Qualification Accredited

OCR
Oxford Cambridge and RSA

Examiners' report

GCSE

GATEWAY SCIENCE PHYSICS A

OCR Level 1/Level 2 GCSE (9-1) in Physics A (Gateway Science)

J249

For first teaching in 2016

J249/04 Summer 2025 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 responses 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 Teach Cambridge.

Paper 4 series overview

J249/04 is the second of the two Higher Tier papers for GCSE (9–1) Physics A (Gateway Science). Question 16 is the overlap question with the Foundation tier paper J249/02.

J249/04 covers the topics:

- P5 Waves in matter
- P6 Radioactivity
- P7 Energy
- P8 Global challenges
- CS7 Practical Skills

The vast majority of candidates completed all questions in the examination within the allotted time. To do well on this paper, candidates needed to able to use the Equation Sheet to identify the correct equations, manipulate these equations and be comfortable applying their knowledge and understanding to both familiar and unfamiliar contexts and practical science activities.

Many candidates showed their calculations in numerical questions in Section B and also made a good attempt at the Level of Response question.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• identified and applied or manipulated equations • demonstrated knowledge of scientific procedures based on, e.g. pendulums and radioactivity • had a good understanding of how transformers work.	• found it challenging to rearrange equations with four terms correctly • gave answers which indicated that they may have read questions carefully • gave answers that were too vague, especially those about scientific procedures • lacked the necessary knowledge about fission and fusion to respond in depth to the Level of Response question.

Section A overview

Section A consists of ten multiple-choice questions, concentrating on Assessment Objectives 1 and 2 (AO1 and AO2).

Nearly all candidates attempted all of the questions.

Candidates need to be aware that when they write their response in the answer box, if they do not clearly write the letter, especially when writing 'B' or 'D', no credit will be given. If a candidate changes their mind about a response, they need to cross out their initial answer and write their final response next to the answer box.

Assessment for learning

Candidates who did well on this section did the following:

- underlined keywords
- worked through the distractors methodically, e.g. by eliminating those they believed to be the most obviously incorrect responses
- wrote the letters clearly, especially to distinguish between B and D.

Question 2

2 A sound wave travels from air to water. The speed of the sound wave is directly proportional to its wavelength.

The wavelength of the sound wave in air is 80 cm.

The speed of the sound wave increases by a factor of 4 when it enters the water.

What is the wavelength of the sound wave in the water?

A 20 cm

B 40 cm

C 160 cm

D 320 cm

Your answer ☐ **[1]**

Candidates of all performance levels performed well on this question and were able to apply the directly proportional relationship between speed and wavelength correctly.

Question 4

4 A scientist is doing an experiment using a radioactive source that emits only gamma rays.

Which safety procedure does **not** reduce irradiation of the scientist?

A The scientist places a lead shield between themselves and the source.

B The scientist points the source away from them.

C The scientist uses very long tongs to handle the source.

D The scientist wears gloves while handling the source.

Your answer ☐ **[1]**

The majority of candidates found this question challenging. They possibly confused irradiation with contamination. The most common incorrect answer was option **B**.

Question 5

5 Red light has a maximum wavelength of 750 nm.

Which part of the electromagnetic spectrum contains radiation with a wavelength of 850 nm?

A infrared

B ultraviolet

C visible light

D X-ray

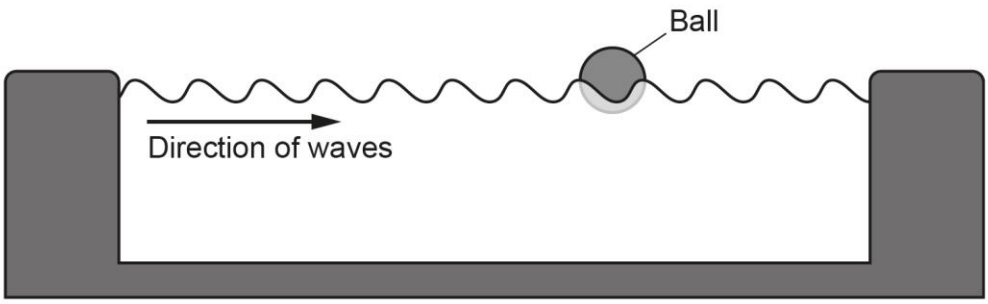
Your answer ☐ **[1]**

This question required candidates to recall the part of the electromagnetic spectrum that had a wavelength slightly longer than red light. Most candidates did not answer the question correctly. Incorrect answers were fairly evenly spread over options **B**, **C** and **D**, indicating some guesswork.

