Qualification Accredited

OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

GATEWAY SCIENCE PHYSICS A

J249

For first teaching in 2016

J249/04 Summer 2024 series

Version 1

ocr.org.uk/science

Contents

Introduction 3
Paper 4 series overview 4
Section A overview 5
Question 2 5
Question 3 6
Question 5 7
Question 9 8
Question 10 9
Question 13 9
Question 16 (a) 10
Question 16 (b) 11
Question 16 (c) 12
Question 17 (a) 12
Question 17 (b) 13
Question 17 (d) 13
Question 18 (a) 14
Question 18 (d) 15
Question 18 (e) 16
Question 18 (f) (ii) 17
Question 19 (b) (i) 17
Question 19 (c) (ii) 18
Question 20 (a) 19
Question 20 (b) (i) 20
Question 20 (b) (ii) 21
Question 21 (b) 22
Question 21 (c)* 23
Question 22 (b) 24
Question 22 (c) (i) 25
Question 22 (c) (ii) 26
Question 22 (d) 27
Question 22 (e) 28
Copyright information 29

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

J249/04 is the second of the two Higher tier papers for GCSE (9–1) Gateway Physics A. 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.

It was pleasing to see many candidates showing their calculations in numerical questions both in Section A and Section B.

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 (e.g. investigating refraction) • analysed and interpreted velocity-time graphs and equated distance to area under the graph.	• found it difficult to rearrange equations with four terms correctly • did not always read questions carefully and gave answers that were too vague • lacked the necessary knowledge about the effect of the Earth's atmosphere on radiation absorbed and emitted 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.

It was pleasing to see some candidates also wrote down their calculations for the numerical multiple-choice questions, especially if the equation needed to be rearranged in order to work out the final answer.

Assessment for learning

Candidates who did well on this section did the following:

- underlined keywords
- wrote 'equation triangles' and/or calculations next to numerical questions
- 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 Which row describes the potential difference for a washing machine and for a battery-operated torch?

	Washing machine	Torch
A	6 V a.c.	6 V a.c.
B	6 V d.c.	230 V d.c.
C	230 V a.c.	230 V d.c.
D	230 V a.c.	6 V d.c.

Your answer ☐ **[1]**

The vast majority of candidates demonstrated an excellent knowledge of the potential difference for a washing machine and for a torch.

Question 3

3 Which factor will **increase** the braking distance of a car travelling on a road?

A Drinking alcohol

B Driving when tired

C More people in the car

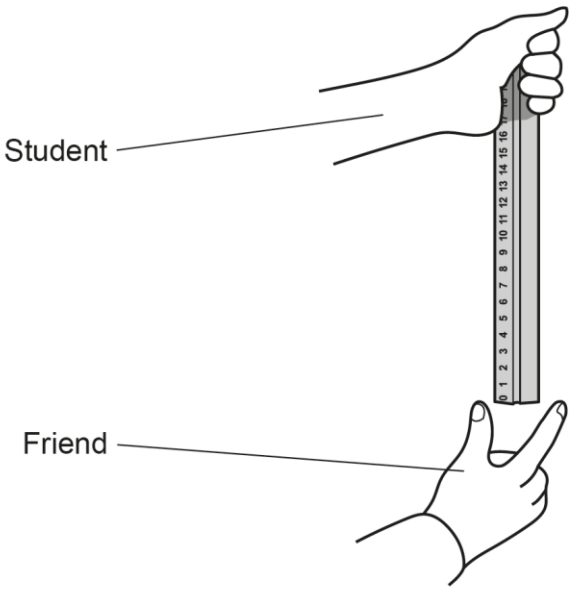
D Using new brake pads

Your answer ☐ **[1]**

Most candidates discarded options A and B as they knew that both of these factors only affected thinking distance. However, a common error was to choose option D.

Question 5

5 A student drops a ruler and a friend catches it.



The reaction time of the friend is calculated from the distance the ruler has fallen. The experiment is repeated.

What does the student do to determine an accurate value for the reaction time?

