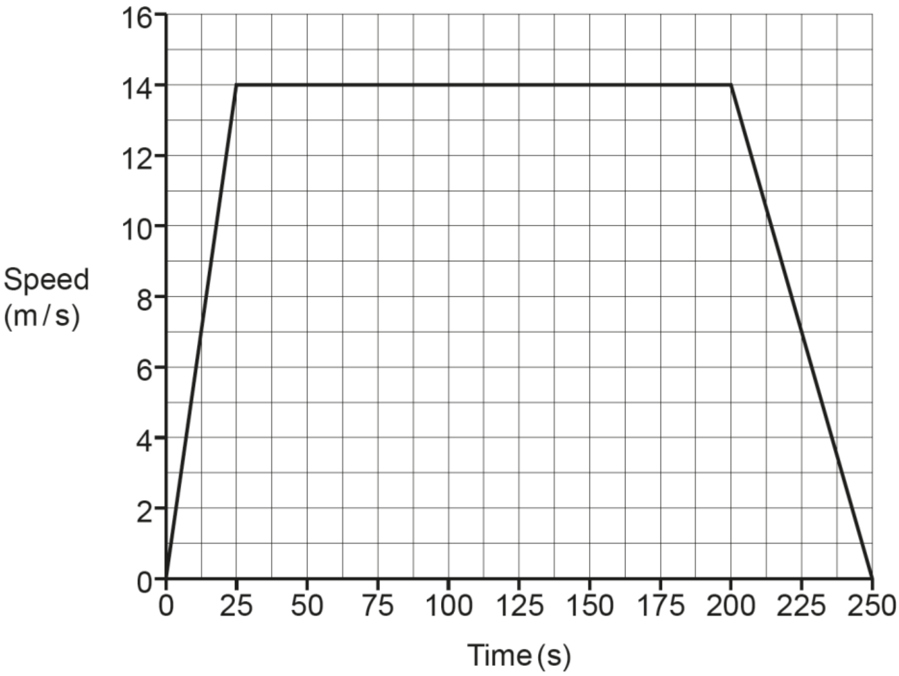
Potential difference across the lamp = ... V **[5]**

Candidates performed well on this question as the majority of candidates correctly applied and rearranged the given equations to calculate a value of potential difference across the lamp given to 1 decimal place. The most common reason for candidates not being given 5 marks was for either an incorrect rearrangement of the equation energy transferred = charge × potential difference, or for omitting to convert the energy transferred from 4 kJ to 4000 J.

Question 5 (a) (i)

5 Zayn owns an electric car.

(a) The speed–time graph shows part of a journey in the car.



(i) Describe the motion of the car for the first 200 s.

....

....

....

.... **[2]**

Candidates gave a correct description of the motion of the car from the speed-time graph as the majority of candidates described that the car reached a constant speed between 25 and 200 seconds but only a small number of candidates described that the car was travelling at a **constant** acceleration for the first 25 seconds. Most candidates just described that the car was accelerating. While this description was correct, it was not sufficient to be given the mark as they had to describe that the acceleration was constant or 0.56 m/s^2.

Question 5 (a) (ii)

(ii) Calculate the deceleration of the car between 200 and 250 seconds.

Use the Equation Sheet.

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

Candidates performed well on this question as the majority of all candidates correctly selected and applied the equation acceleration = change in velocity ÷ time to calculate the deceleration of the car between 200 and 250 seconds.

Question 5 (a) (iii)

(iii) Calculate the distance travelled between 0 and 25 seconds.

Distance travelled = ... m **[2]**

Performance on this question was variable as only around a half of candidates scored 2 marks for correctly calculating the distance travelled by the car between 0 and 25 seconds. Higher achieving candidates performed better as they demonstrated understanding that the distance travelled is equivalent to the area under a speed-time graph to give the correct distance of 175 m.

Misconception

This question demonstrated a misconception as around half of candidates calculated the distance travelled between 0 and 25 seconds while the car was accelerating as 14 × 25 = 350 m. Candidates had not applied understanding that the area under a speed-time graph is the total distance travelled. Candidates just simply calculated a value for the distance travelled using the equation distance = speed × time, without accounting for the fact that the car was accelerating and not travelling at a constant speed of 14 m/s.