Question 6

6 A ball is floating on the surface of some water.

Waves are created on the surface of the water as shown.



Which arrow shows the direction of movement of the ball due to the water waves?

A 

B 

C 

D 

Your answer ☐ **[1]**

Although the majority of candidates knew that the ball would move in a direction perpendicular to the direction of the waves, many candidates incorrectly thought that the ball would move parallel to the direction of the waves and chose option **B** or option **C**.

Question 10

10 Which value is equal to 450 μJ of energy?

A 4.5×10^{-6} J

B 4.5×10^{-5} J

C 4.5×10^{-4} J

D 4.5×10^{-3} J

Your answer ☐ **[1]**

Candidates found this question challenging. The most common incorrect answer was option **A**, indicating that although many candidates appeared to recognise that the prefix 'micro' is 10^{-6}, they did not take into account that the question asked about 450 μJ and not 4.5 μJ.

Question 11

11 Which row describes how a nucleus of an atom changes when a beta particle is emitted?

	Number of neutrons	Number of protons	Total number of protons and neutrons
A	decreases	increases	changes
B	decreases	increases	stays the same
C	increases	decreases	changes
D	increases	decreases	stays the same

Your answer ☐ **[1]**

This question discriminated well with most of the highest performing candidates choosing the correct answer. Incorrect answers from other candidates were fairly evenly spread over options **A**, **C** and **D**, indicating some guesswork.

Question 14

14 The energy released from the fission of a single uranium-235 nucleus is 3.2×10^{-11} J.

A uranium-235 nucleus splits and releases 3 neutrons, causing a chain reaction.

These neutrons are absorbed by 3 further uranium-235 nuclei causing these nuclei to split.

What is the total energy released?

A 6.4×10^{-11} J

B 9.6×10^{-11} J

C 1.3×10^{-10} J

D 2.9×10^{-10} J

Your answer ☐ **[1]**

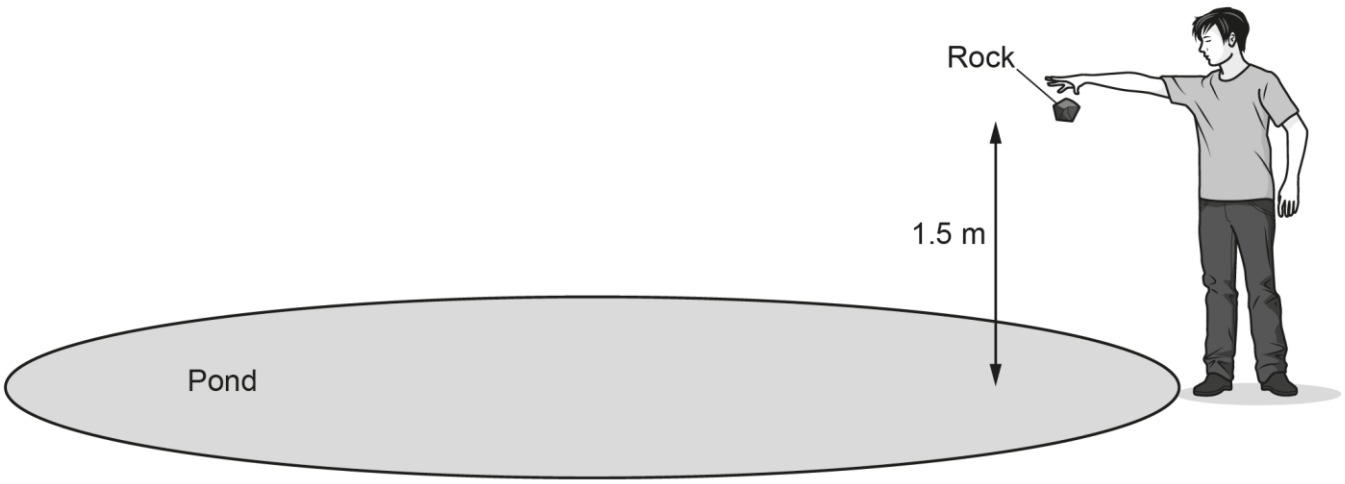
This question required candidates to determine the total energy released when 4 uranium nuclei split. Many candidates did not take into account the first uranium nucleus splitting and therefore incorrectly chose option **B**.

Section B overview

Section B consists of question covering all of the assessment objectives. It was pleasing to see more candidates writing down their calculations for the numerical questions, especially if the equation needed to be rearranged in order to work out the final answer.