A Check the reaction time with a stopwatch

B Drop the ruler at random times

C Drop the ruler from different heights above the friend's hand

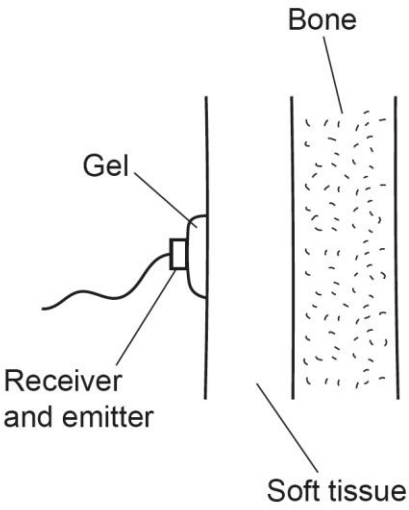
D Tell the friend when the ruler will be dropped

Your answer ☐ **[1]**

Although the majority of candidates answered this correctly, a common error was option A as some candidates thought that reaction time can be measured accurately with a stopwatch.

Question 9

9 The diagram shows a patient having an ultrasound scan.



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

The echo from the boundary between the soft tissue and the bone is received 2.0×10^{-5} s after the ultrasound is emitted.

What is the thickness of the soft tissue?

Ignore the thickness of the gel.

Use the equation: distance travelled = speed × time

A 0.015 m

B 0.030 m

C 0.060 m

D 0.075 m

Your answer ☐ **[1]**

Nearly all candidates were able to substitute the values into the equation provided correctly in order to calculate a distance of 0.030 m. However, the majority of candidates did not take into account that the distance they had calculated was from the emitter to the soft tissue-bone boundary and back to the receiver, and therefore they made the common error of not halving their answer.

Question 10

10 Which answer shows 800 km/h converted into m/s?

A 0.22 m/s

B 13.3 m/s

C 222 m/s

D 13333 m/s

Your answer ☐ **[1]**

This question required students to convert between km/h and m/s. Candidates usually find converting compound units challenging so it was pleasing to see that the majority of candidates were able to do this correctly.

Question 13

13 In one month a wind turbine on a house generates 300 kWh of useful energy.

The efficiency of the wind turbine is 0.60.

What is the wasted energy in one month?

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

A 120 kWh

B 180 kWh

C 200 kWh

D 450 kWh

Your answer ☐ **[1]**

In this question, candidates were required to rearrange the equation given to find the input energy. They then had to subtract the useful energy from the input energy to calculate the wasted energy. The most common errors of option A and option B involved rearranging the equation incorrectly.

Question 16 (a)

16 This question is about how electricity is transferred from a power station to homes.

(a) Draw:

- **one** line to connect **each** type of transformer with the **one** box that describes what it does
- **one** line to connect what each type of transformer does with the **one** box that gives the reason for its use.

Type of transformer	What it does	Reason for its use
Step-down transformer	Decreases current	For safety
Step-up transformer	Decreases potential difference	Increases heat losses
	Generates current	Reduces heat losses

[2]

Question 16 was an overlap question with the Foundation tier paper. Part (a) discriminated very well, with the higher-achieving candidates gaining full credit. Lower-achieving candidates demonstrated less knowledge of both the use of each type of transformer (often thinking that step-down transformers decreased the current), and the reason for its use.

Question 16 (b)

(b) The table shows information for a transformer.

Potential difference across primary coil	132 000 V
Current in secondary coil	1800 A
Potential difference across secondary coil	33 000 V

Calculate the current in the primary coil of the transformer.

Use the Equation Sheet.

Current in primary coil = ... A **[2]**

A number of candidates chose the wrong equation from the Equation Sheet or struggled to rearrange the relevant equation correctly.

Assessment for learning

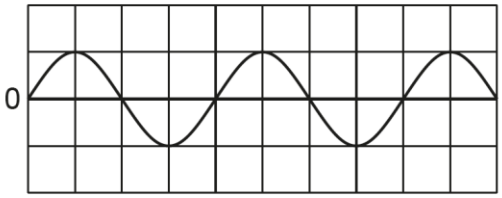
Candidates appear to struggle rearranging equations that contain four terms, especially the equations used with transformers. Candidates would therefore benefit from practising rearranging these equations to make each of the terms the subject of the equation.