Question 5 (b) (i)

(b) When fully charged the battery of the electric car stores 58 kWh.

(i) Zayn has a 7 kW car charger.

Calculate the time it would take to charge the battery.

Use the equation: energy transferred = power × time

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

Time = ... h **[4]**

Candidates performed well on this question as the majority of candidates achieved 4 marks for correctly calculating the time it would take for the battery to fully charge, giving their answer of 8.3 hours to 2 significant figures. A small number of candidates achieved 3 marks for giving a correct answer of 8.29 hours but not given to 2 significant figures.

Question 5 (b) (ii)

(ii) Zayn completes a 420 km journey using all the energy stored in the fully charged battery.

Sara completes the same journey in a petrol car. The petrol car uses 32 litres of petrol.

Sara says that the journey cost her more than twice as much as it cost Zayn.

Show that Sara is **correct**.

Use calculations in your answer.

Use this information:
- electricity costs 34p per kWh
- petrol costs 145p per litre.

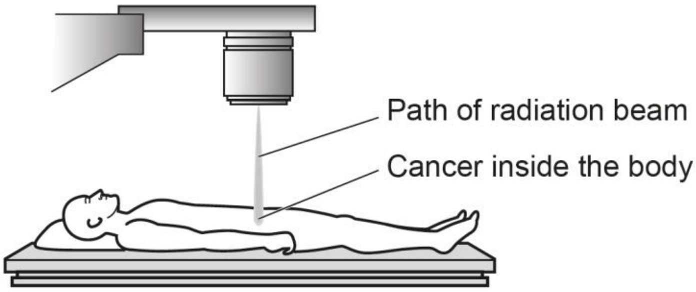
....

.... **[3]**

Candidates performed well on this question as the majority of candidates achieved 1 or more marks for using calculations in their answer to calculate the cost for both Sara or Zayn's journey, or a correct calculation for either Sara or Zayn's journey. Most candidates correctly calculated the cost of each journey and made a quantitative comparison to conclude that Sara's journey cost twice as much as Zayn's journey to be given 3 marks.

Question 6*

6* External beam radiotherapy is a method which uses radiation to treat cancer inside the body.



The table describes external beam radiotherapy.

	External Beam Radiotherapy
What it is	A radiation beam from outside the body is focused on the cancer and rotated around the body
Typical length of treatment	5 minutes once per day for 5 days

There are three types of radiation: alpha, beta and gamma.

Discuss the suitability of each type of radiation for use in the radiation beam.

Include in your answer how damage to healthy cells is reduced during treatment.

....

....

....

....

....

.... **[6]**

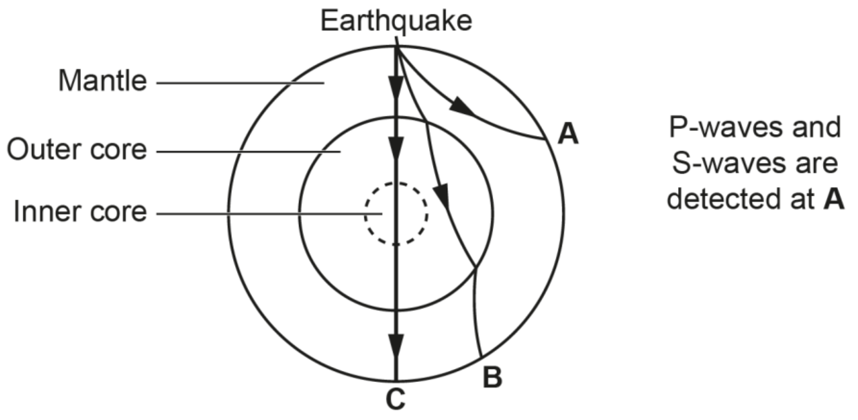
Candidates performed well on this question as the majority of candidates gave a minimum of a Level 2 response by comparing the properties and hazards of the three types of radiation. Candidates demonstrated a good understanding of the ionising and penetration properties of alpha, beta and gamma radiation and compared the properties to conclude that gamma radiation would be the most suitable type of radiation to use in the radiation beam. Around a third of candidates, mostly higher achieving candidates, included an explanation of how damage to healthy cells can be reduced during treatment – by either focusing and targeting the radiation beam on the cancer, or carrying out the treatment for a short period of time which would reduce surrounding healthy tissue being damaged.