Question 16 (a)

16 A student drops a rock into a pond from a height of 1.5 m.



(a) When the rock hits the water, it makes a sound. At the same time ripples form on the surface of the water.

The sound and the ripples are different types of waves.

Complete the table to describe the two waves.

	Type of wave	Direction of particle vibration
Sound	.....	Particles vibrate ..... to wave direction
Water ripples	.....	Particles vibrate ..... to wave direction

[4]

Question 16 was the first of the two overlap questions with the Foundation Tier paper. Candidates performed well in part (a) with the majority identifying the correct type of wave and the direction of particle vibration, therefore gaining full credit. Vague descriptions of the direction of particle vibration, such as up and down or back and forth, did not gain credit.

Question 16 (b) (i)

(b) The student drops an identical rock from a height of 2.0 m.

The student notices that the ripples produced by this rock have a larger amplitude than the ripples produced by the first rock.

(i) Explain why the rock dropped from a greater height produces ripples with a larger amplitude.

.....

.....

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

The majority of candidates were credited at least 1 mark, usually for referring to the rock having more kinetic energy or a higher speed. Many candidates did not mention energy but gained credit for the idea of more force.

Question 16 (b) (ii)

(ii) Describe how the student uses a metre ruler and a stop clock to determine the speed of the ripples.

.....

.....

.....

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

This question assessed candidates' working scientifically skills.

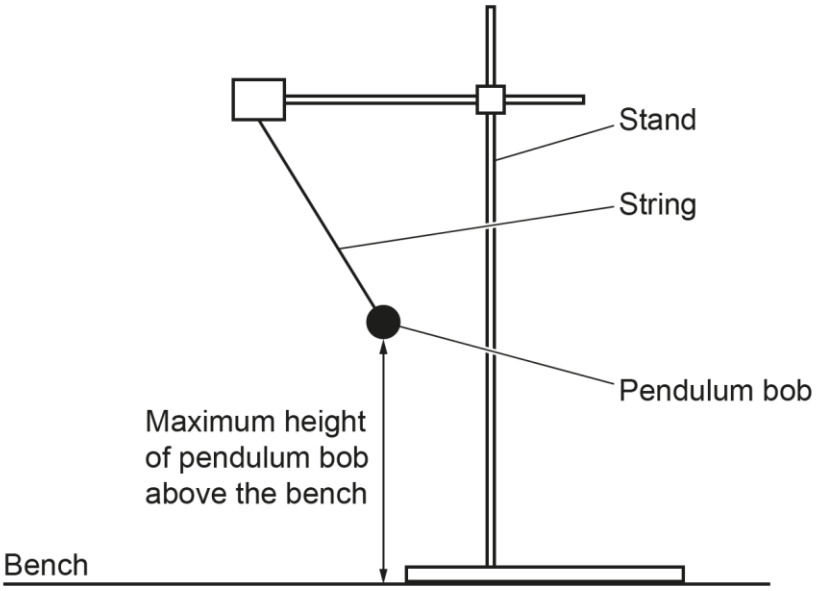
All candidates attempted this question. The majority of candidates were credited at least 1 mark, usually for stating a correct equation. However, many candidates did not explain how to carry out the practical activity in sufficient detail. For example, candidates included vague statements such as measure wavelength or frequency, without describing how this would be done. Lower quality of communication and lack of detail resulted in lower achieving candidates gaining few marks.

Assessment for learning

Candidates may benefit from activities where they are provided with a practical activity and asked to write a short but detailed method.

Question 17 (a)

17 The diagram shows a pendulum bob attached to a stand using string.



A student lifts the pendulum bob to the position shown on the diagram.

The student then releases the pendulum bob so that it swings freely.

(a) The student notices that the maximum height of the pendulum bob above the bench decreases after each swing.

Explain why the maximum height of the pendulum bob decreases after each swing.

.....

.....

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

Question 17 was the second overlap question with the Foundation Tier paper. Candidates found part (a) very challenging, with few credited more than 1 mark. There were many descriptions of the energy transfers between the gravitational potential store and the kinetic store, but not to the thermal store. The most common mark scored was for mentioning air resistance.

Misconception

A common misconception was that the force due to gravity reduces the speed of the pendulum and therefore reduces its maximum height after each swing.

Question 17 (b) (i) and (ii)

(b) The student holds a metre ruler behind the swinging pendulum bob and measures the maximum height of the pendulum bob above the bench.

(i) Give **two** reasons why the student's method might **not** give an **accurate** value for the maximum height of the pendulum bob.

1 .....

.....

2 .....

.....