Question 16 (c)

(c) A teacher connects the primary coil of a transformer to the domestic mains supply.

The teacher uses an oscilloscope to view the potential difference across the secondary coil of the transformer.

The graph shows the oscilloscope trace.



Use the graph to explain which type of current is supplied by the mains supply.

Type of current .....

Explanation .....

[2]

Most candidates correctly identified the type of current but fewer candidates scored a mark for the explanation. Vague answers such as 'it goes up and down' did not gain credit.

Question 17 (a)

17 In 1986, there was an accident when a nuclear reactor in a power station exploded.

In the explosion, radioactive materials from inside the reactor were spread over the power station.

(a) Explain why workers at the power station were both contaminated **and** irradiated in the accident.

Contaminated because .....

.....

Irradiated because .....

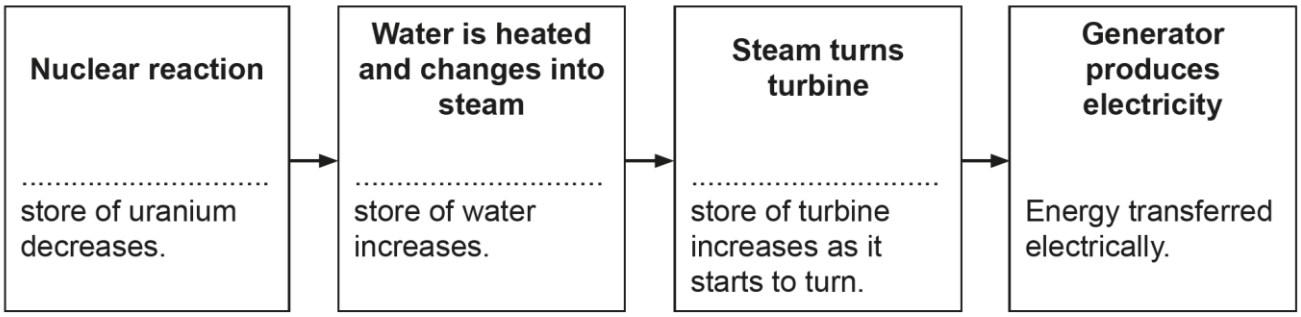
.....

[2]

This area of the specification has clearly been well taught, with most candidates scoring at least 1 mark. Poor quality of communication prevented some candidates gaining full credit.

Question 17 (b)

(b) The flow diagram shows energy transfers when electricity is generated in a nuclear power station.



Complete the flow diagram to show the changes in energy stores. **[3]**

The majority of candidates scored at least 2 marks, mainly for thermal store and kinetic store.

Misconception

A common misconception was that uranium contains a chemical store.

Question 17 (d)

(d) A nuclear reactor needs neutrons to start a nuclear fission reaction.

A plutonium nucleus (Pu) decays into a uranium nucleus (U) and an alpha particle ($^{4}_{2}He$).

The alpha particle then joins with a beryllium nucleus (Be) to produce a carbon nucleus (C) and a neutron (n).

Complete the equations.

$$^{238}_{94}Pu \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}U + {}^{4}_{2}He$$

$$^{9}_{4}Be + {}^{4}_{2}He \longrightarrow {}^{12}_{6}C + {}^{\cdots\cdots}_{\cdots\cdots}n$$

[3]

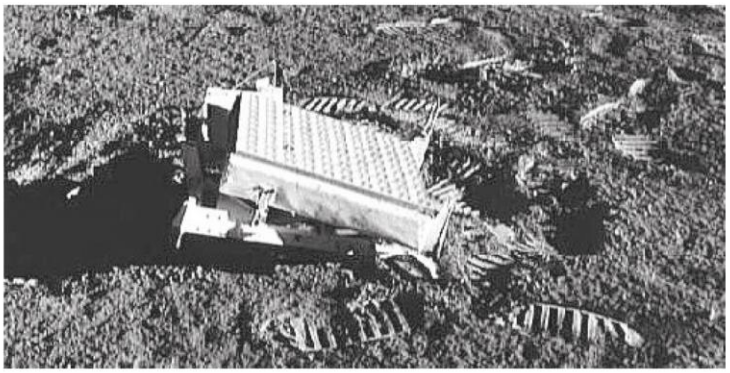
Nearly all candidates were confident in completing the equation for alpha decay. Some candidates lost a mark for the nuclear notation for the neutron, possibly mixing it up with the notation for an electron as they believed that the mass number was -1.