Question 7 (a) (i)

7 During an earthquake, P-waves and S-waves travel through the Earth from the earthquake zone.

Scientists study P-waves and S-waves to find out about the structure of the Earth.

(a) The diagram shows three locations **A**, **B** and **C** that detect the waves from an earthquake.



Only P-waves are detected at **B** and **C**

(i) P-waves can travel through solids and liquids.

S-waves can only travel through solids.

Complete the table to show what conclusions scientists make about the structure of the Earth from this evidence.

Use the diagram to help you.

Tick (✓) **one** box in each row.

	Liquid	**Solid**	**Cannot tell**
Mantle			
Outer core			
Inner core			

[3]

Candidates performed well on this question as the majority of candidates achieved 1 or more marks for correctly concluding the structure of the Earth from the evidence provided in the question and diagram. Over half of candidates achieved 2 marks for correctly concluding that the mantle was solid, and the outer core was liquid from the evidence provided. Over a third of candidates, mostly higher achieving candidates, concluded that they could not tell whether the inner core was liquid or solid from the evidence provided.

Question 7 (a) (ii)

(ii) The density of the mantle is **not** constant.

Suggest why the path of the waves from the earthquake to **A** is curved.

....

....

....

.... **[2]**

Candidates performed less well on this question as over half of all candidates achieved 0 marks for a suggestion on why the path of the waves from the earthquake curved. To achieve marks, candidates had to relate that a change in density causes the waves to change speed and hence they change direction or refract, but most candidates just described that the density varied from high to low density without linking to speed or direction. Also, many responses just described how P-waves and S-waves travel in different mediums, or that the waves curved to avoid areas of different densities in the mantle, so were not given any marks.

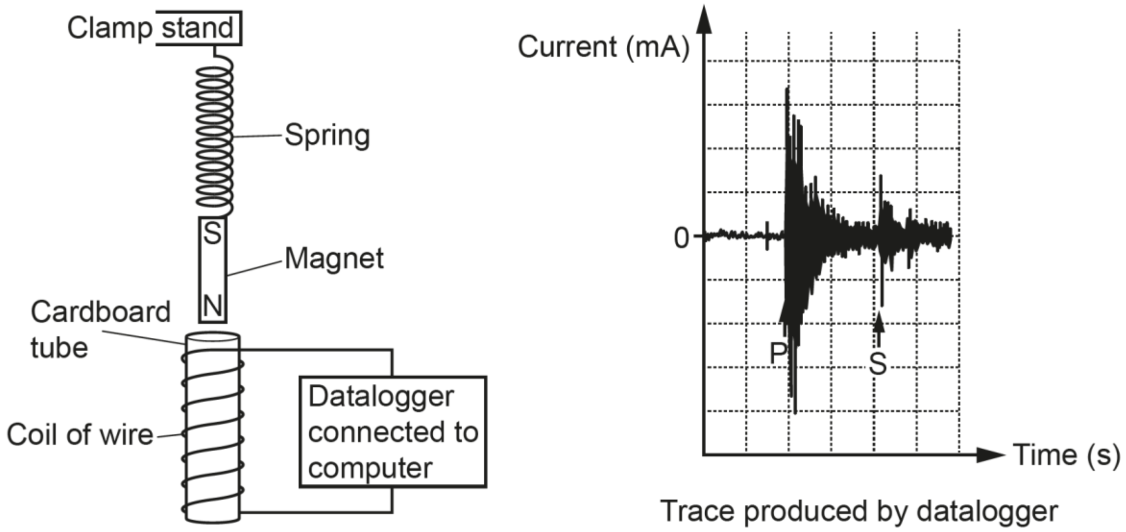
Question 7 (b) (i)

(b) Ryan builds an electromagnetic seismometer for detecting P-waves and S-waves.