[2]

(ii) Describe **two** ways to improve the student's method to obtain a more accurate value of the maximum height of the pendulum bob at the end of each swing.

1 .....

.....

2 .....

.....

[2]

Candidates found Question 17 (b) challenging. In part (i), there were many vague references to 'human error', 'reaction time error' and 'not repeating readings'. The most common creditworthy statements referred to the difficulty in reading the scale while the bob was moving, and the ruler not being vertical.

Very few candidates gained full credit in part (ii) and a wide variety of vague or incorrect suggestions were seen, for example, catching the pendulum bob, using technology/computer/robots/light gates. Many candidates suggested repeating the results and calculating the mean but this would not improve the accuracy. The most common creditworthy answers referred to taking a video or picture of the motion and clamping the ruler in place.

Question 18 (b)

(b) The telescope is accelerating towards the Sun.

Explain why the telescope is accelerating even though its speed remains constant.

.....

.....

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

Most candidates were credited at least 1 mark, usually for recognising that the direction was constantly changing.

Question 18 (c) and (d)

(c) The James Webb space telescope is always within 1.5 million kilometres of the Earth.

The telescope is in constant use by scientists on the Earth.

Suggest a reason why it is important for the telescope to remain close to the Earth.

.....

..... **[1]**

(d) The James Webb space telescope detects electromagnetic radiation from stars and galaxies.

Some telescopes on the Earth's surface also detect electromagnetic radiation from stars and galaxies.

Describe an advantage of using the James Webb space telescope to detect this radiation instead of a telescope on the Earth's surface.

.....

.....

..... **[1]**

Candidates found Questions 18 (c) and (d) challenging, with many failing to gain any credit.

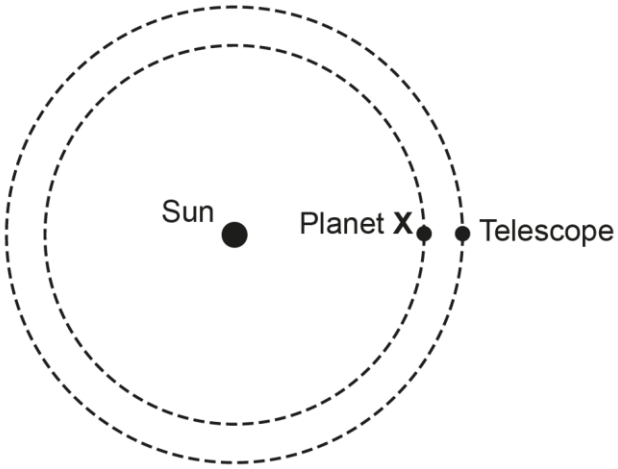
Misconception

? A common misconception in part (c) was that the telescope would 'float off' into space if it were not close to the Earth. In part (d), there was the misconception that the James Webb telescope was a lot closer to other galaxies and would therefore get a clearer picture of them.

Question 18 (e)

(e) **Fig. 18.2** shows the paths of the orbits around the Sun of both the James Webb space telescope and a planet labelled **X**.

Fig. 18.2



Not to scale

Compare the speeds of planet **X** and the telescope.

Explain your answer.

.....

.....

.....

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

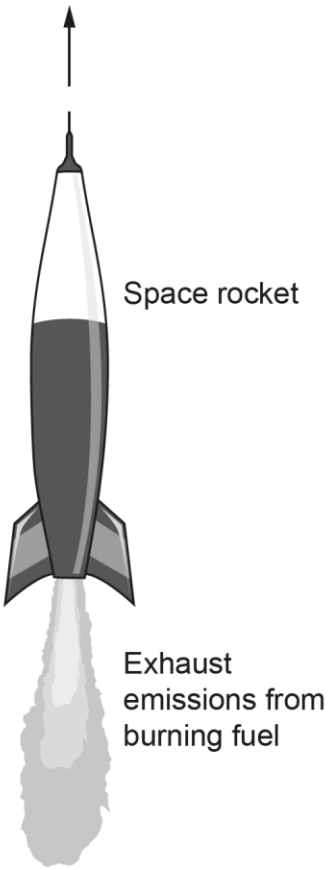
Most candidates were credited at least 1 mark in this question. Some candidates, however, incorrectly thought that the telescope would travel faster in order for it to stay in the same place relative to planet **X**.

Question 19 (a)

19 A student researches rockets.

Fig. 19.1 shows a rocket burning fuel as it moves away from the Earth.

Fig. 19.1



The rocket accelerates vertically upwards.

Fig. 19.2 shows how the energy in the chemical store of the fuel is transferred to other energy stores in the rocket and in the surroundings.