Question 18 (a)

18 A space mission in 1969 placed an object called a retroreflector on the surface of the Moon.

Fig. 18.1 shows the retroreflector.

Fig. 18.1

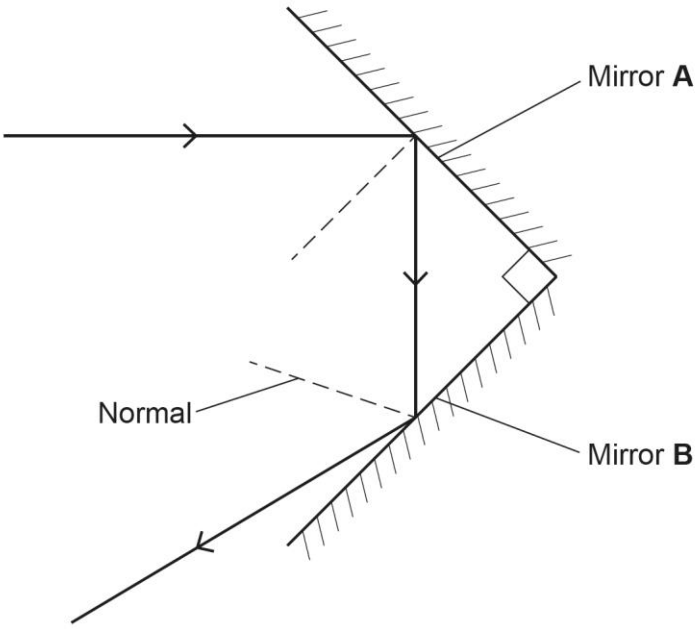


Laser light from the Earth is aimed at the retroreflector and reflects back to the Earth.

(a) A student draws a simple model of a retroreflector using two plane mirrors at right angles to each other.

Fig. 18.2 shows the student's model.

Fig. 18.2



Identify the **two** mistakes the student has made in **Fig. 18.2**.

Mistake 1 .....

.....

Mistake 2 .....

.....

[2]

A significant number of candidates could not apply their knowledge of reflection in enough detail to this question. Answers were often too vague, e.g. the normal is at the wrong angle, so did not gain credit.

Question 18 (d)

(d) A green laser emits light with a wavelength of 5.32×10^{-7} m.

The speed of the green light is 3.0×10^{8} m/s.

Calculate the frequency of the laser light.

Use the Equation Sheet.

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

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

This question required candidates to identify and rearrange the relevant equation from the Equation Sheet to find frequency, and then to give the final answer to 2 significant figures. Candidates performed well on this question, with the majority gaining full credit.

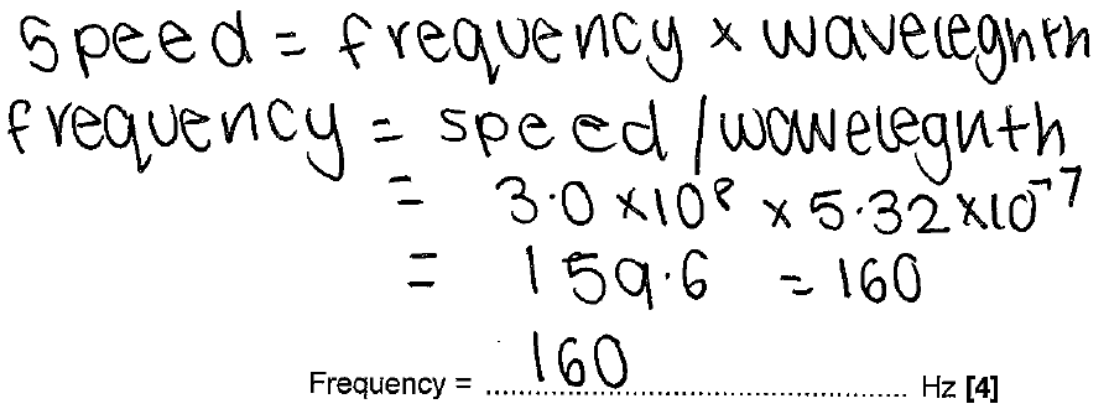
Common errors included:

- incorrectly rearranging the equation
- making an error when using the calculator to give a final answer with an incorrect power of ten
- not giving the final answer to 2 significant figures.