He suspends a bar magnet from a spring and positions the magnet above a coil of wire.

The coil of wire is connected to a datalogger and computer.

The datalogger produces a trace showing the change in the electrical signal from the coil.



Trace produced by datalogger

(i) During an earthquake P-waves cause the magnet to move up and down inside the coil.

Explain how the movement of the magnet produces an electrical signal to the datalogger.

....

....

....

....

....

.... **[3]**

Performance on this question was variable as only around a half of all candidates scored a mark. Many responses were confused and just a repeat of the stem of the question that the movement of the magnet inside the coil of wire produced an electrical signal. Also, some candidates confused electromagnetic induction with the motor effect as they described how magnetic fields interact resulting in a force. The most common mark given was for describing that a current was produced in the coil of wire. Higher achieving candidates performed better as they demonstrated a more confident understanding of electromagnetic induction, and that the movement of the magnet in the coil of wire induced a potential difference and hence a current in the coil of wire and were given 2 marks.

Exemplar 2

Explain how the movement of the magnet produces an electrical signal to the datalogger.

The coil of wire experiences a ~~change~~ changing magnetic field, therefore ~~alternate~~ alternating voltage is induced, since the coil of wire is connected to a closed circuit, ~~alternate~~ alternating current is induced, the frequency of the current produced will correspond to the frequency of P movement of the magnet

Exemplar 2 shows a fully correct response where the candidate demonstrates a clear understanding of electromagnetic induction applied to the electromagnetic seismometer, as the bar magnet attached to the spring moves in and out of the coil of wire when P-waves are produced during an earthquake.

Disciplinary literacy

This question highlights the necessity and importance of using specific scientific terminology to explain the scientific concept of electromagnetic induction that is being assessed in the context of an electromagnetic seismometer. For candidates to achieve marks they must have a strong understanding of scientific vocabulary, including both tier 2 words and tier 3 science specific vocabulary.

Supporting students with their vocabulary knowledge through different teaching strategies will help students to have the confidence to tackle more challenging exam questions, especially when a specific scientific concept is being assessed in an unfamiliar or different context such as the question above.

Assessment for learning

In 2018 the Education Endowment Foundation published *Improving Secondary Science* which highlights five areas for developing literacy in science:

- Promote metacognitive talk and dialogue in the classroom.
- Carefully select the vocabulary to teach and focus on the 'most tricky' words.
- Show the links between words and their composite parts.
- Use activities to engage pupils with reading scientific text and help them comprehend it.
- Support pupils to develop their scientific writing skills.

https://educationendowmentfoundation.org.uk/education-evidence/guidance-reports/literacy-ks3-ks4

Question 7 (b) (ii)

(ii) S-waves cause the magnet to swing from side to side.

During the earthquake the P-waves and S-waves have a similar amplitude of vibration.

Explain why the trace of the S-wave from the datalogger is smaller than the trace of the P-wave.

....

....

....

.... **[2]**

Candidates did not perform well on this question as most candidates scored 0 marks. Most typical responses from candidates were a description of the movement of P-waves and S-waves by describing that P-waves are longitudinal waves and S-waves are transverse waves. While these descriptions were correct they did not explain why the trace from the S-wave was smaller than the trace of the P-wave by linking the movement to a smaller induced potential difference or current in the coil of wire. Only about one fifth of candidates, mostly higher achieving candidates, made this link to explain that there was less current in the coil, with then only a further small percentage of candidates explained this in terms of the reduced cutting of the coil of wire by the magnet.

Question 7 (b) (iii)

(iii) Ryan wants to make the amplitude of the trace larger when P-waves are detected.

Suggest **one** change Ryan can make to his apparatus to increase the signal to the datalogger.

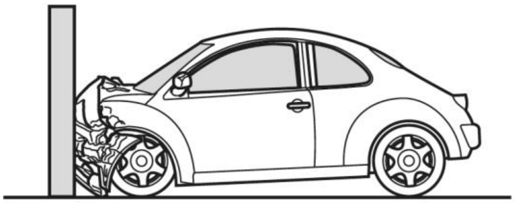
....