Fig. 19.2

(a) The energy in the gravitational potential store of the rocket increases as the rocket accelerates vertically upwards.

Why does the energy in the gravitational potential store of the rocket increase?

..... **[1]**

Most candidates stated that the energy in the gravitational potential store of the rocket increased because the height of the rocket increased.

Misconception

Some candidates had the misconception that the value of the gravitational field strength also increased and therefore caused the energy in the gravitational potential store to increase.

Question 19 (c) (ii)

(ii) When the fuel burns, 320 MJ of energy is wasted in one second.

Calculate the efficiency of the rocket.

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

Efficiency = ... **[3]**

The majority of candidates gained full credit but some candidates used the value for the wasted energy given in the question, instead of the useful output energy, in the equation.

Question 19 (d) (i)

(d)

(i) The student finds out that:

- the energy in the kinetic store of the rocket increases by 1.2×10^8 J every second as the fuel burns
- the initial mass of the rocket is 8.5×10^4 kg.

Calculate the minimum speed of the rocket after the fuel has been burning for 12 seconds if the rocket starts at rest.

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

Speed = ... m/s **[4]**

This question was very well attempted by all candidates and full working was written down by the majority of candidates. Some candidates calculated $E = \frac{1}{2}mv^2$ without taking account of the 12 seconds. They then tried to account for this at the end, which was credited 3 marks. There were a number of small errors that candidates made but, due to working being shown, compensatory marks could be awarded.

Assessment for learning

Candidates should, as always, note how essential it is to write down every step of their workings so that compensatory marks can be awarded if the final answer is incorrect.

Exemplar 1

$\sqrt{\frac{\text{kinetic energy}}{\frac{1}{2} \times \text{mass}}}$

$\sqrt{\frac{1.2 \times 10^8 \times 12}{\frac{1}{2} \times (8.5 \times 10^4)}} = 5205.748313$

Speed = 5206 m/s **[4]**

This response achieved 3 out of the 4 marks and highlights the importance of the candidate showing all of their working. The final answer was incorrect so only compensatory marks can be awarded from the working. The candidate has clearly found the total kinetic energy gained and then substituted and rearranged correctly for 3 marks. The only error the candidate made was in the final answer, presumably when entering the values into a calculator.

Question 19 (d) (ii)

(ii) Explain why the actual speed of the rocket after the fuel has been burning for 12 seconds is **greater** than the value calculated in **(d)(i)**.

.....

.....

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

The majority of candidates found this question challenging with few candidates being credited more than 1 mark - for stating that the mass decreases.

A few candidates had the correct idea that the actual speed would be greater because the kinetic energy would be divided by a smaller mass, but they did not gain the second mark as they also needed to say that the value of the kinetic energy after 12 seconds had not changed.

Question 20 (a) (i)

20 A technician investigates an unknown radioactive metal as shown in **Fig. 20.1**.

Fig. 20.1

(a)

(i) Describe how the technician obtains a precise measurement of the count rate from the radioactive metal.

Include the name of any extra equipment the technician uses.

You may draw on **Fig. 20.1**.

.....

.....

.....

.....

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

This question assessed candidates' working scientifically skills. Nearly all candidates attempted this question but many found it challenging.

Most candidates gained just 1 mark for the mention of a radiation detector.

Question 20 (a) (ii)

(ii) Explain how the technician shows that the radioactive metal emits **only** gamma radiation.

Include the name of any extra equipment the technician uses.

.....

.....

.....

.....

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

This question was well attempted but few candidates gained full credit due to their explanations lacking specific detail, for example, that **only** gamma radiation can pass through thin aluminium.

Question 20 (b) (i)

(b) The technician thinks that the radioactive metal is one of the four metals shown in **Table 20.1**.

Table 20.1

Metal	Nuclear radiation emitted	Half-life
A	gamma	4 hours
B	gamma	10 years
C	gamma	2 years
D	gamma	28 days

(i) The technician uses equal masses of each metal in **Table 20.1**.

Explain which metal in **Table 20.1** is likely to be the most hazardous to the technician while doing the experiment.

Metal .....

Explanation .....

.....

[2]

The majority of candidates incorrectly chose metal **B**, presumably due to it having the longest half-life.

Question 21 (b)*

(b)* Scientists think that nuclear **fusion** would be a better energy source than nuclear **fission**.

The table gives information about nuclear fission power stations and nuclear fusion power stations.