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 given if the final answer is incorrect.

Exemplar 1



The final answer is incorrect and would have scored zero marks if the candidate had not shown their working. The candidate has successfully rearranged the equation, but not substituted the values into it correctly. There is also clear evidence of an incorrect answer given to two significant figures so the candidate scores 2 out of the possible 4 marks.

Question 18 (e)

(e) Recently scientists have aimed infrared lasers at the Moon.

Explain why infrared radiation **cannot** be seen in the sky.

.....

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

A significant number of candidates' explanations used ideas that basically repeated the stem of the question, e.g. infrared radiation is invisible. There were also some misconceptions, e.g. infrared cannot pass through the atmosphere.

Question 18 (f) (ii)

(ii) Water waves are also transverse waves.

A scientist standing near the sea observes water waves moving past them.

Explain how the scientist can measure the **frequency** of the water waves.

.....

.....

.....

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

The majority of candidates gained full credit for the idea of counting the number of waves passing a point in a certain time. The most common errors stemmed from not reading the question carefully enough and changing the scenario, e.g. using a ripple tank and using the equation $f = v \div \lambda$.

Question 19 (b) (i)

(b) The predictions for **winter 2** are:

Lowest predicted system margin = 3.0 GW
Highest predicted system margin = 6.2 GW
Mean predicted system margin = 4.6 GW

(i) Suggest **two** reasons why the national grid predicts a range of values for the system margin.

1 .....

.....

2 .....

.....

[2]

A significant number of candidates appeared not to read the question carefully and did not address what was being asked. Answers were also often too vague, e.g. to prepare for worst case scenarios, instead of recognising that both the supply and the demand can change.

Assessment for learning

Candidates should be encouraged to spend more time reading the question carefully, highlighting key words or phrases.

Question 19 (c) (ii)

(ii) The electrical power that hydroelectric power stations are able to supply can be increased to help meet the customer demand.

On one winter's day:

- the electrical power demanded by customers = 1.0 GW
- the electrical power that can be supplied by a hydroelectric power station = 5.5 GW
- the system margin = 4.5 GW.

The electrical power that the hydroelectric power station is able to supply is then increased so that the system margin is increased by 4.0%.

Calculate the electrical power that the hydroelectric power station is able to supply after the system margin has been increased.

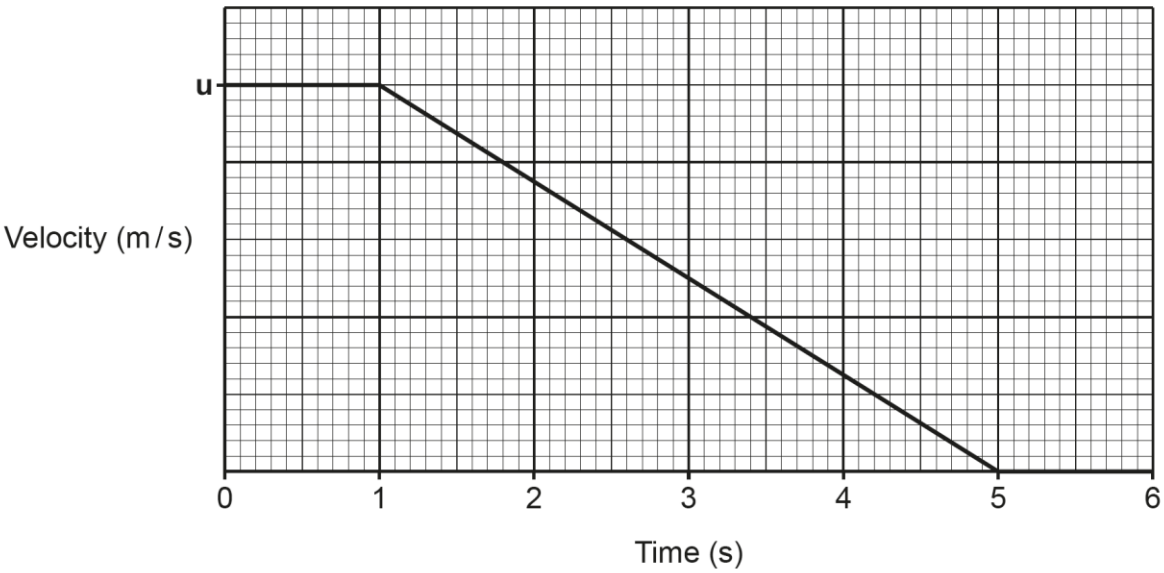
Electrical power supplied = ... GW **[2]**