.... **[1]**

Overall, candidates performed well on this question as over half correctly suggested that increasing the number of coils of wire or using a stronger magnet would increase the signal to the datalogger. The most common responses from candidates who did not achieve the mark were either suggesting using a bigger/longer coil of wire, or a bigger magnet, which was insufficient for the mark to be given.

Question 8 (a) (i)

8 In a crash test, the safety of cars in a collision can be tested.



(a) In one test, a car travels at 14 m/s and collides into a solid barrier. The front of the car crumples whilst the car comes to a stop.

Momentum can be used to describe the motion of the car.

(i) Momentum is a vector quantity.

Describe what is meant by a vector quantity.

....

.... **[1]**

Overall, most candidates correctly described a vector quantity as having a magnitude and direction. Candidates who did not achieve the mark usually gave a description of a named vector quantity, for example, velocity had a speed and direction. While this description was correct, it wasn't sufficient in answering the question to be given the mark.

Question 8 (a) (ii)

(ii) The car has a mass of 1500 kg.

Calculate the momentum of the car just before it collides with the barrier.

Use the Equation Sheet.

Give the correct unit.

Momentum = ... unit .... **[3]**

Candidates performed well as the majority of candidates correctly selected and applied the equation momentum = mass × velocity to calculate the value of momentum of the car as 21 000, for 2 marks. Around half of candidates provided the correct units for momentum as kg m/s but the most common incorrect unit given was kg/m/s.

Question 8 (a) (iii)

(iii) During the collision the resultant force on the car is 750 000 N.

Calculate the time that the resultant force acts.

Use the Equation Sheet.

Time the resultant force acts = ... s **[4]**

Candidates performed well on this question as most candidates correctly selected and applied the equation change in momentum = resultant force × time for which it acts to calculate the time that the resultant force acts as 0.028 s. The most common reason for candidates not achieving marks was either an incorrect rearrangement of the equation, or not applying their value of momentum from Question 8 (a) (ii) when calculating the change in momentum.

Question 8 (b)

(b) Three cars, A, B and C, are tested further.

In this test, when the car collides with the barrier, the front of the car crumples and the car rebounds away.

Some of the kinetic energy store of the car before the collision is transferred to the internal energy store of the crumple zone.

The energy transferred to the crumple zone is the useful energy transferred.

The table shows the kinetic energy store of the cars before and after the collision.

Car	Kinetic energy store of car before collision (kJ)	Kinetic energy store of car after collision (kJ)	Efficiency of the energy transfer to the crumple zone.
A	199	146	
B	147	110	0.25
C	196	140	0.29

Complete the table to find out which car, A, B or C, has the most efficient crumple zone.

Use the equation: $\text{efficiency} = \dfrac{\text{useful energy transferred}}{\text{total energy transferred}}$