Type of power station	Fuel used	Power output from power station (W)	Waste products
Nuclear fission	uranium	1.0×10^9	very radioactive with long half life
Nuclear fusion	hydrogen	1.3×10^9 (expected)	slightly radioactive with short half life

Use the information in the table to compare a nuclear fission power station with a nuclear fusion power station.

In your answer, write about

- differences between a fission reaction and a fusion reaction
- the benefits of using nuclear fusion instead of fission
- the difficulties associated with using nuclear fusion.

.....

.....

.....

.....

.....

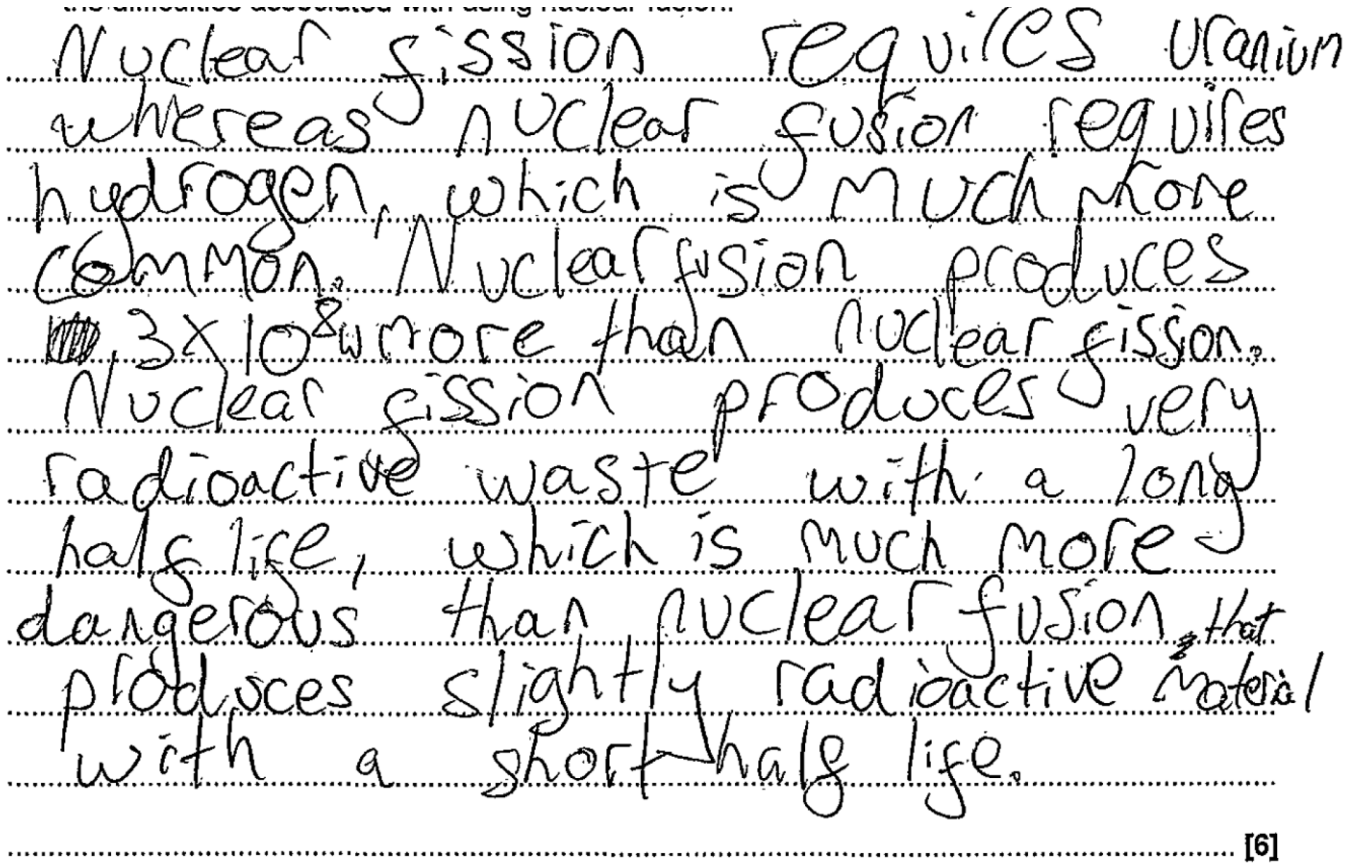
.....

..... **[6]**

The Level of Response question assessed AO1 and AO3 and all candidates attempted it. The question discriminated well, with many of the higher performing candidates giving detailed enough descriptions to gain Level 3. Most candidates were credited at least 2 marks for a basic description of the difference between fission and fusion, or for a basic comparison of the benefits and disadvantages. However, lower quality of communication (e.g. use of the term atom/molecules instead of nuclei), lack of a clear, logical structure and some misconceptions about fission and fusion prevented some candidates from gaining the higher levels.