The majority of candidates gained full credit, but a significant number of candidates appeared to struggle with percentages, often multiplying by 1.4 instead of 1.04. Another common error was forgetting to add on 1.0 GW to the increased system margin.

Question 20 (a)

20

(a) The graph shows how the velocity of car **A** changes when the driver sees a hazard in the road at time = 0 seconds.



The braking distance is 30 m.

Calculate the initial velocity **u** of car **A**.

Use the graph.

Initial velocity **u** = ... m/s **[3]**

This question required candidates to equate the distance travelled to the area under the graph (for the 4 seconds of braking). The majority of candidates did not realise this and did not gain any credit. Some candidates attempted to use an equation of motion or speed = distance ÷ time. A few candidates used the area under the entire graph rather than just the braking distance, but did gain some credit as they had shown their working.

Question 20 (b) (i)

(b) Car **B** brakes and comes to a stop.

(i) The deceleration of car **B** is $6\,m/s^2$.

The initial speed of the car is $18\,m/s$.

Calculate the braking distance of car **B**.

Use the Equation Sheet.

Braking distance = ... m **[3]**

It was good to see that the majority of candidates could select the correct equation from the Equation Sheet and most gained 1 mark from substituting the values into the unrearranged equation. However, rearranging was again an issue, so something candidates need to practise.

Question 20 (b) (ii)

(ii) Estimate the force acting on car **B** when it decelerates at $6\,m/s^2$.

Use the equation: force = mass × acceleration

For the mass in the equation, use an estimate of the mass of car **B**.

Force = ... N **[3]**

The vast majority of candidates scored at least 2 marks for substituting values into the equation and estimating the force acting on car **B**. However, estimates of the mass of the car varied a lot, with values of 6 kg to 600 000 kg seen.