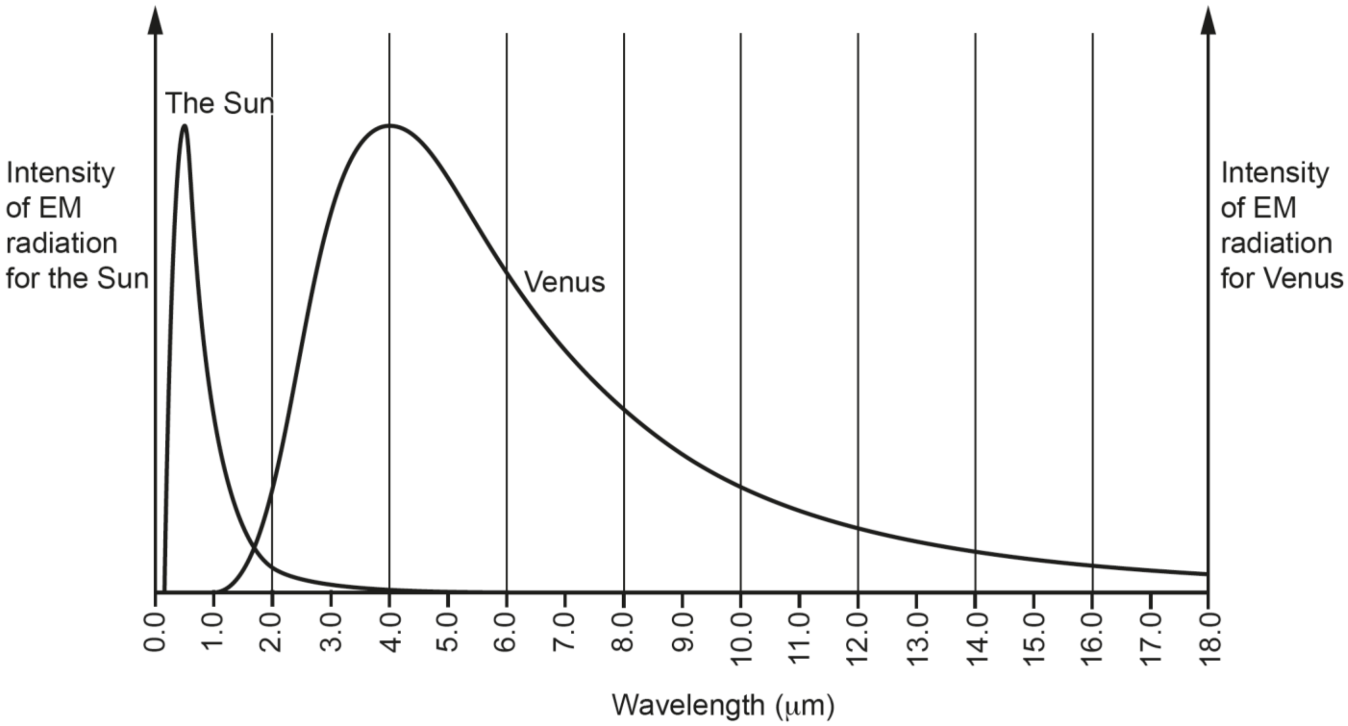
Car with the most efficient crumple zone .... **[3]**

Candidates performed well on this question as the majority of candidates achieved 3 marks for correctly using the given equation to calculate the efficiency of car A (0.27) to conclude that car C had the most efficient crumple zone in a collision. Candidates who did not achieve marks, mostly lower achieving candidates, either incorrectly determined the total energy transferred as 146 kJ rather than 199 kJ or had 146 kJ as the useful energy transferred - rather than calculating the useful energy transferred as the difference between the kinetic energy store before and after the collision (199 – 146 = 53 kJ).

Question 9 (a)

9 All hot bodies emit electromagnetic (EM) radiation.

The graph shows how the intensity of the emitted EM radiation varies with the wavelength, for the Sun and for the planet Venus.



(a) Explain why the EM radiation emitted from the Sun has a shorter wavelength than the EM radiation emitted from Venus.

....

....

....

.... **[2]**

Candidates did not perform well on this question as the majority of candidates achieved 0 marks. Candidates had to explain that the wavelength of the electromagnetic radiation emitted depended on the temperature (as the intensity of radiation was the same for both the Sun and Venus), and that as the Sun had a shorter (peak) wavelength of radiation it had a greater surface temperature compared to Venus. Most typical responses related wavelength to frequency by applying the wave speed equation. Some candidates confused the question by describing that the difference in wavelength was due to red-shift.

Question 9 (b)

(b) The table shows the range of frequencies for different types of EM radiation.

Type of EM radiation	Approximate range of frequencies (Hz)
Radio and microwaves	3.0×10^3 to 3.0×10^{11}
Infrared	3.0×10^{11} to 4.3×10^{14}
Visible light	4.3×10^{14} to 7.9×10^{14}
Ultraviolet (UV)	7.9×10^{14} to 3.0×10^{17}
X rays and Gamma rays	3.0×10^{17} and above

Determine the type of EM radiation, emitted from **Venus**, that has the greatest intensity.

Use the graph and the table.

Use the Equation Sheet.