Most candidates demonstrated a very good interpretation of the information given in the table. However, a number of candidates did not include a description of the differences between fission and fusion, as stated in the question. This capped their mark at Level 1.

Exemplar 2


Nuclear fission requires uranium whereas nuclear fusion requires hydrogen, which is much more common. Nuclear fusion produces 3×10^8 more than nuclear fission. Nuclear fission produces very radioactive waste with a long half life, which is much more dangerous than nuclear fusion, that produces slightly radioactive material with a short half life.

[6]

This response achieved Level 1, 2 marks as it only includes basic comparisons of the benefits of nuclear fusion. As the candidate has written nothing about the processes of fission and fusion, their answer would be capped at Level 1.

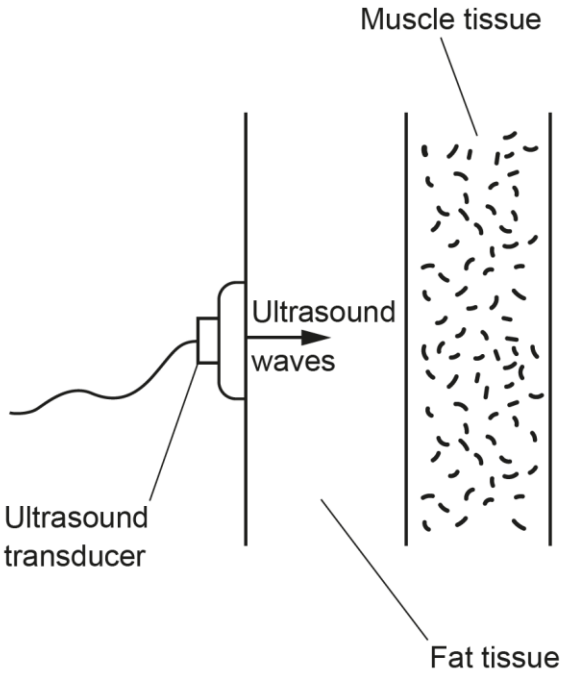
To progress to Level 2, the candidate must include at least a basic description of fission and fusion and clear comparisons of the benefits and disadvantages of nuclear fusion.

Question 22 (a)

22 Ultrasound waves are used to produce images of the inside of the human body.

The ultrasound waves reflect from the boundary between two different materials inside the human body.

The diagram shows an ultrasound transducer that emits and receives ultrasound waves.



A computer is connected to the ultrasound transducer.

The computer records a time of 2.8×10^{-7} s between emitting one ultrasound wave and receiving the reflection of this wave from the boundary between the fat tissue and the muscle tissue.

The speed of ultrasound waves in fat tissue is 1500 m/s.

(a) Calculate the thickness of the fat tissue.

Use the Equation Sheet.

Thickness of fat tissue = ... m **[3]**

The majority of candidates were able to select the correct equation from the Equation Sheet and were credited at least 2 out of the 3 marks. The most common error was to use the time recorded between the pulse being emitted and being received, instead of halving this time.

Question 22 (b)

(b) The wavelength of the ultrasound wave in the fat tissue is 4.3×10^{-4} m.

Calculate the frequency of the ultrasound wave.

Use the equation: wave speed = frequency × wavelength

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

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

The vast majority of candidates were able to rearrange the equation correctly and gained full credit. The most common error was not giving the final answer to 2 significant figures.

Question 22 (c)

(c) When the ultrasound wave hits the boundary between the fat tissue and the denser muscle tissue, the ultrasound wave is partially reflected and partially transmitted.

The transmitted ultrasound wave continues into the denser muscle tissue.

Explain the change in wavelength of the ultrasound wave as it passes from fat tissue into muscle tissue.

.....

.....

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

The majority of candidates found it challenging to explain what happens to a sound wave when it travels into a more dense material.