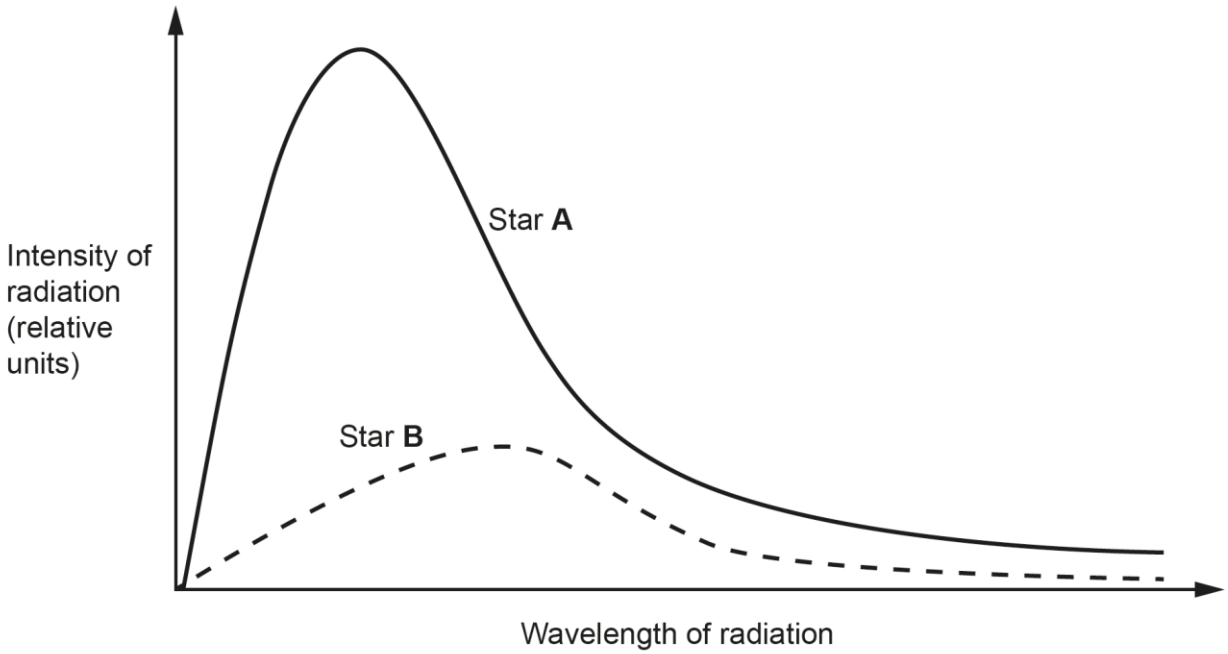
Assessment for learning

Candidates could benefit from short activities where they estimate values of quantities such as the masses and speeds of objects.

Question 21 (b)

(b) All objects emit radiation.

The graph shows how the intensity of the radiation emitted by star **A** and star **B** varies with the wavelength of the radiation.



Describe **two** differences between the graph for star **A** and the graph for star **B**.

1 .....

.....

2 .....

.....

[2]

Question 21 (b) required candidates to analyse the graph. It was well attempted, with most candidates gaining credit for identifying that star **A** has a higher intensity than star **B**. However, only the higher-achieving candidates were able to interpret the second difference, i.e. the graphs peaked in intensity at different wavelengths.

Question 21 (c)*

(c)* Explain why the average temperature of the Earth is increasing.

In your answer, write about:

- the radiation absorbed and emitted by the Earth
- the effect of the Earth's atmosphere.

.....

.....

.....

.....

.....

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

The Level of Response question was of higher demand and assessed AO1 and AO3. The question discriminated well, with only some of the higher-achieving candidates giving detailed enough explanations to gain Level 3. Most candidates scored at least 2 marks for basic ideas about energy being trapped by the Earth's atmosphere instead of being emitted back into space. However, poor quality of communication, lack of a clear, logical structure and some misconceptions prevented them from gaining the higher marks.

Exemplar 2

The sun emits visible light which is mostly absorbed by the Earth but is reflected by some clouds. This visible light increases the temperature of the Earth's atmosphere and it heats up, so the only radiation the Earth can emit is infrared radiation. When the Earth emits infrared radiation, some of it travels ~~to the~~ out of the atmosphere, but some is also reflected back onto the Earth and absorbed by the Earth, further increasing the temperature of the Earth's atmosphere. This is called the greenhouse effect, which is why the average temperature of the Earth is increasing, leading to global warming, rising sea levels and climate change. When infrared radiation increases even further, we call this the enhanced greenhouse effect. [6]

This response achieved Level 1, 2 marks. There are only basic ideas about the radiation emitted travelling out of the atmosphere, some radiation being reflected back and a mention of the greenhouse effect.

To progress to Level 2, the candidate needed to include clear ideas about the Earth emitting less radiation than it absorbs, and more detail about what is reflecting the radiation back to the Earth.

Question 22 (b)

(b) Explain why red light refracts as it enters the glass block.

.....

.....

.....

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

Candidates demonstrated good knowledge of refraction in this question with the majority of candidates achieving at least 1 mark, mainly for identifying that glass is denser than air.

Question 22 (c) (i)

(c) A student uses the red laser and glass block to investigate the relationship between the angle of incidence and angle of refraction for the glass.

The table shows the student's results.

Angle of incidence (°)	Angle of refraction (°)
22	14
34	22
48	30
55	33
62	36

(i) Describe a method the student could have used to investigate this relationship.

You can draw on **Fig. 22.1** to help explain your answer.

.....

.....

.....

.....

.....

..... **[4]**

This question assessed candidates' working scientifically skills.

Nearly all candidates attempted this question, but many did not appear to be very familiar with the practical activity. The question discriminated well between the lower-achieving and higher-achieving candidates. Poor quality of communication and lack of detail resulted in few candidates gaining full credit.

Common errors included:

- vague statements, e.g. measure angles, without adding detail such as the equipment used
- not being explicit as to what they were measuring, e.g. not stating that the angle being measured was between the ray and the normal. Some candidates scored this mark by clearly labelling the angle on Fig. 22.1.

Assessment for learning

Candidates could benefit from starter or plenary activities where they are provided with a practical activity and asked to write a short method, including a list of the equipment and what the equipment measures.

Question 22 (c) (ii)

(ii) The student concludes that the angle of incidence is directly proportional to the angle of refraction.

Show that the student is **incorrect**.

Use data from the table.

.....

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

Many students demonstrated a lack of understanding of how to show if two variables are directly proportional to each other. These candidates often had the misconception that if the differences between corresponding values were not constant, then the variables were not in direct proportion.

To gain credit, candidates could have:

- calculated a ratio from one pair of data values and shown that this was not the same as the ratio calculated from another pair of data values
- found the multiple for one pair of data values and then shown that this would not work for another pair of data values
- shown that if the angle of incidence was multiplied by a factor, then the angle of refraction was not multiplied by the same factor.

Assessment for learning

Candidates should note that they must evaluate the ratios, rather than expressing them as fractions with different denominators.

Question 22 (d)

(d) The student replaces the red laser with a **green** laser and repeats the experiment for the same angles of incidence.

The student notices that the angles of refraction for the green light are all different from the angles of refraction for the red light.

Explain why the angles of refraction are different when light of a different colour is used.

.....

.....

.....

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

Most candidates were able to explain that different colours have different wavelengths/frequencies, although some candidates thought that red light has a shorter wavelength than green light. Only the higher-achieving candidates recognised that the amount the speed changes in glass is different for each colour.

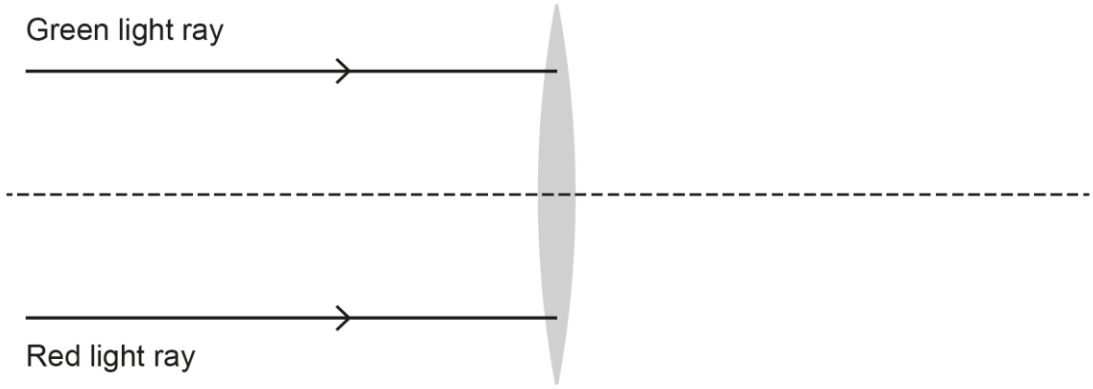
Misconception

A common misconception was that different colours of light have different speeds in air.

Question 22 (e)

(e) The student replaces the glass block with a glass lens and directs both the red and green lasers into the lens at the same time as shown in **Fig. 22.2**.

Fig. 22.2



Complete **Fig. 22.2** by continuing the paths of the red and green light rays. **[2]**

The vast majority of candidates scored at least 1 mark for showing rays that converged as they passed through the lens. However, a significant number of these candidates incorrectly thought that rays of light would converge and meet at the principal axis.

Copyright information

Question 18: Retroreflector on moon, NASA, © GRANGER - Historical Picture Archive / Alamy Stock Photo

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.

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