Speed of light in a vacuum = 3.0×10^8 m/s

Type of EM radiation = ... **[4]**

Performance on this question was variable and around a third of candidates achieved 0 marks as they either did not select and apply the equation wave speed = frequency × wavelength or correctly convert the wavelength of radiation emitted from Venus. For candidates to determine the type of radiation emitted from Venus, they first had to read off the correct wavelength of radiation emitted from Venus from the graph as 4 µm, but most candidates did not use the graph and just attempted to use values given in the table. Around a quarter of candidates did correctly use the graph but did not convert µm to m and as result they calculated the frequency of the radiation as 7.5×10^7 Hz to conclude that the type of radiation was in the radio and microwave range of values, which was given 3 marks.

Only a small number of candidates, mostly higher achieving candidates, correctly converted the wavelength to calculate the value of frequency of 7.5×10^{13} Hz to conclude that the type of EM radiation emitted from Venus was infrared radiation and achieved 4 marks. Some candidates attempted to calculate frequency at each boundary between the different types of EM radiation. While this was a valid method, they did not compare their calculated values of the wavelength for each type of EM radiation to 4 µm to make a correct conclusion that Venus emitted infrared radiation.

Question 9 (c)

(c) The atmosphere of Venus is filled with carbon dioxide CO_2 which is a greenhouse gas.

The surface temperature of Venus is the highest of all the planets in the solar system.

Explain how the presence of CO_2 causes the high temperature on Venus.

....

....

....

....

....

.... **[3]**

Candidates did not perform well on this question as the majority of all candidates achieved 0 marks. Candidates had to explain that the atmosphere allows some of the electromagnetic radiation (ultraviolet or light) emitted by the Sun to pass through. This radiation warms Venus's surface when it is absorbed. The radiation emitted by Venus, which has a lower principal frequency than that emitted by the Sun (which is infrared radiation), is then absorbed and re-emitted in all directions by the CO_2 in the atmosphere which causes a high temperature on Venus.

Most typical responses given by candidates described the atmosphere as an insulating layer of CO_2 where heat from the Sun was trapped, which then in turn caused a high temperature on Venus.

Exemplar 3

CO_2 is a greehouse gas, the sun emits mostly high frequency radiation like UV or visible light towards Venus, the greenhouse gases ~~&~~ mostly does not absorb these radiation, so the radiation is absorbed by Venus and Venus ~~emits~~ emits lower frequency radiation like infrared radiation, the ~~great~~ greehouse gases absorbs these lower frequency radiations and ~~&~~ re emits it in all direction including back towards Venus so heat is trapped on Venus **[3]**

Exemplar 3 shows a fully correct response where the candidate demonstrates a clear understanding of the greenhouse effect applied to the atmosphere of Venus. This candidate demonstrates confident and correct use of specific scientific terminology such as 'emit', 'absorb', 'frequency' and types of EM radiations, to explain why the presence of CO_2 causes a high temperature on Venus due to the greenhouse effect.

Disciplinary literacy

Similarly to Question 7 (b) (i), this question highlights the necessity and importance of using specific scientific terminology to explain the scientific concept of the greenhouse effect that is being assessed by the context of carbon dioxide in the atmosphere of Venus. For candidates to achieve marks they must have a strong understanding of scientific vocabulary including both tier 2 words and tier 3 science specific vocabulary.

Supporting students with their vocabulary knowledge through different teaching strategies will help students to have the confidence to tackle more challenging exam questions, especially when a specific scientific concept is being assessed in a different context such as the question above.

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on
01223 553998

Alternatively, you can email us on
support@ocr.org.uk

For more information visit
- **ocr.org.uk/qualifications/resource-finder**
- **ocr.org.uk**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Access to Scripts

We've made it easier for Exams Officers to download copies of your candidates' completed papers or 'scripts'. Your centre can use these scripts to decide whether to request a review of marking and to support teaching and learning.

Our free, on-demand service, Access to Scripts is available via our single sign-on service, My Cambridge. Step-by-step instructions are on our website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular professional development courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is a free test-building platform, providing unlimited users exclusively for staff at OCR centres with an Interchange account.

Choose from a large bank of questions to build personalised tests and custom mark schemes, with the option to add custom cover pages to simulate real examinations. You can also edit and download complete past papers.

Find out more.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals (examined units only).

Find out more.

You will need an Interchange account to access our digital products. If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.