Misconception

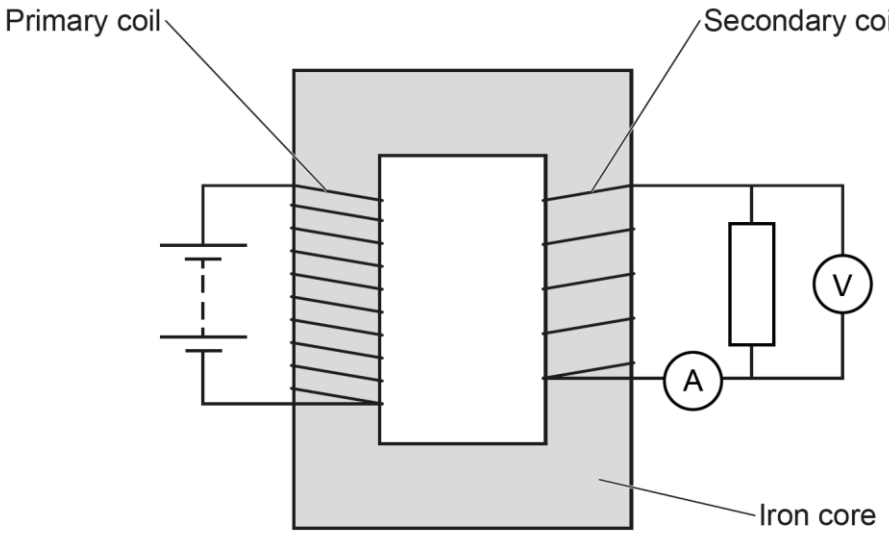
Most candidates had the misconception that a sound wave travels more slowly in a more dense material, and therefore the wavelength of the sound wave decreases.

Question 23 (a)

23 A student investigates the relationship between

- the number of turns of wire on the secondary coil of a transformer
- the potential difference across the secondary coil
- the current in the secondary coil.

The diagram shows the equipment the student uses to make their transformer.



(a) When the battery is connected to the primary coil the transformer does **not** work and the voltmeter reads zero.

Describe what change the student needs to make to their equipment so that the voltmeter shows that there is a continuous potential difference across the secondary coil.

Explain your answer.

Change .....

.....

Explanation .....

.....

[2]

Most candidates found this question very challenging with only the highest performing candidates gaining full credit. Candidates appeared to have a limited understanding of how transformers work and did not appreciate that an alternating current was required in the primary coil. Incorrect responses varied from the ammeter and voltmeter being connected in the wrong places to removing the resistor.

Misconception

? Many candidates have the misconception that the primary coil is directly connected to the secondary coil.

Question 23 (b) (i)

(b) The student changes the equipment in the diagram so that the transformer works.

The student obtains the results shown in the table.

Number of turns on secondary coil	Potential difference across secondary coil (V)	Current in secondary coil (A)
160	6.4	0.47
120	4.8	
80	3.2	0.94

(i) Describe the relationship between the number of turns on the secondary coil and the potential difference across the secondary coil.

.....

.....

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

Candidates were able to describe the relationship correctly with nearly all candidates credited at least 1 mark.

Question 23 (b) (ii)

(ii) Calculate the current in the secondary coil when there are 120 turns on the secondary coil.

Assume the transformer is 100% efficient.

Use the Equation Sheet.

Current = ... A **[3]**

Many candidates found the calculation required for this question challenging and therefore selected the wrong equation from the Equation Sheet. Those who chose the correct equation mostly achieved full credit if they could rearrange the equation successfully. However, many candidates selected the equation linking the number of turns and the potential differences for the primary and secondary coils, so did not gain any credit.

Assessment for learning

Candidates appear to find rearranging equations that contain four terms challenging, especially the equations used with transformers. Candidates may benefit from practising rearranging these equations in order to make each of the terms the subject of the equation.

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 the exam paper builder platform for a range of our qualifications. Find out more.

Free for all OCR centres with an Interchange account, it allows unlimited users per centre. We require an Interchange username to verify your centre's users for ExamBuilder.

If you do not have an Interchange account, please contact your centre administrator (usually the Exams Officer) to request a username.

Once you have an Interchange username, use the form on this page to sign up for ExamBuilder, or ask an existing user at your centre to create an ExamBuilder account for you.

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.

Tell us what you think

Your feedback plays an important role in how we develop, market, support and resource qualifications now and into the future. We want you and your students to enjoy and get the best out of our qualifications and resources, but to do that we need your honest opinions to tell us whether we're on the right track or not.

You can email your thoughts to resources.feedback@ocr.org.uk or visit our feedback page to learn more about how you can help us improve our resources.

Designing and testing in collaboration with you and your students

Helping young people develop an ethical view of the world

Equality, diversity, inclusion and belonging (EDIB) are part of everything we do

---

Contact the team at:

01223 553998

ocr.org.uk

To stay up to date with all the relevant news about our qualifications, register for email updates at ocr.org.uk/updates

Visit our Online Support Centre at support.ocr.org.uk

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT